No. 97024020

MEMORANDUM

TO Mr. K. D. Desai — Richmond, Virginia

FROM W. R. Murray — October 30, 1980

REQUEST FOR ADDITIONAL INFORMATION
SEISMIC DESIGN MARGIN REVIEW
OF NORTH ANNA UNIT 2

As you requested in our recent telephone conversation, a copy of "Seismic Design Margins for Anchorage of Selected Components" is enclosed. This document is referenced on page 1 of the responses provided in our October 17, 1980 submittal.

If you have any questions or require any additional information, please call me at (804) 771-3700.

W. R. Murray

W. R. Murray

WRM/ms:A42

Attachment

cc: Mr. E. C. Rodabaugh (w/attachment)
Mr. E. S. Grecheck
Mr. C. G. Chewning
Mr. E. R. Smith, Jr.

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STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SUMMARY

A5010.62

J.O./W.O./CALCULATION NO.	REVISION	PAGE
11715-STR-059	0	1 OF 114

CLIENT/PROJECT: Vepco/ North Anna Units 1 & 2	QA CATEGORY / CODE CLASS: I
SUBJECT/TITLE: Seismic Design Margins for Anchorage of Selected Components	

SUMMARY

OBJECTIVE OF CALCULATION:

To respond to the portion of NRC FSAR Comment 3.74 concerning the "design margin" for the structural anchorage of selected safety related components under various loading conditions. Design margins were determined by evaluating the magnitude of the forces or stresses due to applied loads, with respect to allowable forces or stresses.

CALCULATION METHOD/ASSUMPTIONS

The method used to compute forces or stresses consisted of treating the component as a rigid free body, and applying the equations for static equilibrium to determine anchorage reactions. These reactions, either in terms of force or stress, were then compared with elastic allowables dictated by the criteria given in the Results Summary

SOURCES OF DATA/EQUATIONS

*1. Component loads: EMD Calc# 11715-297-CBD
2. ACI 318-63 and 71
3. AISC Spec for Design Fab & Erection of Struc Steel for Buildings 69
4. USNRC Standard Review Plan 3.5.5 (NUREG75/087)
5. North Anna FSAR
6. S&W Standard STD-MS-13-3
7. Hilti Fastening Systems Catalogue H-390 6/76

CONCLUSIONS

All component anchorages evaluated were demonstrated to have a "design margin" ≥ 1.0 which by definition means it is acceptable

REVIEWER(S) ~~COMMENTS~~	PREPARER	DATE
RJ Faust RJ Belanger ER Stefaniak (no longer employed by S&W)	[signature]	6/12/78
	REVIEWER / CHECKER: [signatures]	DATE: 6/12/78
	INDEPENDENT REVIEWER	DATE

CALCULATION SUMMARY

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STONE & WEBSTER ENGINEERING CORPORATION

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CLIENT / PROJECT	QA CATEGORY / CODE CLASS
Vepco / North Anna Units 1 & 2	I

SUBJECT / TITLE: Seismic Design Margins for Anchorage of Selected Components

SUMMARY (CONT'D)

OBJECTIVE OF CALCULATION

CALCULATION METHOD/ASSUMPTIONS (CONT'D)

Additional details on methods and assumptions are contained within the computations for each component.

SOURCES OF DATA / EQUATIONS

* Note that the loads input used to prepare these calculations was, at the time, unapproved. These inputs are included here as attachments, and the appropriate attachment is referenced in the text of each computation. An essential element of the review process, at the time this computation was formalized was therefore, to confirm agreement between Calc* 297 & initial inputs

CONCLUSIONS

REVIEWER (S) COMMENTS	PREPARER	DATE
	REVIEWER / CHECKER	DATE
	INDEPENDENT REVIEWER	DATE

TABLE OF CONTENTS*

* Names of preparers & reviewers indicated in parenthesis

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SUBJECT / TITLE	QA CATEGORY / CODE CLASS

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SUBJECT/TITLE	QA CATEGORY/CODE CLASS
	I

RESULTS SUMMARY

REV-0
DATE- 7/21/

ATTACHMENT

VEPCO PROJECT MANAGEMENT

Notes of Telephone Conversation
Surry Power Station - Units 1 & 2

CALL DATE: ____________ TIME: ____________

FROM	TO		
		[illegible]	OF VEPCO
			OF WESTINGHOUSE
		[illegible]	OF STONE & WEBSTER
			OF N. N. I.
			OF

SUBJECT: [illegible]

SUMMARY: [illegible]

[illegible] ROSEMOUNT

THUS [illegible] LETTER [illegible] DATED [illegible] REGARDING ROSEMOUNT

OVERRANGE PROBLEMS ON AUX FEED [illegible] (ROSEMOUNT) APPLIES

ONLY [illegible] ATWS FLOW

TRANSMITTER [illegible]

DISTRIBUTION:

RM BERRYMAN [illegible]
R SMITH [illegible]

T C [illegible]
I. [illegible]
G. [illegible]
R. ARSENAULT
K. KNOLL

SIGNATURE: ____________

.50

FOR INFORMATION ONLY
DO NOT USE FOR DESIGN

Criteria Reference	Maximum Reaction F	Design Margin F_A/F	Seismic Event	Estimated % of Reaction due To Seismic Event
ACI 318-63, Sect 1707 (c)	2173 Kips	1.37	DBE	49
ACI 318-63, Sect 1707 (c)	1895 Kips	1.11	DBE	39
AISC 69 Spec. Sect 1.6.3 plus 1/3 increase	21.5 ksi Tens. 2.9 ksi shear	1.3	DBE	46
SRP 3.8.5 Sect II, 3, c.	701 Kips	1.54	DBE	100
AISC 69 Spec. Sect 1.6.3 plus 1/3 increase	1.83 ksi Tens. .91 ksi shear	14.75	DBE	100
F.S.A.R. SECTION 3.8.1.4	25.44 K	1.14	DBE	75
S&W STD-MS-13-3 (FA ≈ 1/5 manufacturer average ultimate Tension)	2.3K	1.3	DBE	50
SRP 3.8.5 Sect II, 3, C.	494 lb	1.2	DBE	100
AISC 69 Spec. Sect 1.6.3 plus 1/3 increase	9.5 ksi Tens. 2.12 ksi shear	2.8	DBE	90
S&W STD-MS-13-3	980 lb Tens. 946 lb shear	1.05	DBE	100
S&W STD-MS-13-3	181 lb Tens 147 lb shear	5.3	DBE	100
S&W STD-MS-13-3	520 lb Tens 260 lb shear	1.81	DBE	100
S&W STD-MS-13-3	146 lb Tens 149 lb shear	4.46	DBE	100
MANUFACTURER'S RECOMMENDATION	525 lb	2.88	DBE	100
MANUFACTURER'S RECOMMENDATION	940 lb	1.44	DBE	100
	1410 lb	1.08	DBE	100

REV 6/12/78 [illegible]

ORIGINATOR [illegible] 6/15/77
CHECKED [illegible] 6/14/77

COMPARISON OF BIDS 11715-STR-059
A 48781

BOSTON May 12 19 7[illegible]

JOB ORDER 11715/[illegible]

RESULTS SUMMARY

FOR USNRC Comment 3.74 a

CLIENT Vepco North Anna Units 1 & 2

Component	Failure Mode Controlling Design Margin at Interface of Component / Structure	Criteria for Allowable Capacity (F_A)
Steam Generator Supports	Punching Shear in Concrete	$F_A = 4\phi\sqrt{f'_c}\, b_o d$
Reactor Coolant Pump Supports	Punching Shear in Concrete	$F_A = 4\phi\sqrt{f'_c}\, b_o d$
SI Accumulator Supports	Combined Shear and Tension on ASTM A307 Gr A bolts	$F_A = 1.33(28.0 - 1.6 f_v) \le$ [illegible]
Refueling Water Storage Tank	Tank sliding on concrete foundation	$F_A = 1.1$ (sliding force[illegible]
Quench Spray Pump Anchor	Combined Shear and Tension on ASTM A307 Gr A bolts	$F_A = 1.33(28.0 - 1.6 f_v) \le$ [illegible]
Residual Heat Exchanger Supports: main	Tension on ASTM A307 Grade A bolts	$F_A = 0.9 F_y = 30$ ksi
upper	Tension on drilled in anchor	$F_A = 3$ K for 7/8" ϕ anch[illegible]
Main Instrument Air Receivers	Base sliding on concrete	$F_A = 1.1$ (sliding force[illegible]
Service Water Pump Supports	Combined Shear and Tension on ASTM A307 Gr A bolts	$F_A = 1.33(28.0 - 1.6 f_v) \le 27$[illegible]
Control and Relay Room AC Coil Assembly Support	Combined Shear and Tension on drilled-in anchor	$(T/T_A)^{5/3} + (S/S_A)^{5/3} \le 1$[illegible]; $T_A = 1500$ lb, $S_A = 1500$ lb fo[r] 5/8" ϕ anchor
Process Instrumentation Rack Supports	Combined Shear and Tension on drilled-in anchor	$(T/T_A)^{5/3} + (S/S_A)^{5/3} \le 1$[illegible]; $T_A = 1000$ lb, $S_A = 1000$ lb f[or] 1/2" ϕ anchor
Battery Racks	Combined Shear and Tension on drilled-in anchor	$(T/T_A)^{5/3} + (S/S_A)^{5/3} \le 1$[illegible]; $T_A = 1000$ lb $S_A = 1000$ lb for 1/2" ϕ anchor
DC Distribution Panels	Combined Shear and Tension on drilled-in anchor	$(T/T_A)^{5/3} + (S/S_A)^{5/3} \le 1$[illegible]; $T_A = 700$ lb $S_A = 700$ lb f[or] 3/8" ϕ anchor
R.C. [illegible]	Tension on drilled-in anchor	$S_A = \frac{1}{4}$ (Avg Ultimate [illegible]
Static Inverter: 15 KVA, 20 KVA	Shear on drilled-in anchor	$S_A = \frac{1}{4}$ (Avg Ultimate S[illegible]

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Criteria Reference		Maximum Reaction F	Design Margin FA / F	Seismic Event	Estimated % of Reaction due to Seismic Event
ANCHOR MANUFACTURER'S RECOMMENDATION		T = 6.2K S = 2.0K	1.29	DBE	80%
F.S.A.R. SECTION 3.8.1.4		10.48K	1.73	DBE	90
ACI 318-71	Sect 10.14	2.75K	3.27	DBE	100
F.S.A.R. SECTION 3.8.1.4		6.93K	1.44	DBE	90
AISC 69 Spec, Sect 1.6.3					
		1.13K	5.44	OBE	80
		5.22K	1.28	OBE	60

ORIGINATOR: [illegible] 5/12/77
CHECKER: [illegible]

~~COMPARISON OF BIDS~~ 11715-STR-059
A 4025.1

BOSTON June 3 19 7-

RESULTS SUMMARY

JOB ORDER 11715/120

FOR USNRC Comment 3.74 a

CLIENT Vepco North Anna Units 1 & 2

Component	Failure Mode Controlling Design Margin at Interface of Component / Structure		Criteria for Allowable Capacity	(FA)
Recirc Spray Heat Exch Lower Support	Combined Shear & Tension on Drilled in Anchor		$(T/T_A) + (S/S_A) \leq 1.0$ $T_A = 11.13K$ $S_A = 9.88K$	
Main Support	Tension on ASTM A307 Grade A Bolts		$F_A = 0.9 F_y$	= 30 KSi
4160 Volt Switchgear	Shear at channel embedment producing bearing on concrete		$F_A = .85 \phi f'_c$	
Component Cooling Water Pump Support	Tension on ASTM A307 Grade A Bolts		$F_A = 0.9 F_y$	= 30 KSi
Auxiliary Feed Pump Support Motor Driven Steam Driven	Tension on ASTM A307 Gr A bolts		$F_A = 28.0 -$	$1.6 f_v \leq 20$

CALCULATION SHEET

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SUBJECT/TITLE	QA CATEGORY/CODE CLASS
	I

REFUELING WATER STORAGE TANK

11715-STR-059

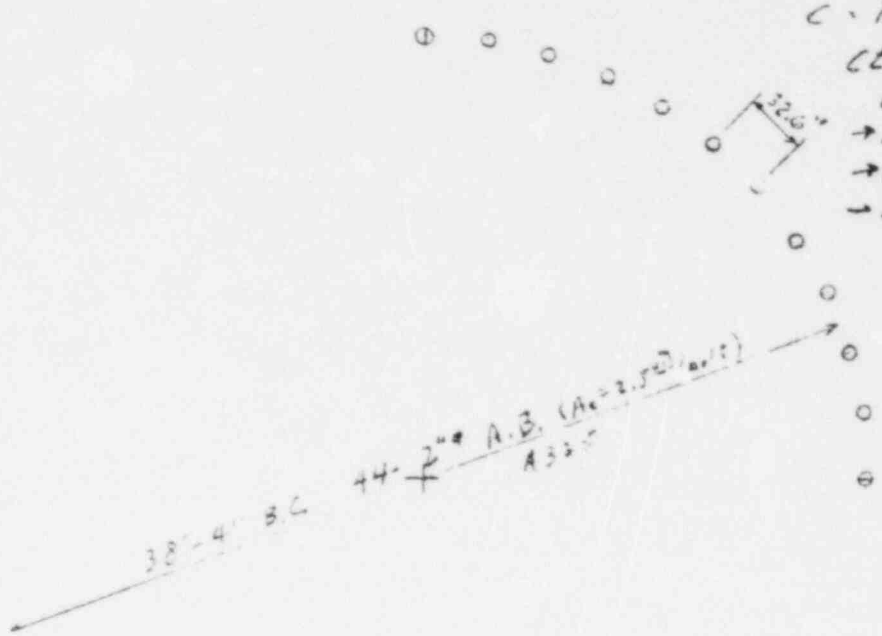
5010.1D

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

Page No. 9/14
Preliminary
Item

Client: VEPCO — Location: NA #1 — File No. — J.O. No. 11715
Subject: Refueling Water Storage Tank — Date: 4/1/77 — By: [illegible]
Checked: 7/4/77 — By: [illegible]
Based on: [illegible] — Revised — By



PLAN

Scale: 1/8" = 1'-0"

$C = \pi D = 119.8' = 1434"$

$C t = A = 44(2.5) = 110$ □"

$t = .0768"$

→ $M = 32,700^{'k} = 392,000^{"k}$

→ $P = 5800^{k}$ *

→ $S = 1195^{k}$

* Total wt. including Mat. Min wt.

$P_{min} = 5800 - 1300 - .12(5800 - 1300)$
$= 4500 - .12(4500)$
$= 4500 - 540$
$P_{min} = 3950^{k}$

GO TO P
FOR REVISED
COMPUTATION

FOR INFORMATION ONLY
DO NOT USE FOR DESIGN

$S = \pi r^2 t = \pi(19.17)^2(.0768)(144) = 12,780 \text{ in}^3$ (19.17: 3? 7 written above)

$f = \frac{P}{A} + \frac{M}{S} = \left(\frac{5800}{110} - \frac{392,000}{12,780}\right) = 35.9 - 30.7$ ∴ OK (3950 written below 5800)

uplift does not occur.

Shear Resistance

$S_R = 3950(.3) = 1185^{k} \sim 1195^{k}$ ∴ will be considered ok as bolts will also resist sliding.

(.3 — Steel Friction)

5010.10

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

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Preliminary 2
Item

Client VEPCO | Location NA #1 | Est. No | J.O. No. 11715
Subject Refueling Water Storage Tank | Date 4/5/77 | By E.R. Litafanich
Checked 4/6/77 | By RJ Fa..
Based on | Revised | By

Check using final Ld. Values

$M = 18,600^{k-1}$, $P = W_{Tank} + H_2O = 100 + 4400 = 4500$
$V = 726^k$
$.12(4500) = 540$
$P_{min} = 3950$

$f = \frac{P}{A} \pm \frac{M}{S} = \frac{3950}{110} \pm \frac{18,600 \times 12}{12,780} = 36.0 \pm 17.5$ ∴ OK

uplift does not occure

Shear Resistance

$S_R = P(.3) = 3950(.3) = 1185 > V = 726$ ∴ OK
(shear fr.

GO TO P
FOR REVISED
COMPUTATION

11715-STR-059

A 5010.1D

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

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Preliminary 3
Item

Client VEPCO	Location NA #1	Est. No.	J.O. No. 11715
Subject Refueling Water Storage Tank		Date 5/9/77	By E.R. Stefani
		Checked 5/12/77	By
Based on 11715-FC-12F-4		Revised	By

Most severe loading based IOC S.A. Kenrick to L.G. Pickman dated 5-2-77

ATTACHMENT #1

4100↓ H = 701^k
518↑ M = 18,628^{k-'} = 224,000^{k-''}
3582↓

from p. 1 Ct = A = 110^□ S = 12,780 in³.

$f = \frac{P}{A} \pm \frac{M}{S} = \frac{3582}{110} \pm \frac{224,000}{12,780} = 32.6 \pm 17.5 = \begin{cases} 15.1 \downarrow \\ 50.1 \downarrow \end{cases}$

Friction

.3(3582) = 1080^k > 701 ∴ OK Margin = $\frac{1080}{701}$ = 1.54

Actual Bolt Force

P = fA = 17.5(32.6)(.0768)^{2.5} = 43.8^k/bolt (2" ϕ bolt)

or f = 17.5 ksi for A325 bolt < 40.0 ksi ∴ OK

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SUBJECT/TITLE	QA CATEGORY/CODE CLASS
	I

Quench Spray Pumps

A 5010 1D

11 1175-SIR-057

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

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Preliminary

Item

Client VEPCO	Location NA #1	Est. No	J.O. No. 11715
Subject Quench Spray Pumps		Date 4/29/77	By E.R. Ste...
		Checked 5/4/77	By RJFAUST
Based on 11715-FM-35A-11, -FC-19B-11		Revised	By

11715-2.20-2B

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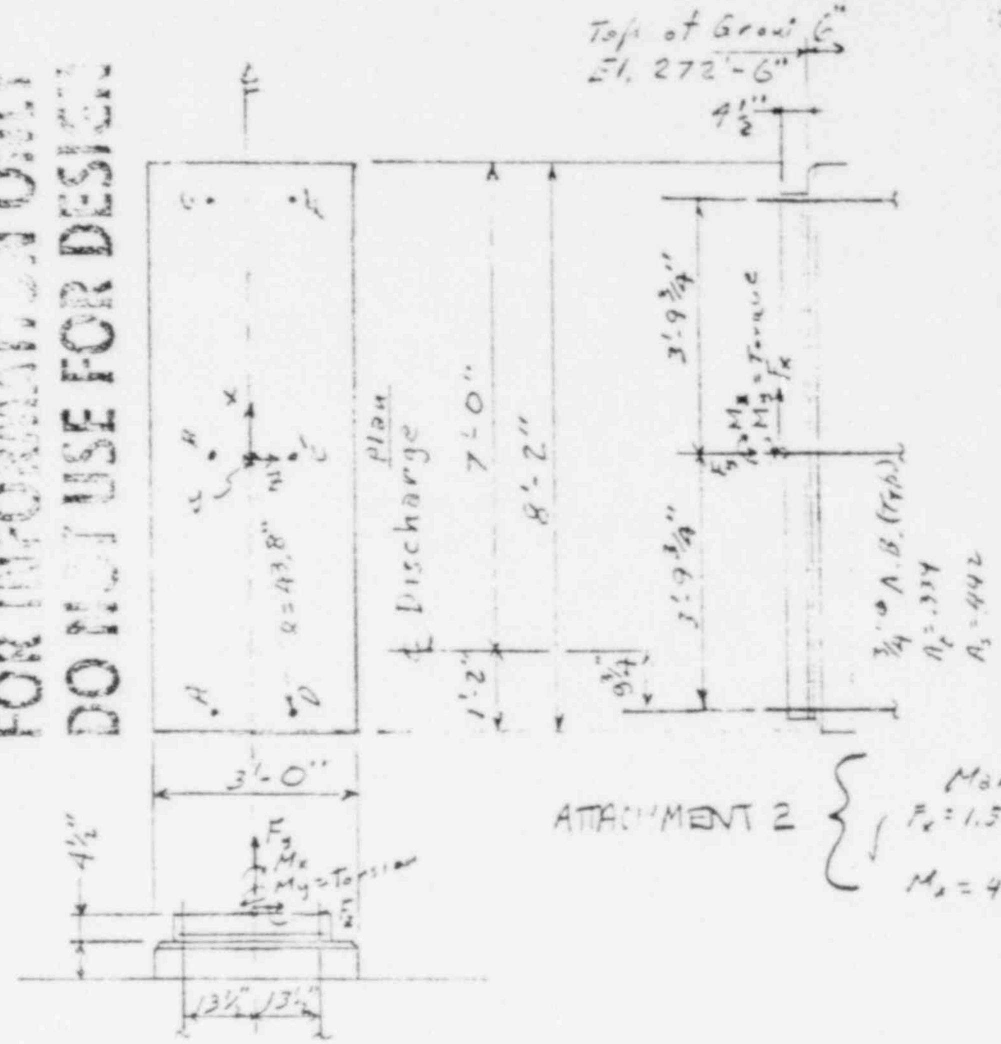

ATTACHMENT 2

Max. Lds.
$F_x = 1.5^k = F_z$, $F_y = 3.0\downarrow$
$F_y = 4.6\downarrow$
$M_x = 43.2$, $M_y = 23.0$, $M_z = 42.1$

3.8↓
.8↑
3.0 = F_y

.2
1.3
1.5 = $F_z = F_x$

Most Severe Bolt Stress (Bolt C)

$M_x = 43.2^{k-\prime\prime}$ $\quad T_t = \frac{43.2 + 1.5(4.5)}{27} = $ or 1.85^k $\quad .61^k$/bolt

CHECKERS NOTE

$F_z = \frac{1.5}{6} = .3^k$

$S_t(43.8)(4) + S_t\left(\frac{6.75}{43.8}\right)(6.75)(2) = M_y$, $175.6\,S_t + 2.1\,S_t = 23.0$

(ASSUME SHEAR/TORMENT IN BOTH DIRECTIONS CAN'T ACT TOGETHER) $S_t = .13^k$

Assume $t = 1.23$ and shear $= .4^k$ (no problem by inspection)

$f_t = \frac{.61}{.334} = 1.83$ ksi $\quad f_s = \frac{.4}{.442} = .91$, $f_v = .91$ ksi

5010 1D

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

Preliminary

Item

Client VEPCO	Location NA-#1	Ext. No.	J.O. No. 11715
Subject Quench Spray Pumps		Date 5/3/77	By [illegible]
		Checked 5/8/77	By RJ[illegible]
Based on 11715-FM-35A-11, -FC-19B-11		Revised	By

$F_t = 28.0 - 1.6 f_v = 28.0 - 1.6 (.91) = 28.0 - 1.5$ ∴ use 20

$\text{Margin} = \frac{20}{1.83} = 10.92$ TENSION ØK

$SF = \frac{10}{.91} = 11.0$ SHEAR ØK

$\frac{1}{3}$ INCR. $SF = \frac{27}{1.83} = 14.75$

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SUBJECT/TITLE	QA CATEGORY/CODE CLASS

RECIRCULATION SPRAY HEAT EXCHANGER

(lower support)

11715-STR-059

A 5010 1D

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

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Preliminary /
Item

Client	VEPCO	Location	N.A. #1	Est. No	J.O. No. 11715
Subject	RECIRC. SPRAY HEAT EXCHANGERS			Date 3/29/77	By R. FAUST
				Checked 6/2/77	By [illegible]
Based on				Revised	By

PROBLEM STATEMENT: INVESTIGATION OF THE ADEQUACY OF THE ANCHOR BOLTS IN THE MAIN SUPPORT @ EL. 242'-6 AND THE LOWER SUPPORT @ EL 216'-11" FOR THE RECIRC. SPRAY HEAT EXCHANGERS.

REFERENCE DRAWINGS:

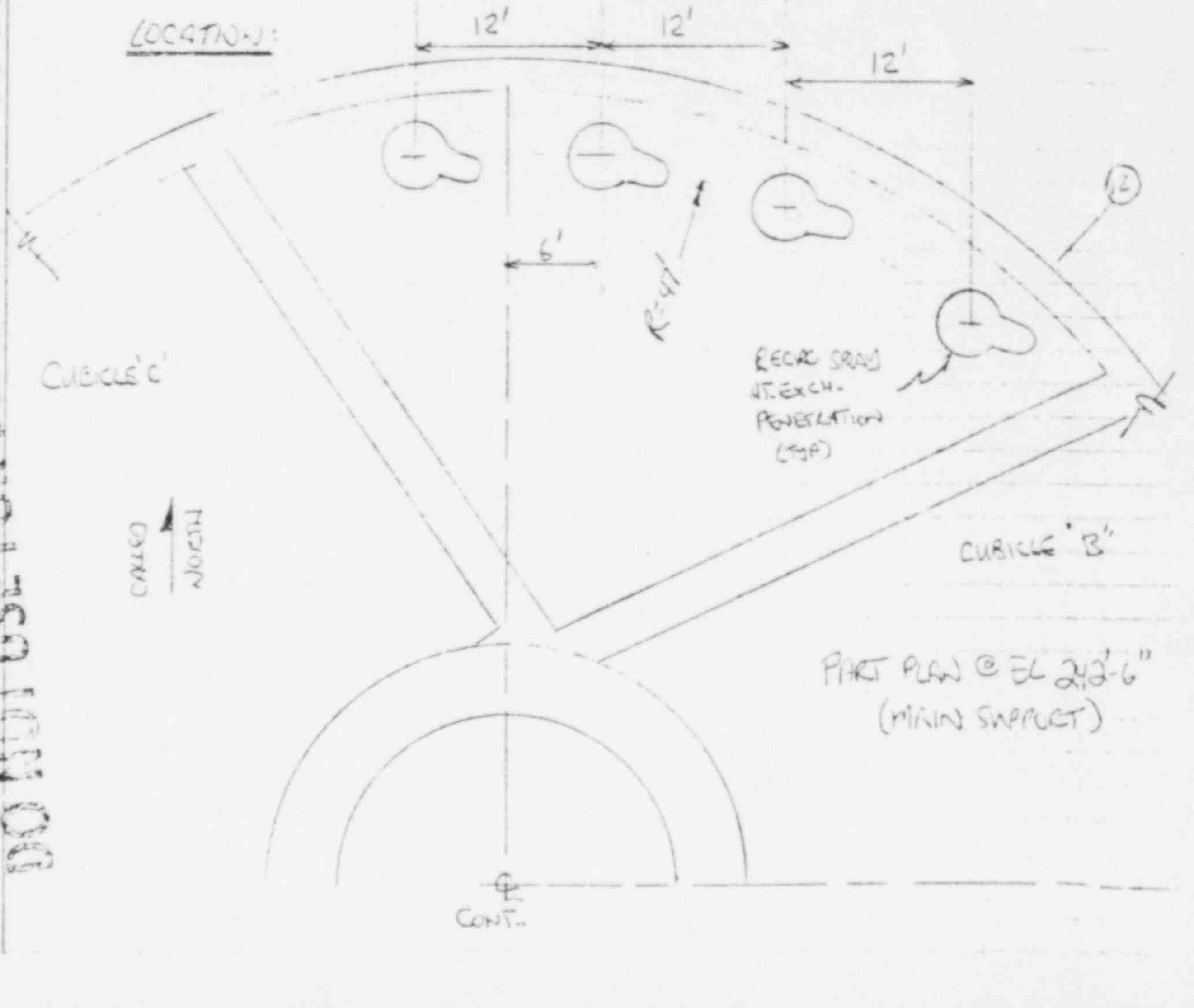
11715 - FM - 1C } MECH.
" FM - 1G }

11715 - FC - 16F } STRUCT.

11715 - FV - 75A }
" - FV - 75B } VESSEL
" - FV - 75C }

1 - RS - E - 1A,B,C,D } MANUFACTURER

LOCATION:



PART PLAN @ EL 242'-6"
(MAIN SUPPORT)

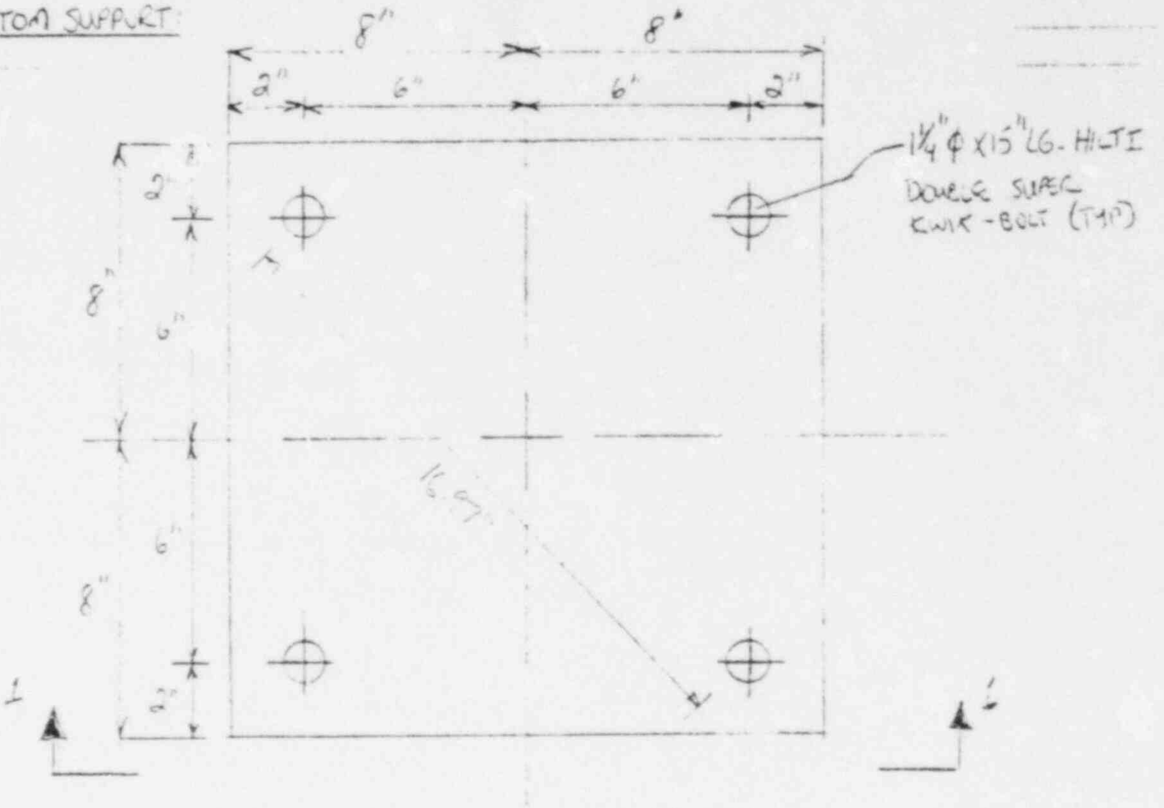
▲ 5010.1D

STONE & WEBSTER ENGINEERING CORPORATION

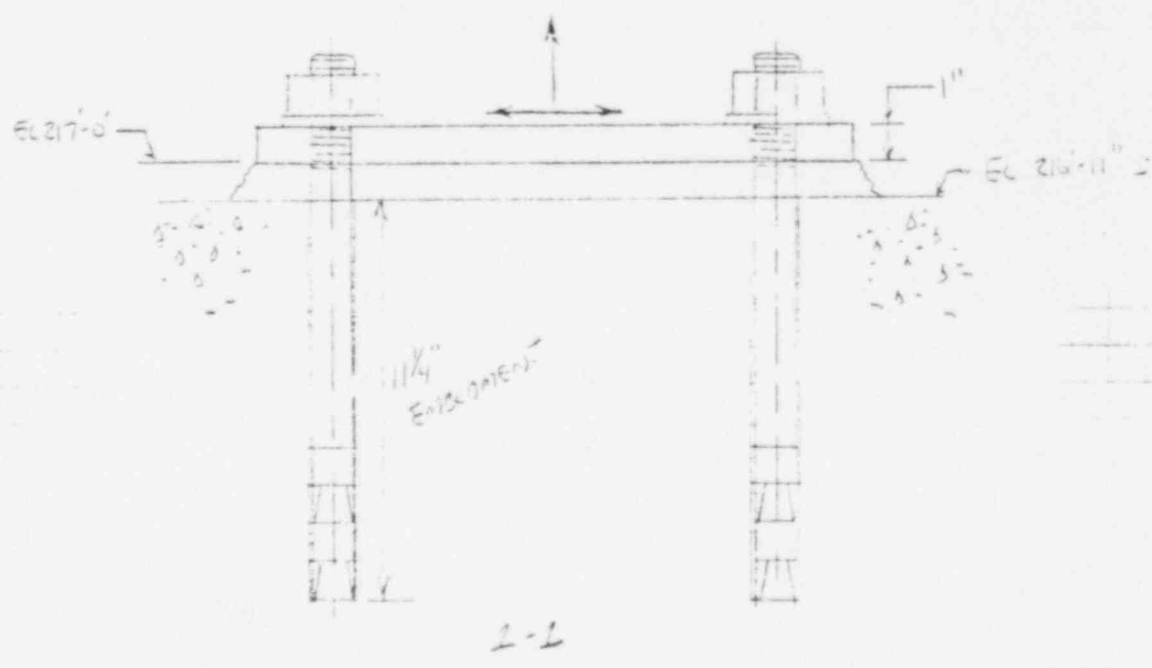
CALCULATION SHEET

Client VEPCO	Location N.A. #1	Est. No.	J.O. No. 11715
Subject RECIRC. SPRAY HEAT EXCHANGERS		Date 3/29/77	By R.F.L.
		Checked 6/2/77	By E. R. [illegible]
Based on		Revised	By

BOTTOM SUPPORT:



PLAN - BOTTOM ANCHOR PLATE



1-1

11 115-STR-039

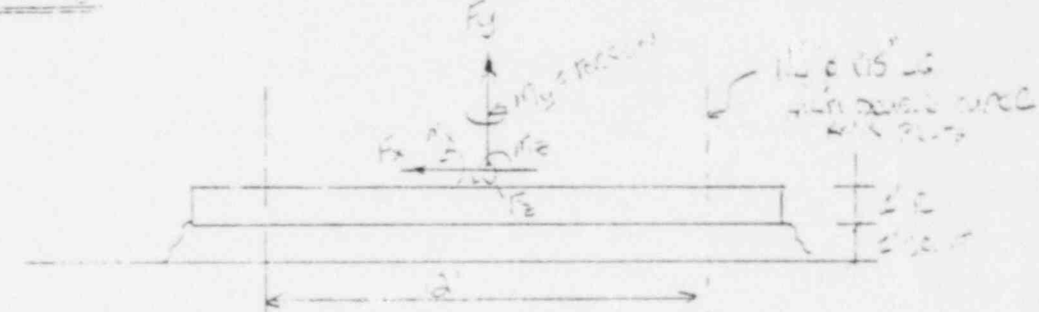
Client [illegible]	Location [illegible]	Est. No.	J.O. No. 11715
Subject [illegible]		Date 5/[illegible]/77	By [illegible]
[illegible]		Checked	By
Based on		Revised	By

BOTTOM STRESSES (CHECK IS BY ALTERNATE ANALYSIS BY E.R.S 6/1/77 (PGS. 9A - 9B))

THE REACTION LOADS FOR THIS SUPPORT ARE [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]-E-1D. (ATTACHMENT D)

[illegible] [illegible] [illegible] THAT 4½" [illegible] [illegible] [illegible] [illegible] THE [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]

[illegible]



[illegible]: Fx = 0.57[illegible] Mx = 36.5 in-k
Fy = [illegible] My = -2.15 in-k
Fz = -8.32k Mz = 5.97 in-k } DBE

DETERMINE MAXIMUM LOAD PER ANCHOR:

a) TENSION

TENSION DUE TO [illegible] TENSILE FORCE = $\frac{[illegible]}{4\ ANCHORS}$ = 4.035 k/ANCHOR

FROM M_z : $T=C = \frac{M_z}{(arm)} = \frac{5.97(1)}{12} = 0.4975^k$ ∴ $T = \frac{.4975}{2\ ANCH}$ = 0.249 k/ANCHOR

FROM M_x : $T=C = \frac{36.5(1)}{12} = 3.0417^k$ ∴ $T = \frac{3.0417}{2}$ = 1.521 k/ANCHOR

FROM F_x : $T=C = \frac{F(e)}{arm} = \frac{0.57(1)}{12} = .0475^k$; $T = \frac{.0475}{2}$ = 0.024 k/ANCHOR

FROM F_z : $T=C = \frac{8.32(1)}{12} = 0.6933^k$ $T = \frac{.6933}{2}$ = 0.347 k/ANCHOR

MAX TENSION PER ANCHOR = 6.166k

▲ 5010 1D

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

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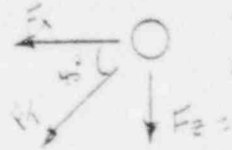
Preliminary

Item

Client [illegible]	Location [illegible]	Est. No.	J.O. No. 11715
Subject SEISMIC DESIGN MARGIN [illegible]		Date [illegible]	By R. FAIST
[illegible]		Checked	By
Based on		Revised	By

II) <u>SHEAR</u> :



T3 [illegible] ANCHOR LOADING DIAGRAM

F_T = TORSIONAL SHEAR PRODUCED [illegible] $= \frac{M_{[illegible]}}{2(16.[illegible])}$

$F_T = .081^K$

$F_X = 0.57/4 = 0.143^K$

$F_Z = 8.3[illegible]/4 = 2.08^K$

∴ TOTAL SHEAR $= (F_X^2 + F_Z^2)^{1/2} + F_T = ((0.143)^2 + [illegible])^{1/2} + .081$

$V = 2.169^K$

** ∴ <u>[illegible] CASE FOR ANCHORAGE - UNIT [illegible]</u> $\begin{cases} T = [illegible] \\ V = 2.169^K \end{cases}$

<u>CONCRETE [illegible]</u> : $T_{ALL} = 11.12^K$, $V_{ALL} = 9.88^K$ } SEE CHART & GRAPH [illegible]

[illegible] ON PG. [illegible]

Client VEPCO Location NA #1 Est. No J.O. No 11715
Subject RECIRC SPRAY HEAT EXCHANGERS Date 3/29/77 By R FAUST
Checked By
Based on Revised By

CAPACITY OF 1¼"φ HILTI DOUBLE SUPER KWIK BOLTS:

REFERENCE: PHONE CONVERSATION BETWEEN R. FAUST AND MULARCHI, HILTI FASTENING SYSTEMS. 3/29/77

EMBEDMENT LENGTH	ULT. TENSION (LBS) 2000	3000*	4000	ULT. SHEAR (LBS) 2000	3000*	4000
8½"	28,972	35836	42700	37558	39518	41479
10⅝"	30971	42325	53680	37558	39518	41479
** 11¼"	32541	(44515)	56490	37558	(39518)	41,479
13⅛"	37250	51086	64922	37558	39518	41479

* VALUES FOR 3000 PSI CONCRETE WERE INTERPOLATED LINEARLY BETWEEN 2000 PSI & 4000 PSI PER HILTI INSTRUCTIONS

** VALUES FOR 11¼" EMBEDMENT WERE INTERPOLATED LINEARLY BETWEEN 10⅝" & 13⅛" PER HILTI INSTRUCTIONS.

MAXIMUM WORKING LOADS = ¼ (ULTIMATE VALUE) ∴ $T = \frac{44515}{4} = 11129$ # ; $V = \frac{39518}{4} = 9880$ #

COMBINED SHEAR & TENSION: (PER HILTI, STRAIGHT LINE APPROACH IS CONSERVATIVE)

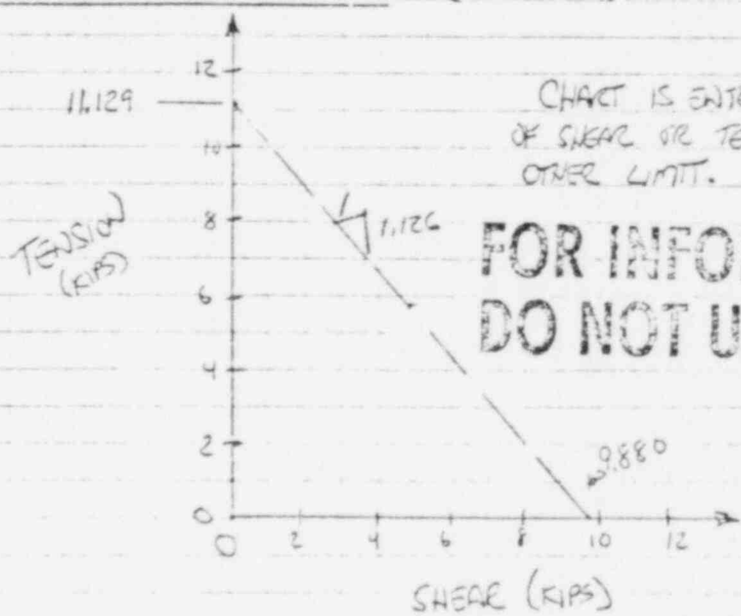


CHART IS ENTERED WITH KNOWN VALUES OF SHEAR OR TENSION, AND READ TO FIND OTHER LIMIT.

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DO NOT USE FOR DESIGN

Client VEPCO | Location NA #1 | Est. No. | J.O. No. 11715

Subject RECIRC SPRAY HEAT EXCHANGERS | Date 3/29/77 | By R. FAUST

Checked | By

Based on | Revised | By

FOR THE PURPOSE OF DETERMINING A SAFETY FACTOR FOR THE ANCHOR BOLTS, THE HILTI APPROACH FOR ALLOWABLE WORKING LOADS WILL BE USED.

STONE & WEBSTER STANDARD MS-13-3-1 DOES NOT INCLUDE 1¼"Ø ANCHORS OF THIS DOUBLE CONED VARIETY. ALSO, THE STANDARD WAS NOT IN EFFECT AT THE TIME THESE PLATES WERE DESIGNED (1972).

∴ FROM CHART (PG 51)

WITH SHEAR CONSTANT @ 2.169^K : $T_{ALL} = 8.3^K$, $T_{ACT} = 6.166^K$ } $SF = \frac{8.3}{6.166} = 1.35$

WITH TENSION CONSTANT @ 6.166 : $V_{ALL} = 4.3^K$, $V_{ACT} = 2.169^K$ } $SF = \frac{4.3}{2.169} = 1.98$

SAY MINIMUM SAFETY FACTOR = 1.35

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Client | Location | Est. No. | J.O. No.

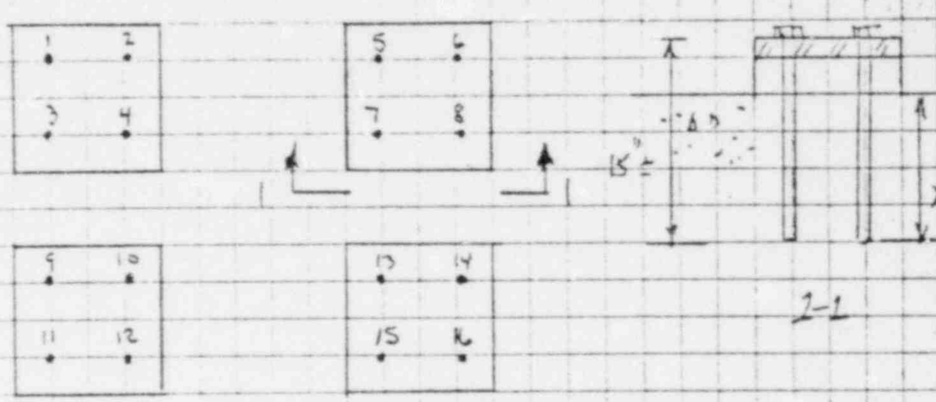
Subject | Date 6/2/77 | By R. Faust

Checked | By

Based on TELCON R. FAUST - T. TRACY ATTACHMENT F | Revised | By

RECIRC. SPRAY COOLERS - UNIT #1

LOWER SUPPORT ANCHORS - RESULTS OF UT TESTS



BOLT DEPTH EMBEDDED IN CONCRETE (INCHES)

INDIVIDUAL VALUES OF DIMENSION "X" (SEE 1-1 ABOVE)

BOLT #	1-RS-E-1A	1-RS-E1B	1-RS-E-1C	1-RS-E-1D
1	7.625	8.1875	8.0	8.75
2	8	8	7.25	8.50
3	8	8	8.25	8.625
4	8	8.25	8.25	8.375
5	7.5	8	7.875	8.50
6	8.25	8.375	8	8.75
7	8	7.75	8.25	8.50
8	8	7.75	8.25	8.75
9	8	7.75	8.25	8
10	8	8	7.375	8
11	8	7.75	7.375	8
12	8	8	7.5	8.375
13	8	8	7.1875	8.75
14	8	8.1875	8.6875	8.5625
15	7.75	7.875	7.875	7.75
16	8	7.75	7.750	8.25

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▲ 5010.1D

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

Page No. 23/114 ... Preliminary ... Item ...

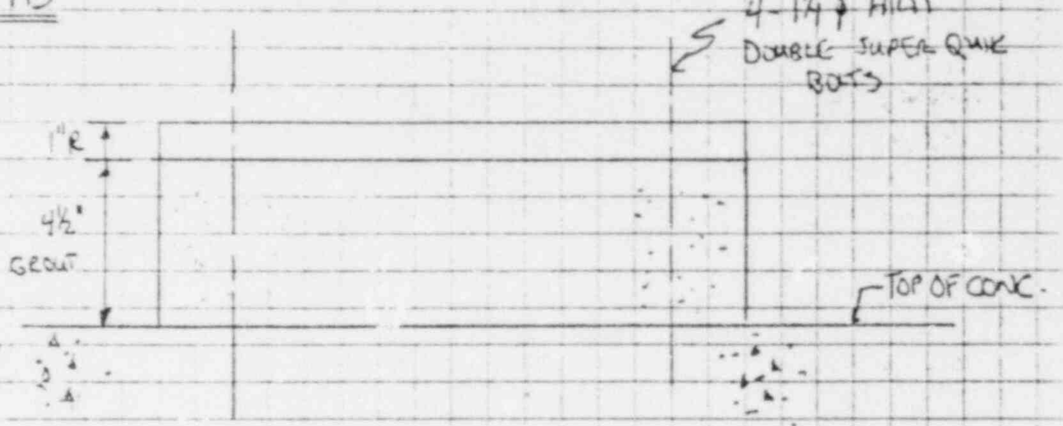
Client: VEPCO — Location: N.A. #2 — Est. No. — J.O. No. 11715

Subject: SEISMIC DESIGN MARGINS — RECIRC SPRAY HEAT EXCHANGERS — Date: 5/26/77 — By: R. FAUST

Checked ... By ...

Based on ... Revised ... By ...

2-RS-E-1D



LOADINGS - (SAME AS UNIT 1) $F_x = 0.51$ $M_x = 36.5$
$F_y = 16.10$ $M_y = -2.85$
$F_z = -8.32$ $M_z = 5.97$

EMBEDMENT INTO CONCRETE = 11¼" - 3½ = 7¾"
(10¾ - 7 = 7⅞")

COMPUTE ALLOWABLE ANCHOR LOADS FOR 7¾" EMBEDMENT
(INTERPOLATE LINEARLY FROM CHART P.51)

Field Data: 64 Bolts, 62 - 15" lg., 2 - 14¾" lg. Bolts 6¼" to 7" above Fl.

$$T_{ULT} = 35836 - \frac{42325 - 35836}{2.125}(.75) \quad (6489)$$

$T_{ULT} = 33546^{\#}$

$\therefore T_{ALL} = 33546/4 = 8386.5^{\#}$ $V_{ALL} = 9880^{\#}$ MAX

$T_{ACT} = 6.166^{k}$ $V_{ACT} = 2.169^{k}$

COMPUTE MARGINS BASED ON INTERACTION

$$\left(\frac{T}{T_A}\right)^{5/3} + \left(\frac{V}{V_A}\right)^{5/3} \leq 1.0$$

FOR COMBINED CASE $\left(\frac{6.166}{8.3865}\right)^{5/3} + \left(\frac{2.169}{9.88}\right)^{5/3} = 0.679 < 1.0$ MARGIN = 1.47

MARGIN ON SHEAR $\left(\frac{6.166}{8.3865}\right)^{5/3} + \left(\frac{V}{9.88}\right)^{5/3} = 1$ $V = 5.71$ MARGIN = 2.63

MARGIN ON TENSION $\left(\frac{T}{8.3865}\right)^{5/3} + \left(\frac{2.169}{9.88}\right)^{5/3} = 1$ $T = 7.978$ MARGIN = 1.294

A 5010 ID

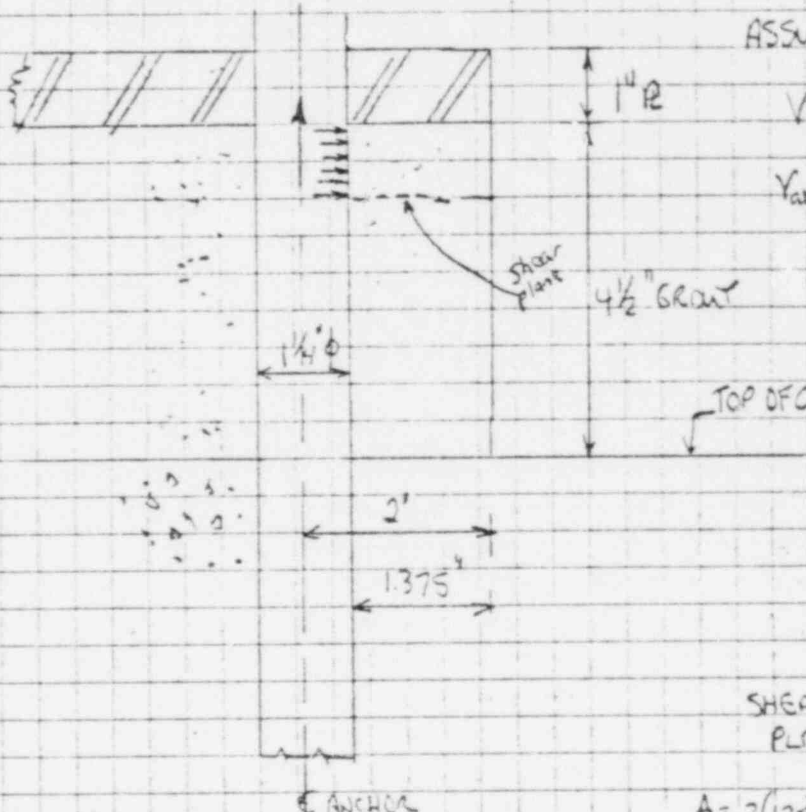
STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

Client VEPCO Location N.A. #2 Est. No J.O. No. 11715
Subject SEISMIC DESIGN MARGINS Date 5/26/77 By R FAUST
RECIRC SPRAY HEAT EXCHANGERS Checked By
Based on Revised By

IT HAS BEEN SHOWN THAT IF THE 1" PLATE AND 4½" GROUT ACTED TOGETHER AS ONE UNIT, THE RESULTING LOADS COULD BE RESISTED BY THE ANCHOR AT A 7¾" EFFECTIVE EMBEDMENT.

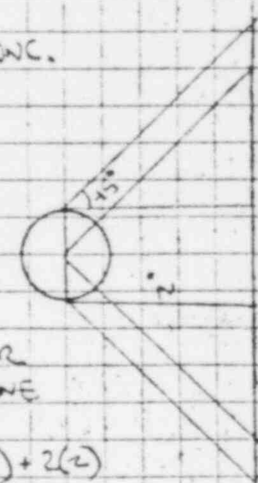
HOWEVER, THE GROUT SHOULD BE CHECKED AGAINST BEARING AND SHEAR STRESSES APPLIED AT THE ANCHOR.



ASSUME $f'_c = 3000$ FOR GROUT

$V_{APPLIED} = 2.169^k$

$V_{all} = 2\sqrt{f'_c} = 109.5$ psi



$A = 2(1.25) + 2(2)$
$= 6.5 \text{ in}^2$

$V_{all} = 6.5(.1095) = 712$ LBS

∴ 712# allowable < 2169# applied shear (NG)

BEARING: 0.85(0.7) 3000 = 1785 psi can be developed

but only 712# can be resisted.

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STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

Client VEPCO Location NA 1&2 Est. No J.O. No 11715

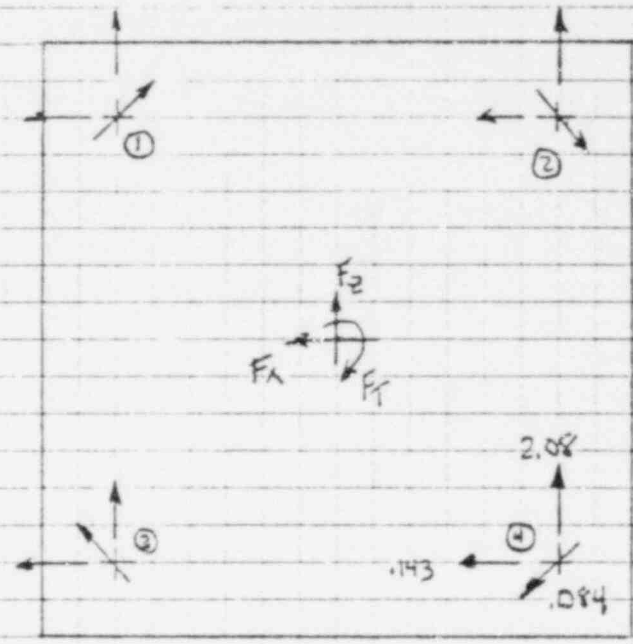
Subject Date 5/27/77 By R. FAUST

Checked By

Based on Revised By

COMPUTE RESULTANT SHEAR DIRECTIONS ON BOLTS

USE ACTUAL WORST CASE DIRECTIONS



① } BY INSPECTION, NO GOOD
② } WILL NOT BE EFFECTIVE IN SHEAR SINCE EDGE DISTANCE IS SMALL

③ & ④ WILL BE ASSUMED TO TAKE ALL THE SHEAR

NEGLECT TORSION SINCE ECCENTRICITY OF F_X ACTS OPPOSITE F_T.
(BOTH VALUES ARE SMALL)

WORST ANCHOR: $V_{TOT} = \left(\left(\frac{8.32}{2} \right)^2 + \left(\frac{0.57}{2} \right)^2 \right)^{1/2} = 4.169^K$

COMPUTE MARGINS: $\left(\frac{6.166}{8.3865} \right)^{5/3} + \left(\frac{4.169}{9.88} \right)^{5/3} = 0.836$ MARGIN = 1.19

∴ OK, NO FIX REQ'D

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Client VEPCO Location NA #2 Est. No. J.O. No. 12050

Subject SEISMIC DESIGN MARGINS Date 6/1/77 By E. R. Stefaniak

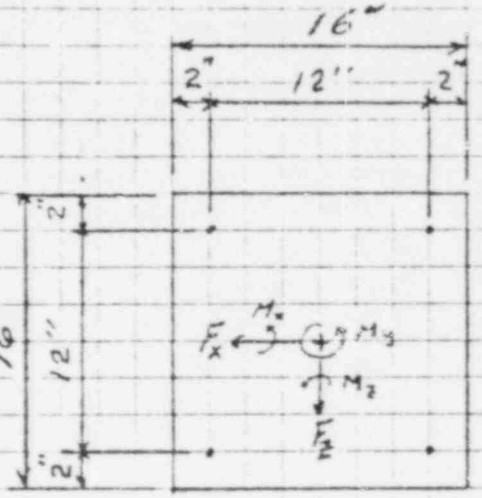
RECIRC. SPRAY HEAT EXCHANGERS Checked By

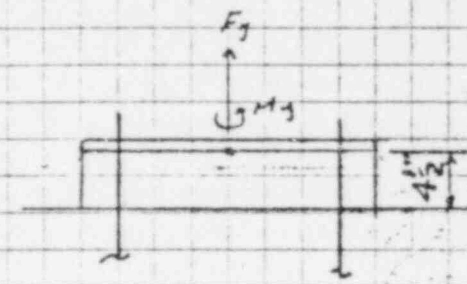
Based on Revised By

$F_x = .57$ kips, $M_x = 36.5$ k-in

$F_y = 16.1$ kips, $M_y = -2.85$ k-in

$F_z = -8.32$ kips, $M_z = 5.97$ k-in



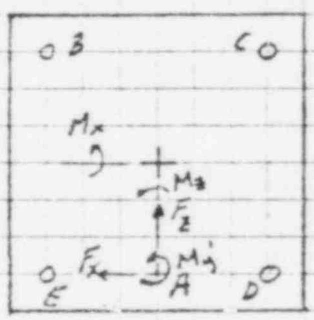


Loading (Positive Directions Shown)

Assumptions: Grout fails for bolts B and C.

$M_y' = M_y + F_x(6) = -2.85 + .57(6)$ [3.42]

$M_y' = 0.57$"



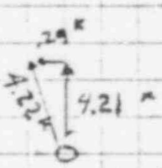
Check Bolt D

$\frac{16.1}{4} = 4.03 = 4.03\uparrow$

$\frac{M_x}{12\times 2} = \frac{36.5}{24} = 1.52\uparrow$

$\frac{M_z}{12\times 2} = \frac{5.97}{24} = .25\uparrow$

Ten. = $5.80\uparrow$



$\frac{F_z}{2} = \frac{8.32}{2} = 4.16\uparrow$

$\frac{M_y'}{12} = \frac{.57}{12} = .05\uparrow$

$4.21\uparrow$ Shear z dir.

$\frac{F_x}{2} = \frac{.57}{2} = .29 \leftarrow$ Shear x dir.

$t = 5.80^k$

$v = 4.22^k$

9.88
4.77
5.11

1¼ bolt $\{ S = .0982(1.25)^3 = .192$; $A = \pi \frac{d^2}{4} = \frac{\pi}{4}(1.25)^2 = 1.228$"

A 5010.1D

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

Client VEPCO Location NA #2 Est. No. J.O. No. 12050

Subject SEISMIC DESIGN MARGINS Date 6/1/77 By E.R. Stefaniak

RECIRC. SPRAY HEAT EXCHANGERS Checked By

Based on Revised By

Interaction Formula

$$\left(\frac{T}{T_A}\right)^{5/3} + \left(\frac{V}{V_A}\right)^{5/3} \leq 1.0$$

$T = 5.80^k$

$V = 4.22^k$

$T_A = 8387^{\#}$ say 8.39

$V_A = 9880^{\#}$ say 9.88

$$\left(\frac{5.80}{8.39}\right)^{5/3} + \left(\frac{V}{9.88}\right)^{5/3} = 1$$

(.691)

$.541 + \left(\frac{V}{9.88}\right)^{5/3} = 1.00$, $\left(\frac{V}{9.88}\right)^{5/3} = .459$, $\frac{V}{9.88} = .627$

$V = 6.18$ Margin $= \frac{6.18}{4.22} = 1.46$

$$\left(\frac{T}{8.39}\right)^{5/3} + \left(\frac{4.22}{9.88}\right)^{5/3} = 1.0, \left(\frac{T}{8.39}\right)^{5/3} + .241 = 1.0$$

(.427)

$\left(\frac{T}{8.39}\right)^{5/3} = .759$, $\frac{T}{8.39} = .828$ $T = 6.95^k$

Margin $= \frac{6.95}{5.80} = 1.20$ say 1.20 ✓

Calcs. made to check comps. by R. Foust. R. Foust comps. OK. E.R. Stefaniak
Applies to unit 1 & 2.

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11715-STR-059

A 5010.1D

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

Page No. 28/114
Preliminary 9C
Item

Client VEPCO
Location N.A. #1&2
Est. No.
J.O. No. 11715/12050
Subject RECIRC. SPRAY COOLERS LOWER SUPPORTS
Date 6/15/77
By R. FAUST
Checked 6/15/77
By RJ Balog
Based on
Revised
By

@ EMBEDMENT = 11 1/4"

$T_{ALL} = 11.129^k$
$V_{ALL} = 9.880^k$

} SEE pg 5 line 30

APPLIED LOADS $T = 5.8$, $V = 4.22$ } P9b

MARGIN: (1) COMBINED $\frac{5.8}{11.129} + \frac{4.22}{9.88} = 0.94$ MARGIN = 1.05

ABOVE USING E. STEFANIAKS BOLT LOADS WHICH ASSUME ONLY 2 BOLTS EFFECTIVE IN SHEAR.

WITH CONCRETE PAD: 4 BOLTS WILL TAKE SHEAR (PG C)

$V_{APP} = 2.17^k$

$T_{APP} = 6.2^k$

$$MARGIN = \frac{1}{\left(\frac{6.2}{11.129} + \frac{2.17}{9.88}\right)} = 1.29$$

USE! ✓

CALCULATION SHEET

A5010 61

J.O./W.O./CALCULATION NO.	REVISION	PAGE
11715-STR-059		29/114

PREPARER/DATE	REVIEWER/CHECKER/DATE	INDEPENDENT REVIEWER/DATE

SUBJECT/TITLE	QA CATEGORY/CODE CLASS

RECIRCULATION SPRAY HEAT EXCHANGER

(main support)

5010.1D

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

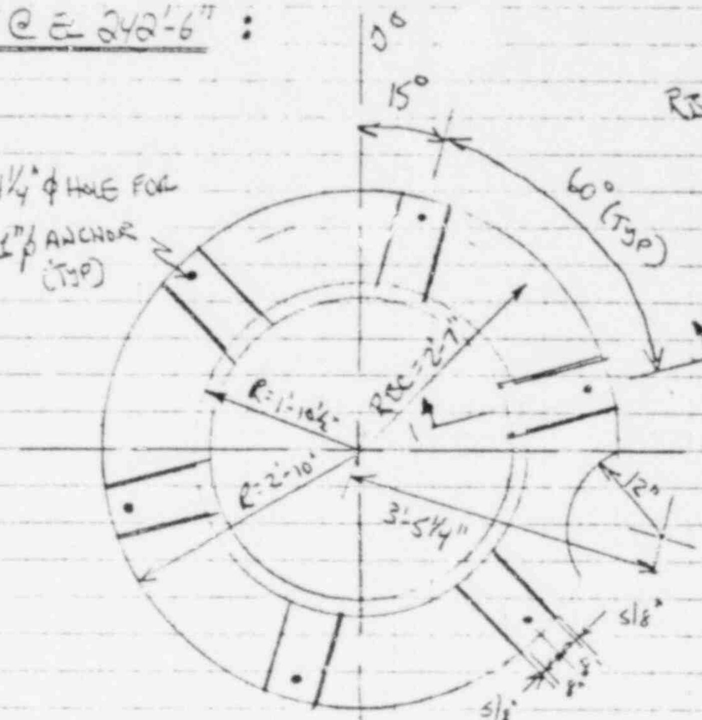
Preliminary

Item

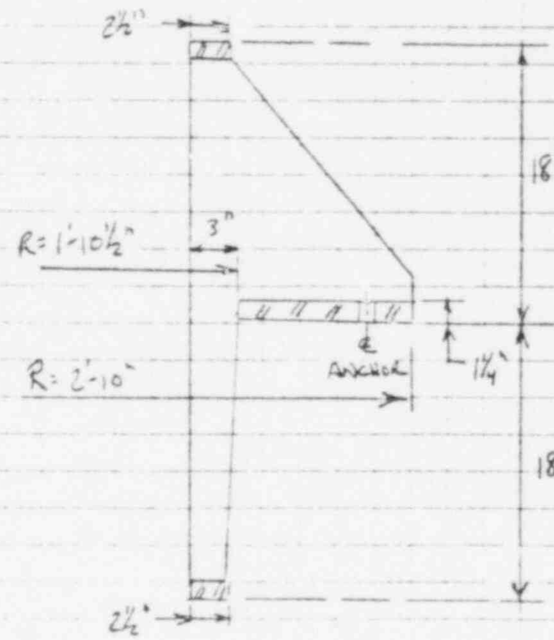
Client VEPCO	Location NA #1	Est. No.	J.O. No. 11715
Subject RECIRC SPRAY HEAT EXCHANGERS		Date 5/5/77	By R. FAUST
		Checked 6/2/77	By S. A. Stefaniak
Based on		Revised	By

MAIN SUPPORT @ EL 242'-6":

RBC = RADIUS OF BOLT CIRCLE



PLAN - SUPPORTS @ EL 242'-6"



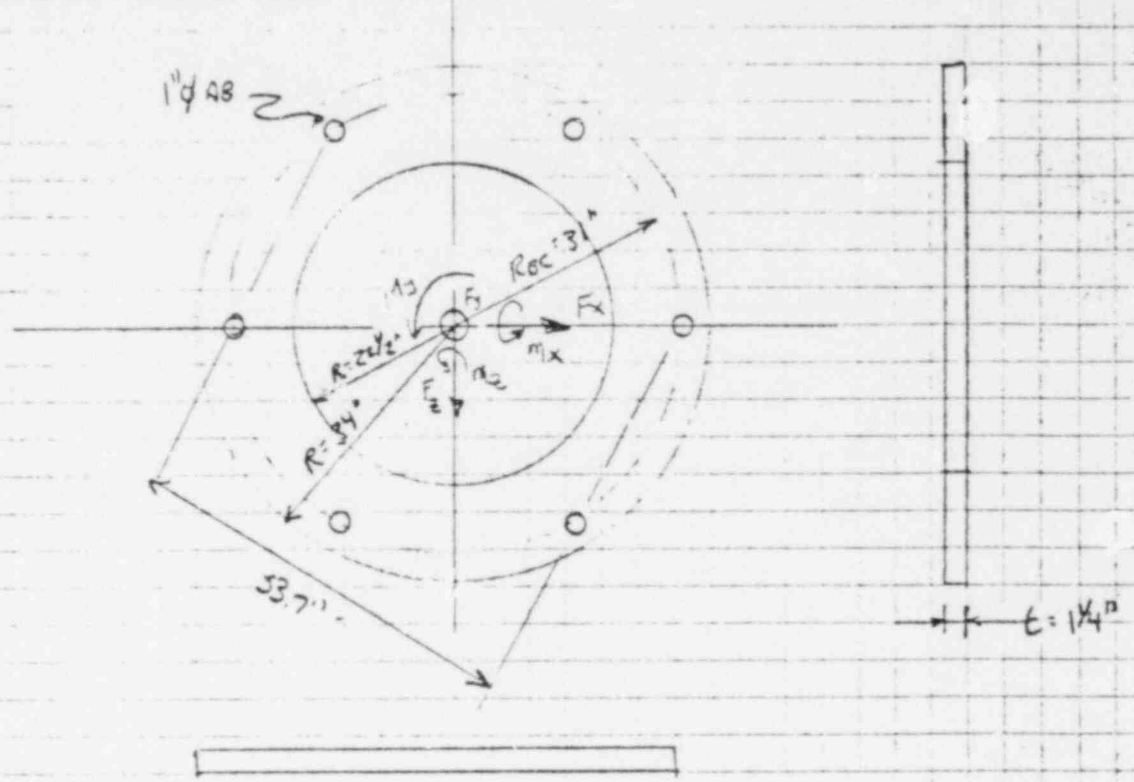
1-1

Client: VEPCO | Location: N.A #1 | Est. No | J.O. No. 11715

Subject: RECIRCULATING SPRAY HEAT EXCHANGERS | Date 5/5/77 | By R. FAUST

MAIN SUPPORT - El. 242'-6" | Checked 6/2/77 | By E. R. [illegible]

Based on | Revised | By



ASSUMPTIONS:

THE SEISMIC MARGIN CALCULATIONS WILL BE PERFORMED FOR THE WORST POSSIBLE BOLT CASE ONLY. MOMENTS & SHEARS ARE COMBINED BY THE SRSS METHOD.

$$V/_{BOLT} = (F_z^2 + F_x^2)^{1/2} / 6$$

$$T/_{BOLT} = C = (M_x^2 + M_z^2)^{1/2} / 2(53.7)$$

4 BOLTS ARE ASSUMED EFFECTIVE IN RESISTING T:C

TORSION = M_y $V_{my} = \dfrac{M_y}{6 \cdot 31}$

$$\left\{ \begin{array}{l} \text{NET SHEAR} = V + V_{my} \\ \text{NET AXIAL} = \dfrac{F_y}{6} \pm T \end{array} \right\}$$

11715-STR-059

A 5010.1D

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

Page No. 32/114
Preliminary 12/
Item

Client VEPCO — Location N.A #1 — Est. No — J.O. No 11715

Subject RECIRC. SPRAY HEAT EXCHANGERS — Date 5/8/77 — By R FAUST

MAIN SUPPORT EL 242'-6" — Checked 6/1/77 — By E.R. Stefanich

Based on — Revised — By

LOADING BREAKDOWN * (D.L + EQ) DBE

RECIRC. SPRAY HEAT EXCHANGERS - MAIN SUPPORT

HEAT EXCHANGER IDENTIFICATION	CASE	Fx (k)	Fy (k)	Fz (k)	Mx ('k)	My ('k)	Mz ('k)
1-RS-E-1A	1)	-12.2	-9	-3	133	-361	-355
	2)	-13.0	-7	-1.5	-112	224	-332
1-RS-E-1B	3)	12.2	-8	-3	-136	-162	-322
	4)	-12.6	-6	-2	-178	389	-300
1-RS-E-1C	5)	-2.2	-8	12.1	-220	-253	-236
	6)	-3.2	-7	13.5	-263	344	-230
1-RS-E-1D	7)	-13.3	-9	2.5	-147	-258	-327
	8)	-14.3	-7.5	4.0	-190	453	-321
2-RS-E-1A	9)	-13.7	-8	2.1	-206	435	-109.5
	10)	-13.7	-6	3.8	310	436.8	-86
2-RS-E-1B	11)	-12.8	-10	1.5	-124	364	-279
	12)	-12.1	-8	2.0	158	431	-210
2-RS-E-1C	13)	-12	-9	1.9	-161	290	-261
	14)	13	-8	2.6	-128	401	-266
2-RS-E-1D	15)	12.1	-10	2.1	-145	288	-268
	16)	12.5	-9	3.3	148	352	-221

* ABOVE LOADS REPRESENT MAXIMUM MAGNITUDE OF FORCES

ATTACHMENT E

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Client VEPCO Location N.A. #1 Est. No. J.O. No. 11715
Subject RECIRC. SPRAY HEAT EXCHANGERS Date 5/8/77 By R FAUST
MAIN SUPPORT EL 242'-6" Checked 6/2/77 By [illegible signature]
Based on Revised 6/4/77 By [illegible signature]

CASE ①:

$$F_y = 9/6 = 1.5^k \downarrow$$

$$T = C = \frac{(133^2 + 355^2)^{1/2}}{2(53.7)} = 3.53^k$$

NET TENSION = 2.03^k

$$V = \frac{(122^2 + 3^2)^{1/2}}{6} = 2.10^k$$

$$V_{my} = 361/6.31 = 1.94^k$$

NET SHEAR = 4.04^k (directions neglected - very conservative)

$F_T = 28 - 1.6 f_v \le 20$ ksi 1" ANCHORS - TENSILE AREA = .6057 in²

$F_T = 1.33(28 - 1.6 f_v) \le 27$ SHEAR AREA = .7854

$$f_v = \frac{4.04}{.7854} = 5.144 \text{ ksi} < 10 \text{ ksi OK}$$

$F_T = 28 - 1.6(5.144) = 19.77$ ksi

$F_T = 1.33[28 - 1.6(5.144)] = 26.35$

$f_t = 2.03/.6057 = 3.35 < 19.77$ OK 26.35 OK

SEISMIC MARGINS:

SHEAR ONLY $S.F = \frac{10}{5.144} = 1.944$

TENSION $S.F = \frac{19.77}{3.35} = 5.90$ ~7.8 (26.35)

A 5010.1D

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

Page No. [illegible]
Preliminary 141
Item

Client VEPCO
Location N.A. #1
Est. No
J.O. No. 11715

Subject RECIRC. SPRAY HEAT E[illegible]CHANGERS
MAIN SUPPORT [illegible] 242'-6"
Date 5/8/77
By R FAUST
Checked 6/2/77
By S.R. Stefaniak

Based on
Revised
By

CASE (8)

$F_y = 7\ldots - 1.25^k \downarrow$

$T = C = \frac{((190^2)+(321)^2)^{1/2}}{2(53.7)} = 3.473^k$

NET TENSION = 2.223

$V = \frac{(14.3^2+4^2)^{1/2}}{6} = 2.475$

$V_{my} = 453/6.31 = 2.435$

NET SHEAR = 4.91^k

$f_v = 4.91/.7854 = 6.25\ ksi < 10$ OK

$F_T = 28 - 1.6(6.25) = 18\ ksi \times 1.33 = 24\ ksi$

$f_t = 2.223/.6057 = 3.67 < 18$ OK 24 ksi

SEISMIC MARGINS:

SHEAR $S.F = 10/6.25 = 1.6$

TENSION $SF = 18/3.67 = 4.9$ (24/3.67 =) 6.54

FOR INFORMATION ONLY
DO NOT USE FOR DESIGN

Client VEPCO — Location N.A. 1&2 — Est. No — J.O. No 11715/12050

Subject RECIRC. SPRAY HEAT EXCHANGERS – MAIN SUPPORT — Date JUNE 15, 1977 — By R. FAUST

Checked — By

Based on — Revised — By

CHECK SHEAR FRICTION CAPABILITY OF SUPPORT:

(ACI 11-30) $A_{vf} = \dfrac{V_u}{\phi f_y \mu}$

$V_u = \phi f_y A_{vf} \mu$ WHERE $\phi = 0.85$

$\mu = 0.7$ (conc. against steel)

$f_y = 33$ KSI (A-307)

$A_{vf} = 0.6057 \text{ in}^2$ (1" ϕ ANCHOR) TENSILE AREA

CHECK WORST BOLT LOAD CASE: (CASE 8 PIH)

$T_{APPLIED} = 2.223^k$

$V = 4.91^k$

$F_T = 20$ KSI = ALLOW. TENSILE STRESS

$T_{ALL} = (20)(.6057)(1.33) = 16.1^k$

$\therefore T' = 16.1 - 2.223 = 13.877^k$ REMAINING CAPACITY OF BOLT IN TENSION

$V_u = 0.85(0.7)(13.877) = 8.26^k$ MAX SHEAR FRICTION FORCE AVAILABLE

$v_u = .2 f'_c = 600$ psi

SHEAR FRICTION AREA REQ'D $= \dfrac{8260}{600} = 13.8 \text{ in}^2$

TRIBUTARY AREA OF PLATE PER BOLT $\cong \dfrac{1}{6}\left[\pi\left(34^2 - 22.5^2\right)\right] = 340''^2 >> 13.8$

COMPUTE MARGIN ON TENSION IF $(V_u)_{DEVELOPED} = 4.91^k$

$T' = \dfrac{4.91}{0.85(0.7)} = 8.252^k$ NECESSARY

$T = 8.252 + 2.223 = 10.475^k$

$\text{MARGIN} = \dfrac{16.1}{10.475} = \underline{\underline{1.54}}$ $\underline{\underline{OK}}$

USING $F_t = 0.9 F_y = 30$ KSI

MARGIN:

$\dfrac{30(.6057)}{10.475} = 1.73$

CALCULATION SHEET

A5010.61

J.O./W.O./CALCULATION NO.	REVISION	PAGE
11715-STR-059		36/112

PREPARER/DATE	REVIEWER/CHECKER/DATE	INDEPENDENT REVIEWER/DATE

SUBJECT/TITLE	QA CATEGORY/CODE CLASS
	I

RECIRCULATION SPRAY HEAT EXCHANGER

(upper support)

NOTE: This support is shown on the 11715-FV-75 series drawings and was designed by others. Therefore its' seismic design margin was not included in the scope of the structural effort.

COMPONENT COOLING WATER PUMPS

▲ 5010.1D

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

Page No. 38/114
Preliminary 1
Item

Client VEPCO	Location N.A. 1&2	Est. No	J.O. No. 11715
Subject COMPONENT COOLING WATER PUMPS		Date 5/17/77	By R. FAUST
		Checked 6/2/77	By ERS
Based on		Revised	By

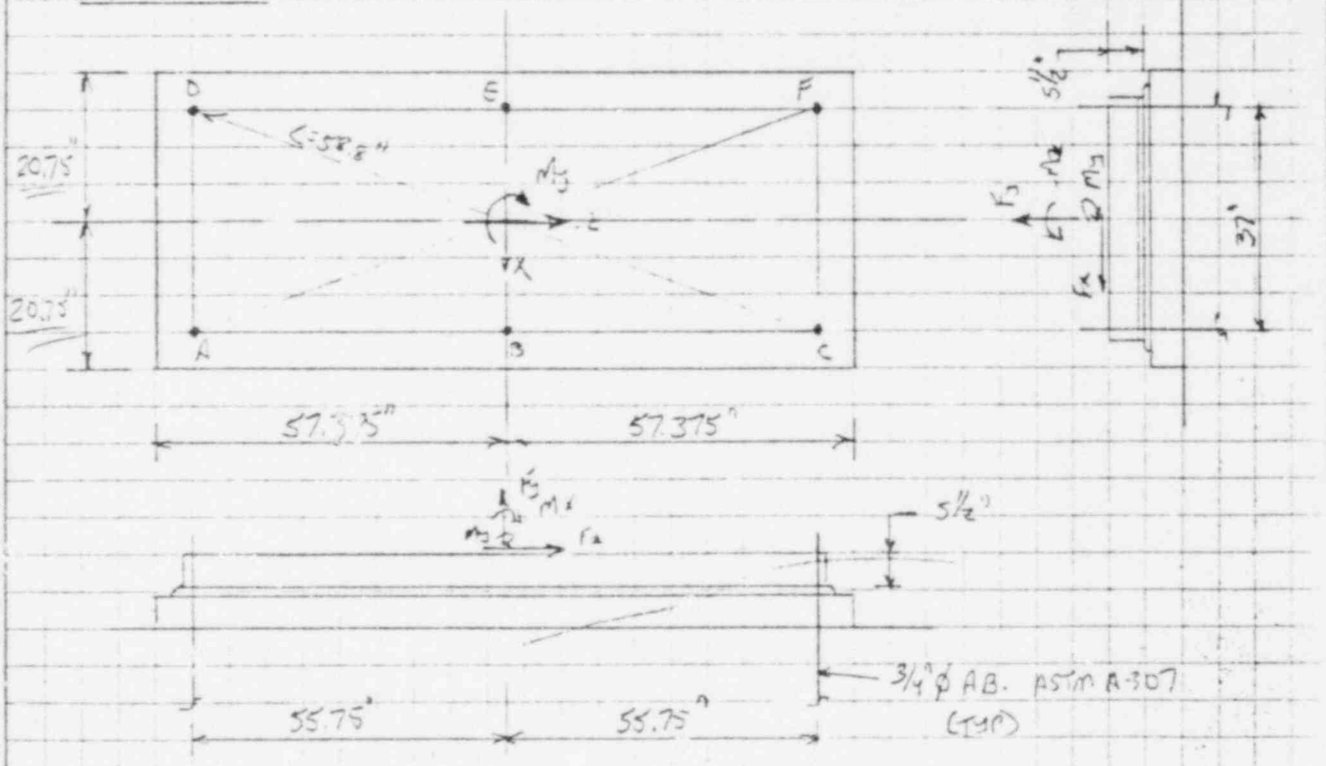
PROBLEM STATEMENT:

DETERMINE THE SEISMIC DESIGN MARGIN FOR THE ANCHORAGE SYSTEM SUPPORTING THE COMPONENT COOLING WATER PUMPS. THESE PUMPS ARE LOCATED IN THE AUXILIARY BUILDING AT EL. 244'-6"

REFERENCES: 11715 - FC - 24B (H-2)
11715 - FC - 24Z (DETAIL "D")
11715 - FM - 2A
INGERSOLL-RAND C-14ALV86X49-A

		ATTACHMENT
IØC S. LEHRMAN TO G. DYCKMAN DATED	3/28/77	J
"	5/9/77	I
"	5/17/77	H

ARRANGEMENT:



▲ 5010.1D

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

Page No. 39/114
Preliminary 2/
Item

Client	VEPCO	Location	N.A. #1	Est. No	J.O. No 11715
Subject	COMPONENT COOLING WATER PUMPS			Date 5/17/77	By R. FAUST
				Checked 6/2/77	By ERS
Based on				Revised	By

CHECK CASE 1-CP-P-1A - I DBE

DETERMINE LOADS @ UNDERSIDE OF BASE PLATE

	F_x	F_y	F_z	M_x	M_y	M_z
DEADLOAD	1.0	-10.5	0	2.1	-1.3	-3.8
OPERATING	0	0	0	0	0	1.5
DBE	10.1	3.7	.14	7.3	-17.9	-24.4
TOTAL	11.1^k	-6.8^k	$.14^k$	$9.4^{ft\text{-}k}$	$-19.2^{ft\text{-}k}$	$-26.7^{ft\text{-}k}$

WORST BOLT LOADS:

A) AXIAL : $F_y/2 = 6.8/2 = 3.4^k \downarrow$ (3 BOLTS ACTING)

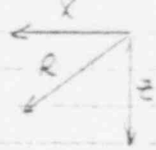
$T=C = M_z/37 = 26.7 \times 12/37 = 8.66^k \uparrow\downarrow$ - (3 BOLTS ACTING)

$T=C' = M_x/111.5 = 9.4(12)/111.5 = 1.01^k \uparrow\downarrow$ - (2 BOLTS ACTING)

NET TENSION $= (-3.4 + 8.66)\frac{1}{3} + 1.01(\frac{1}{2})$

$T = 2.26^k$/ANCHOR

B.) SHEAR :



$\left(\left(\frac{F_x}{6}\right)^2 + \left(\frac{F_z}{6}\right)^2\right)^{1/2} = \left(\left(\frac{11.1}{6}\right)^2 + \left(\frac{.14}{6}\right)^2\right)^{1/2}$

$R = 1.85^k$

$M_y = S(56.8)(4) + S\left(\frac{18.5}{56.8}\right)(18.5)(2)$

$(19.2)(12) = S(235.2 + 11.6)$

$S = 230.4/246.8 = 0.93^k$

NET SHEAR $= 1.85 + .93 = 2.78^k$ (very conservative direction ignored).

A 5010.1D

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

Client VEPCO | Location N.A. #1 | Est. No. | J.O. No. 11715
Subject COMPONENT COOLING WATER PUMPS | Date 5/17/77 | By R. FAUST
Checked 6/2/77 | By ERS
Based on | Revised | By

WORST CASE FOR ANCHOR: $T = 2.26^k$
$V = 2.78^K$ N.G. See p 3A

3/4"ϕ ANCHOR BOLTS { TENSILE AREA = 0.3345 in² ; SHEAR AREA = 0.4418 in² } ASTM A-307

$S = .785(.375)^3 = .0414\ in^3$

$$f_t = \frac{2.26^k}{.3345} = 6.756\ ksi$$

$$f_v = \frac{2.78^k}{.4418\ in^2} = 6.292\ ksi < F_v = 10\ ksi\ \text{ALLOWABLE} \therefore OK$$

AISC 1.6.3: $F_T = 28 - 1.6 f_v \le 20\ ksi$

$= 28 - 1.6(6.292)$

$F_T = 17.933\ ksi > f_t = 6.756\ ksi$ OK

SEISMIC MARGINS

WITH $f_v = 6.292$ $SF_{TENSION} = \frac{17.933}{6.756} = 2.65$

$SF_{SHEAR} = \frac{10.00}{6.292} = 1.60$ * GOVERNS

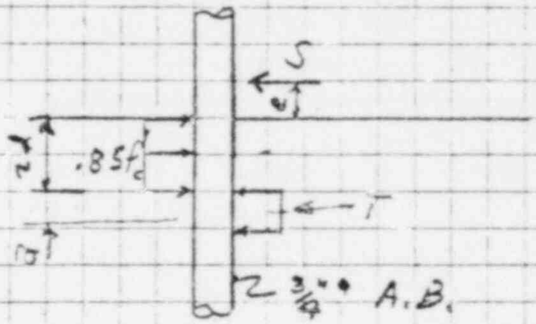
N.G.

CHECK SHEAR CAPACITY OF BOLT

P 3A

Client VEPCO	Location NA #1	Est. No.	J.O. No. 11715
Subject		Date 6/7/77	By E. [illegible]
		Checked 6/8/77	By [illegible]
Based on		Revised	By

Shear Capacity of Bolt



let e = 1" S = 2.78^k

$M = (.75+1)S - .85f'_c(.75)(a+d) = 0$

$1.75(2.78) = 1.91(a+.75)$

$a = 2.55 - .75 = 1.80$

T = 4.87^k this is impossible ∴ can not develop Comp. in 1½". Bolt capacity N.G.

Use Fix as shown on p. 7 of voided comps. (5)

$(0.85)(0.7)(3000)(2)(.75)^2 = 2.01^k$ (2.68) $< 2.78^k$

CAPACITY IN BEARING — APPLIED SHEAR

Client VEPCO Location NA #1 Est. No. J.O. No 11715
Subject COMPONENT COOLING WATER PUMPS Date JUNE 15, 1977 By R FAUST
Checked 6/15/77 By RJ Bologna
Based on Revised By

CHECK SHEAR FRICTION CAPABILITY OF SUPPORT:

$$A_{vf} = \frac{V_u}{\phi f_y \mu}$$ ACI 318-71 (11.15.4)

$V_u = \phi \mu (A_{vf} f_y)$ where $\phi = 0.85$
$\mu = 0.7$ ✓
$f_y = 33$ KSI
$A_{vf} = 0.3345 \text{ in}^2$ (3/4"φ ANCHORS)

CHECK WORST CASE FOR ANCHOR:

APPLIED FORCES @ ANCHOR LOCATION { $T = 2.26^k$, $V = 2.78^k$ }

$T_{ALL} = 0.3345(1.33)(20) = 8.9^k$ ✓

T': RESIDUAL TENSILE CAPACITY $= 8.9 - 2.26 = 6.64^k$

$V_u = 0.85(0.7)(6.64) = 3.95^k > 2.78^k$ OK

$$A_{REQ} = \frac{3950}{.2(3000)} = 6.6 \text{ in}^2 \text{ OK}$$ (AREA OF CONCRETE)

COMPUTE MARGIN ON TENSION FOR $V_u = 2.78^k$

$$T' = \frac{2.78}{.85(.7)} = 4.67^k$$

$T_{TOT} = 4.67 + 2.26 = 6.93^k$

$$\text{MARGIN} = \frac{8.9}{6.93} = 1.28 \quad \text{OK.}$$

USING $F_A = 0.9 F_y = 30$ KSI FSAR SECTION 3.8.1.4

$$\text{MARGIN} = \frac{30(.3345)}{6.93} = 1.44$$

CALCULATION SHEET

A5010 61

J.O./W.O./CALCULATION NO.	REVISION	PAGE
11715-STR-059		43/1'2

PREPARER/DATE	REVIEWER/CHECKER/DATE	INDEPENDENT REVIEWER/DATE

SUBJECT/TITLE	QA CATEGORY/CODE CLASS

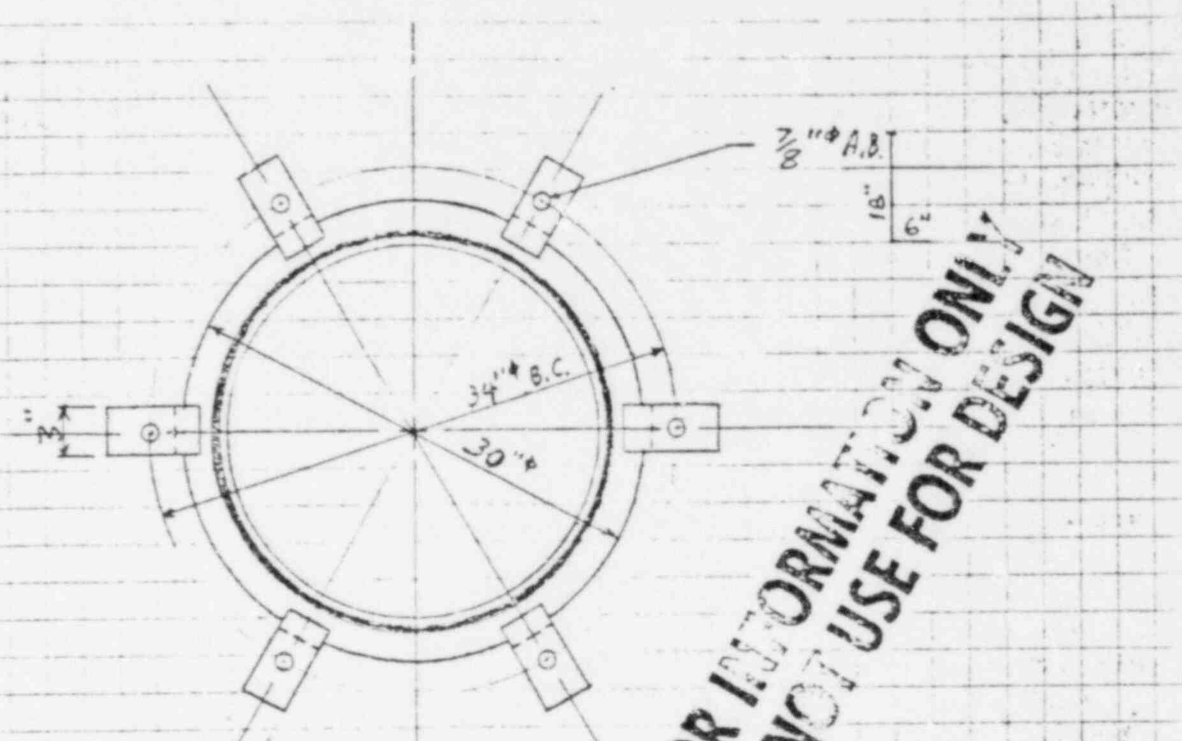
Main Instrument Air Receivers

Client VEPCO Location NA 1 & 2 Est. No. J.O. No. 11715

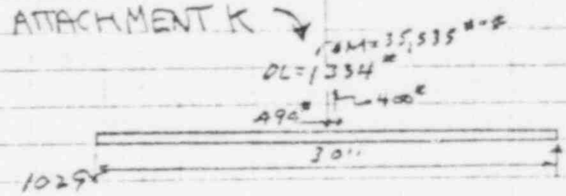
Subject Main Instrument Air Receivers in the Auxiliary Building @ El. 259'. Date 3/30/77 By E.R. [illegible]

Checked 4/4/77 By R.J. [illegible]

Based on Revised By



ATTACHMENT K →

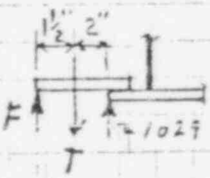


$T_1 = \frac{35{,}535}{30} = 1184.5 \uparrow$

$T_2 = \frac{400}{6} = 66.7 \uparrow$

$T_3 = \frac{1334}{6} = 222.3 \downarrow$

1028.9 ↑ say 1029



$T = \frac{1.029(3.5)}{1.5} = 2.40^k$

Assume Shear = 494# on on 7/8"Φ Anchor.

$F = 2.40 - 1.03 = 1.37^k$ but spread over 3" should not be a great problem.

Ten. in 7/8"Φ Bolt = 9.23k

$F.S. = \frac{9.23}{2.40} = 3.85$

Sliding $T_1 = 1184.5 \downarrow$ F_{r1} = Fr. Force Stl. to Stl. = .20 assumed

$T_2 = 66.7 \uparrow$ F_{r2} = Fr. Force Stl. to Conc. = .30

$T_3 = 222.3 \downarrow$

1340.1 ↓ say 1340# ↓ $F_{r1} = 1029(.2) = 205.8$ say 206#

$F_{r2} = 1340(.3) = 402$ say 402

608# > 494

$F.S. = \frac{608}{494} = 1.23$ against initial slippage.

Use F.S. = 1.2 ←

CALCULATION SHEET

A5010.51

J.O./W.O./CALCULATION NO.	REVISION	PAGE
11715-STR-059		45/114

PREPARER/DATE	REVIEWER/CHECKER/DATE	INDEPENDENT REVIEWER/DATE

SUBJECT/TITLE	QA CATEGORY/CODE CLASS

SERVICE WATER PUMPS

11715-STR-059

▲ 5010.1D

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

Page No. 46 / 1/4
Preliminary 1
Item

Client VEPCO	Location N.A. #1	Est. No	J.O. No. 11715
Subject SERVICE WATER PUMP HOLD DOWN ANCHORAGE.		Date APRIL 26, 1977	By R. FAUST
		Checked 4/27/77	By E. R. Stefani
Based on		Revised	By

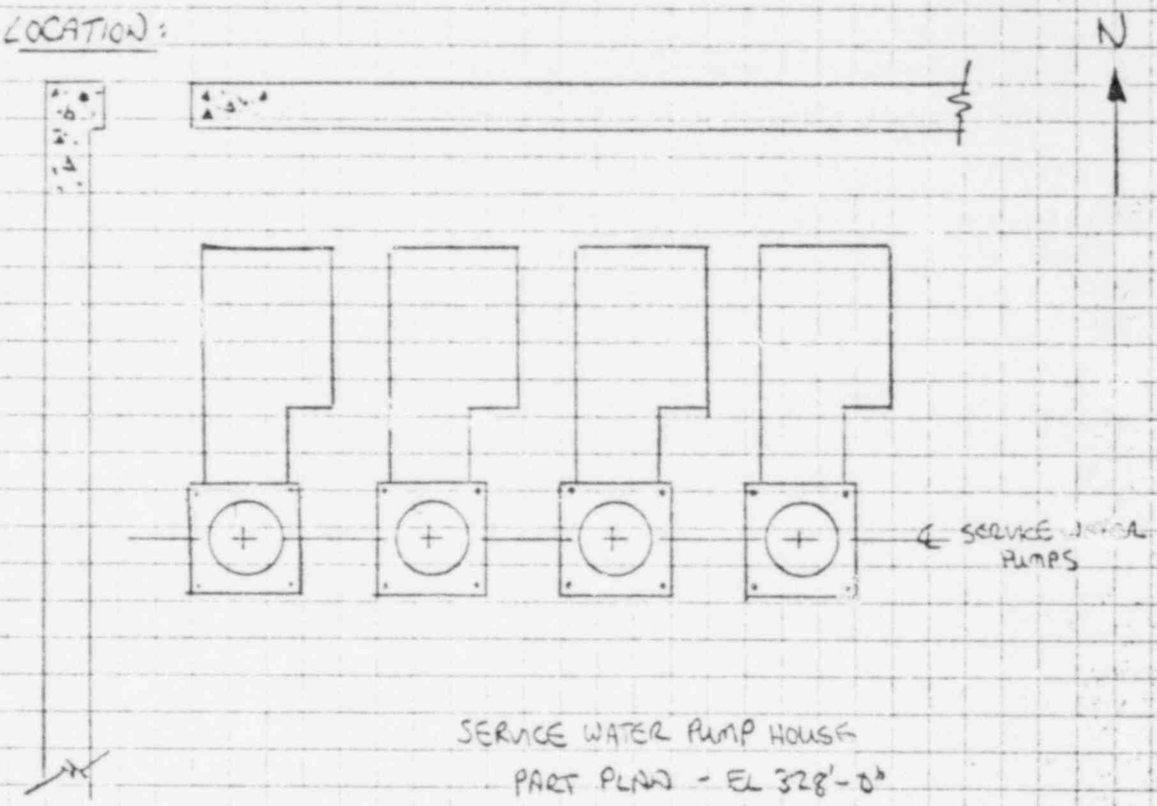
PROBLEM STATEMENT:

DETERMINE THE AVAILABLE MARGIN OF SAFETY FOR THE SERVICE WATER PUMP ANCHORAGE SYSTEM UNDER SEISMIC CONDITIONS.

REFERENCES: I.O.C S. LEHRMAN TO J. DYCKMAN 4/25/77
ATTACHMENT L
11715 - FC- 38B

E&DCR - P1637, 1640, 1571

LOCATION:



SERVICE WATER PUMP HOUSE
PART PLAN - EL 328'-0"

FOR INFORMATION ONLY
DO NOT USE FOR DESIGN

11715-STR-059

S 1010.1D

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

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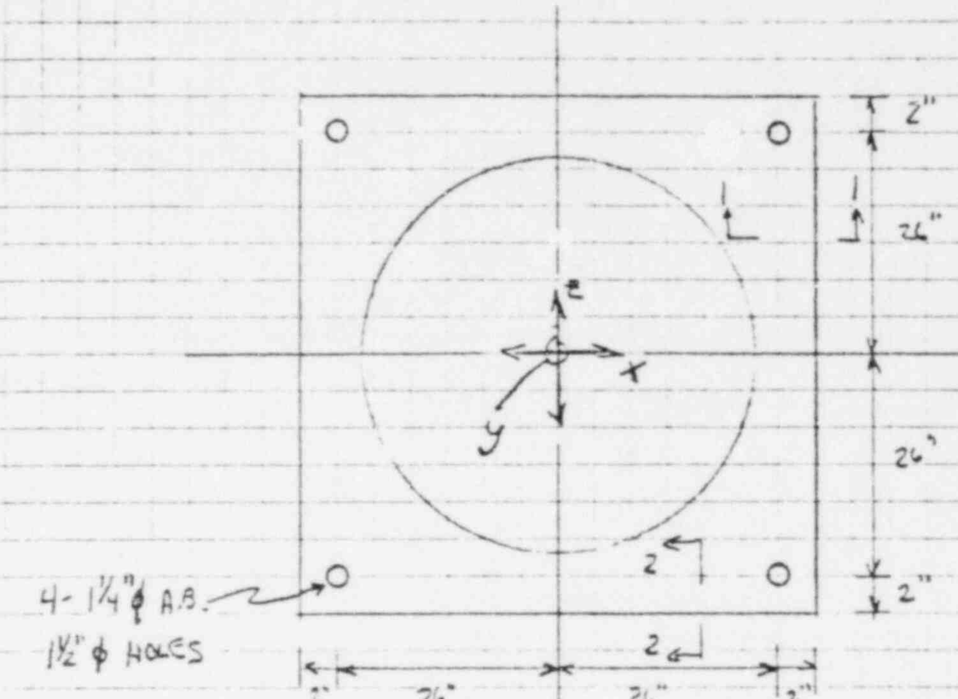
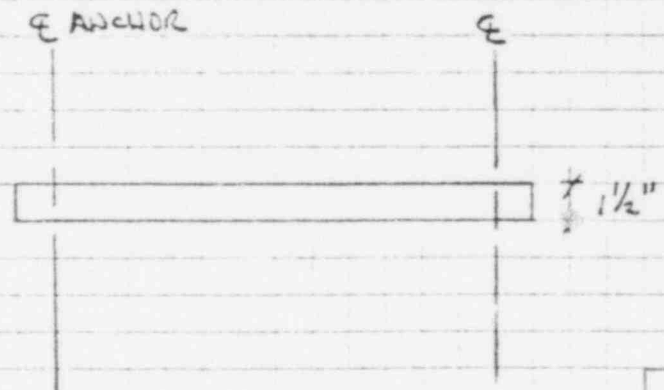
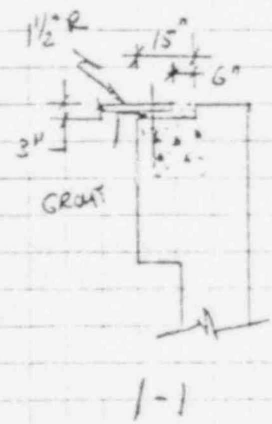
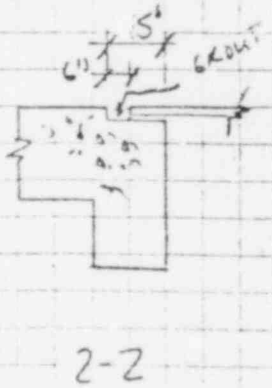
Preliminary 2/
Item

Client	VEPCO	Location	N.A. #1	Est. No.	J.O. No. 11715
Subject	SERVICE WATER PUMP HOLD DOWN ANCHORAGE	Date	4/26/77	By	R. FAUST
		Checked	4/27/77	By	S. R. Stefanick
Based on		Revised		By	









A 5010.1D

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

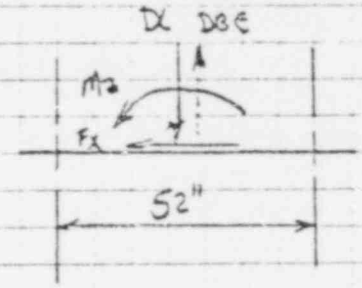
Page No. 481/114
Preliminary 3/
Item

Client VEPCO	Location NA #1	Est. No.	J.O. No. 11715
Subject SERVICE WATER PUMP HOLD DOWN ANCHORAGE		Date 4/27/77	By R FAUST
		Checked 4/28/77	By E. R. Stefaniak
Based on		Revised	By

$1\frac{1}{4}"\phi$ ASTM A-307 ANCHORS × 36" LG (33" EMBEDDED)

$F_T = 28 - 1.6 f_v \le 20$ KSI

I) DEAD LOAD + OPERATING + DBE CONDITIONS

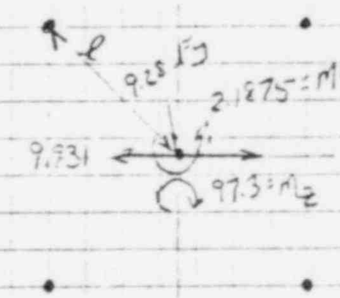


DL = 16.28^k ↓
DBE = 7.00^k ↑
} NET = 9.28^k ↓

F_x = 9.931^k ⟷

$M_y = 26250/12{,}1000$ = 2.1875 ft-k

$M_z = 116765/12000$ = 97.3 ft-k



$l = 26\sqrt{2}$ = 36.77" = 3.06'

$M_y = (V)_{my} (4l)$

↳ SHEAR DUE TO M_y

$\therefore V = \left[(.707 V_{my})^2 + (F_x + .707 V_{my})^2\right]^{1/2}$

$V = (V_{my}^2 + 1.414 F_x V_{my} + F_x^2)^{1/2}$

AXIAL FORCES ON ANCHORS:

1) FROM DL+DBE = 9.28/4 = 2.32^k ↓

2) FROM M_z = $\frac{97.3(12)}{52}\left(\frac{1}{2}\right)$ = 11.23^k ↑

@ CONC-GROUT INTERFACE (SECT. H1) → 3.) FROM F_x ECCENTRICITY = $\frac{9.931(3/12)}{52/12}\,\frac{1}{2}$ = 0.29^k ↑

MAX. TENSION = 9.2^k

SHEAR FORCES ON ANCHORS:

1.) FROM F_x = 9.931/4 = 2.483^k

2.) FROM M_y = $\frac{2.1875(12)}{4(36.77)}$ = 0.178^k

5010 1D

STONE & WEBSTER ENGINEERING CORPORATION
CALCULATION SHEET

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Preliminary 4/
Item

Client VEPCO Location N.A.#1 Est. No. J.O. No. 11715
Subject SERVICE WATER PUMP HOLD DOWN ANCHORAGE Date APRIL 27, 1977 By R. FAUST
Checked 4/27/77 By S.R. Stefanick
Based on Revised By

NET SHEAR ON ANCHOR $= \left[(2.483)^2 + (.178)^2 \right) + 1.414(2.483)(.178) \right]^{1/2} = (6.83)^{1/2}$

$V = 2.61^{k}$ use $V = 2.6^{*}$

∴ NET FORCES ON ANCHOR : $T = 9.2^{k}$, $V = 2.6$ } WORST CASE

$1\frac{1}{4}''\phi$ ANCHORS - TENSILE STRESS AREA = $0.9691''^2$

SHEAR AREA = $1.2272\ in^2$

$f_V = \frac{2.6^k}{1.2272\ in^2} = 2.12\ ksi \qquad F_V = 10\ ksi$

$F_T = 28 - 1.6(2.04) = 24.7 > 20$ use $F_T = 20\ ksi$

$f_t = \frac{9.2}{.9691} = 9.50\ ksi$

SEISMIC MARGINS:

SHEAR ONLY $S.F. = \frac{10}{2.12} = 4.7$

TENSION ONLY $SF = \frac{20}{9.50} = 2.11$ { USING 1/3 INCR $SF = \frac{20 \times 1.33}{9.5} = 2.8$

COMBINED SHEAR & TENSION USE F.S. = 2.1

* Actually this plate is locked in grout - shear can not really occure. S&W Std. MS-13-3-1 allows 2500 lbs. for 1"ϕ ∴ 2500 ok for 1¼"ϕ.

CALCULATION SHEET

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J.O./W.O./CALCULATION NO.	REVISION	PAGE
11715-STR-059		50/1__

PREPARER/DATE	REVIEWER/CHECKER/DATE	INDEPENDENT REVIEWER/DATE

SUBJECT/TITLE	QA CATEGORY/CODE CLASS

CONTROL & RELAY ROOM AIRHANDLING UNITS

Client VEPCO   Location NA 1 & 2   Est. No.   J.O. No. 11715

Subject Check Anchor Bolts   Date 3/30/77   By E. R. Stefaniak

Checked 4/4/77   By R. J. Fawl

Based on 1-HV-AC-1, 1-HV-AC-2, 2-HV-AC-8, 2-HV-AC-9   Revised   By

Anchor Loadings on Fan

T = 871 lbs } from Calcs. of Buffalo Forge
S = 593 lbs } also see below. Buffalo

$M = 62{,}785 \quad T = \frac{1\,M_x}{254.75} = 573\uparrow$ (2 bolts)

$\frac{F_z}{4} = \frac{1191}{4} = \quad 298\uparrow$

$\qquad 871$

$\frac{DL}{4} = \frac{1215}{4} = \quad 304\downarrow$

$T = 567 \quad) \quad T_A = 1500$
$\qquad S_A = 1500$

$\frac{2370}{4} = 593 \qquad S = 593$

5/8 Bolts used (See Enclosed Telecon)

∴ from STD-MS-13-3-1 $\quad T/T_A = \frac{567}{1500} = .378$

$S/S_A = \frac{593}{1500} = .395$

for $\frac{S}{S_A} = .395$, $\frac{T}{T_A} = .87$ Margin is $= \frac{.87}{.378} = 2.30$

for $\frac{T}{T_A} = .378$, $\frac{S}{S_A} = .87$ Margin is $= \frac{.87}{.395} = 2.20$ ✓

Margin of loads compared to STD-MS-13-3-1 is abt. 2.20 for the above loads. ✓

Anchor Loadings on Coil Assembly (5/8 Bolts)

ATTACHMENT N

ATTACHMENT M

$M = 100{,}250 \qquad T = \frac{M/2}{50.625} = \frac{100250/2}{50.625} = 990\uparrow$

$F_y = 1900 \qquad T = \frac{1900}{4} = 475\uparrow$
$\qquad DL = \frac{1940}{4} = 485\downarrow \qquad -10$

$\qquad 980\uparrow$ max. uplift.

$S = 3785 \qquad S = \frac{3785}{4} = 946$

$T = 1465 \qquad T/T_A = \frac{980}{1500} = .652$
$S = 946 \qquad S/S_A = \frac{946}{1500} = .63$ } OK by MS-13-3-1

Margin of loads compared to STD-MS-13-3-1 is abt. 1.05 for the above lds.

for $S/S_A = .63 \quad T/T_A \approx .68 \quad$ Margin is $= \frac{.68}{.65} = 1.05$

for $T/T_A = .65 \quad S/S_A = .66 \quad$ Margin is $= \frac{.66}{.63} = 1.05$

CALCULATION SHEET

A5010 51

J.O./W.O./CALCULATION NO.	REVISION	PAGE
11715-STR-059		52/118

PREPARER/DATE	REVIEWER/CHECKER/DATE	INDEPENDENT REVIEWER/DATE

SUBJECT/TITLE	QA CATEGORY/CODE CLASS

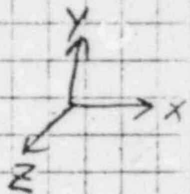
CONTAINMENT GAS & PARTICULATE MONITORS

Client VEPCO	Location No. ANNA	Est. No.	J.O. No 11715/R050
Subject SEISMIC MARGINS		Date 5/18/77	By R.J.Baker
AIR PARTICLE DETECTION ASSEMBLY		Checked 5/19/77	By RJ [illegible]
Based on ANCHOR BOLTS		Revised	By

ATTACHMENT O

LOADINGS: (in kips or inch-kips)

	F_x or F_z	F_y	M_x or M_z	M_y
D.L.	0	-4.25	0	0
OBE	±1.5	±0.9	±37.3	0
DBE	±2.1	±1.3	±51.0	0



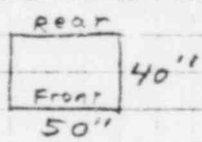
PER RON TATE: THIS EQUIPMENT IS HELD DOWN WITH 4 - 1/2" Ø ALL-THREAD RODS ANCHORED WITH HILTI - DROP INS.

SHEAR (D.L + OBE)

$$\frac{2.1^k}{4 \text{ BOLTS}} = .525^k/\text{BOLT}$$

Moment (ABOUT 50" EDGE)

PLAN VIEW:



Ref Mfg Print 11715/R050 1.21-57A

ASSUME 38" moment arm for anchor bolts to "front" of cabinet

$$\Sigma M_F = 0 = (-4.25+1.3)^k(20'') + 51^{k\text{-}in}$$

$$= -8 \text{ in-kips}$$ ← this means that the restoring moment is greater than the overturning moment, so there is no tension in bolts.

SHEAR RESISTANCE FROM FRICTION:

ASSUME COEFFICIENT OF FRICTION = .3

$(.3)(4.25-1.3) = .9^k < 2.1^k$ APPLIED.

ASSUME NO FRICTION - CALC MARGIN

FOR INFORMATION ONLY
DO NOT USE FOR DESIGN

Client VEPCO Location Est No J.O. No. 11715/12050
Subject SEISMIC MARGINS Date 5/18/77 By R.A. Belanger
Checked 5/19/77 By R.J. Faust
Based on Revised By

THE FOLLOWING PAGE CALCULATES THE BOLTING SEISMIC DESIGN MARGIN FOR ANCHORING THE AIR PARTICLE DETECTION ASSEMBLY (AUX BLDG 291')

Reference 11715-FM-2D (F-4, H-5)

11715/12050 1.21 - 57A
58A
59A

INFORMATION FROM THE FIELD (FXO - RON TATE) IS THAT THIS EQUIPMENT IS ANCHORED WITH 4-½" ø ALL THREAD RODS ANCHORED WITH HILTI-DROP IN ANCHORS.

LOADS ARE PER IOC FROM H.A. MUNI / S.A. LEHRMAN TO J.G. DYCKMAN / R.B. BRADBURY DATED 5/6/77.

CONCLUSION: NO ANCHOR BOLTS REQUIRED, FOR OVERTURNING - MARGIN OF SAFETY FOR SHEAR = 2.88

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11715-STR-059

▲ 5010.1D

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

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Item

Client | Location | Est. No. | J.O. No. 11715/12050

Subject | Date 5/18/77 | By [signature]

Checked 5/23/77 | By [signature]

Based on | Revised | By

$\frac{1}{2}$" Φ HDI CAPACITY IN SHEAR FOR 3000PSI CONCRETE :

	capacity
$f_c' = 2000$	5873
$= 3850$	6224

interpolating for $f_c' = 3000$

ULT Shear Cap $= \frac{1000}{1850}(6224 - 5873) + 5873 = 6073$ lbs

USING A F.S. OF 8 WRT ULTIMATE
SHEAR ALLOW = 758 lbs

FACTOR OF SAFETY (IN SHEAR)

$$F.S. = \frac{758}{525} = 1.44$$

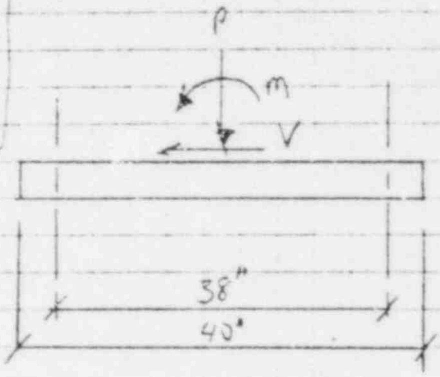
USE MANUFACTERER'S F.S. OF 4 $\therefore FS = \frac{2(758)}{525} = 2.88$

FOR INFORMATION ONLY
DO NOT USE FOR DESIGN

Client VEPCO	Location N.A. #1 & 2	Est. No.	J.O. No. 11715
Subject SEISMIC DESIGN MARGINS		Date MAY 19, 1977	By R. FAUST
AIR PARTICLE DETECTION ASSEMBLY UNITS 1 & 2		Checked May 19 1977	By E. G. Stefanick
Based on		Revised	By

THESE CALCULATIONS ARE PERFORMED TO CHECK WORK BY R.J.B 5/18/77

RJF



LOADINGS: $P = 4.25 - 1.30 = 2.95^k$ ↓

$V = 2.1^k$ ↔

$M = 51.0$ in-k

BOLT LOADINGS:

$\text{MAX COMP} = \frac{2.95}{4} + \frac{51}{2(38)} + 2.1(1)/38(2) = 1.436^k$

$\text{MAX TENSION} = \frac{2.95}{4} - \frac{51}{(38)2} - \frac{2.1(1)}{2(38)} = 0.039^k$

∴ NO TENSION IN BOLTS

SHEAR RESISTANCE FROM FRICTION. $\mu = 0.3$

$0.3(4.25 - 1.3) = 0.885^k < V_{APPLIED} = 2.1^k$

↖ MIN. VERT. LOAD

∴ BOLTS MUST TAKE SHEAR
WORST CASE (ASSUME NO FRICTION)

CAPACITY OF 1/2" HILTI IN PURE SHEAR = 758#

$V_{BOLT} = 2.1/4 = 0.525^k$

S.F = 1.444

FOR INFORMATION ONLY
DO NOT USE FOR DESIGN

AUXILIARY FEEDWATER PUMPS

NOTE: There are minor differences between The input used herein Taken from Attachment R, and The approved input given in Calc # 297 CBD. These differences do not warrant a recomputation of The "seismic design margin" by inspection. Note also that The margin for These motor driven pumps is quite high (see RESULTS SUMMARY)

Client VEPCO   Location N.A. 1&2   Est. No.   J.O. No. 11715/12050
Subject SEISMIC DESIGN MARGINS   Date JULY 12, 1977   By R. FAUST
AUXILIARY FEEDWATER PUMPS   Checked 7/19/77   By P.A. Colonna
Based on   Revised 7/19/77   By R. Faust
7/21/77   R. Faust

PROBLEM STATEMENT:

DETERMINE THE SEISMIC DESIGN MARGINS FOR THE HOLD-DOWN ANCHORAGE OF BOTH THE TURBINE DRIVEN AND MOTOR-DRIVEN AUXILIARY FEEDWATER PUMPS. THESE PUMPS SIT ON 5" CONCRETE PADS IN THE AUX. FEEDWATER PUMPHOUSE.

SUPPLEMENTED BY CALC. No. 13075.33-DC-12-8

REFERENCE DRAWINGS: 1) N.A. PROJECT FILE 246

2) 11715 - FC - 12B
" FC - 12H

ATTACHMENT

attached → 3.) IOC's TO DYCKMAN from LEHPINAN OTD { 6/21/77 R, 6/24/77 Q, 6/29/77 P }

RESULTS: 3/4" ϕ A-307 ANCHORS

A) MOTOR DRIVEN PUMPS:

UNIT ① → MARGIN = 11.50 ON TENSION (DBE)

UNIT ② → MARGIN = 5.94 ON TENSION (DBE)

B) TURBINE DRIVEN PUMPS:

UNIT ① → MARGIN = 1.71 ON TENSION (DBE)

UNIT ② → MARGIN = 1.28 ON " (DBE)

11715-STR-059

A 5010.1D

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

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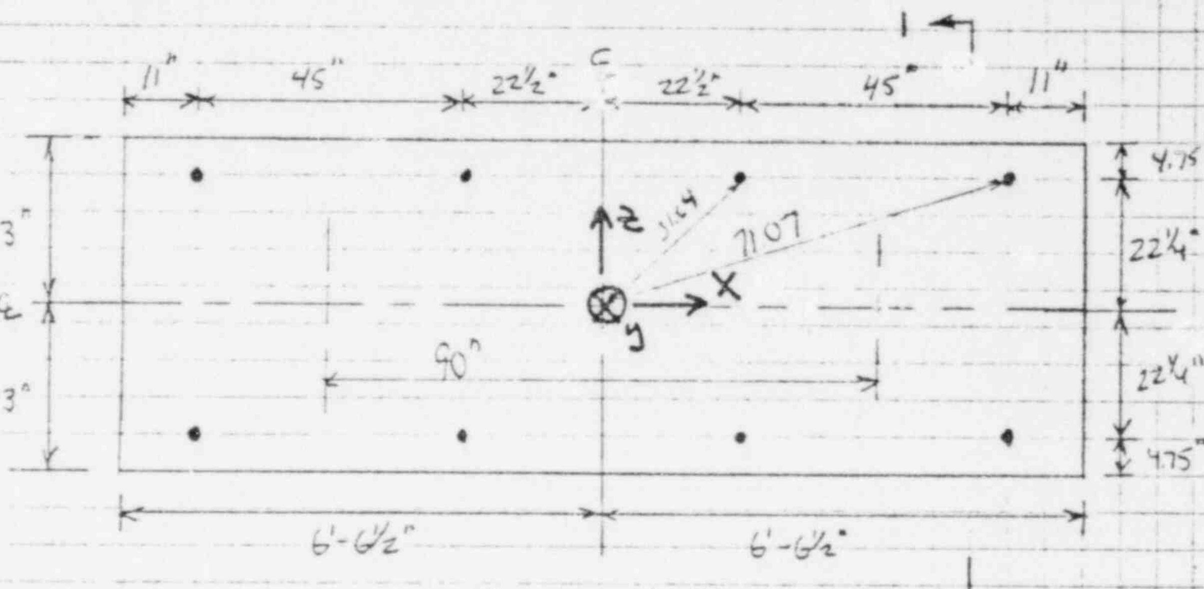
Client	VEPCO	Location	N.A. 1&2	J.O. No.	11715/12050
Subject	SEISMIC DESIGN MARGINS - AUX. FW PUMPS MOTOR DRIVEN	Date	July 12, 1977	By	R. FAUST
		Checked	7/19/77	By	[signature]
Based on		Revised		By	

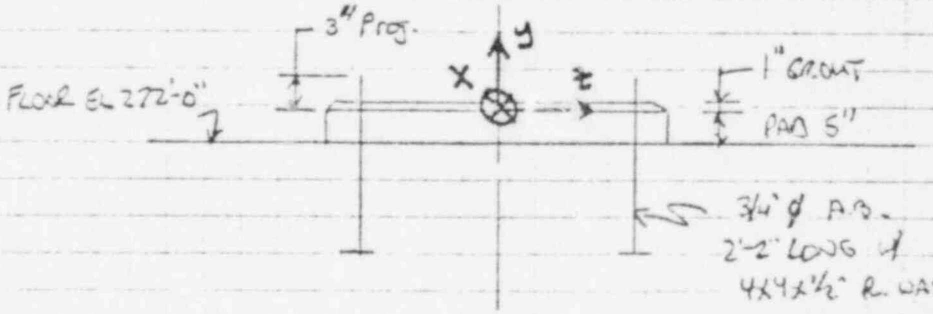
1-FW-P-3A :

	Fx (LBS)	Fy (LBS)	Fz (LBS)	Mx (ft-lbs)	My (ft-lbs)	Mz (ft-lbs)	
DL+THER+OP+OBE	1000	-9584	-1699	-7918	2800	-17403	✓
DL+THER+OP+DBE	838	-9527	-2589	-7587	3652	-17560	✓

NOTE: Fy REPRESENTS LEAST DOWNWARD FORCE, ALL OTHER FORCES AND MOMENTS CORRESPOND TO MAXIMUM MAGNITUDE. ✓



PLAN @ 272'-5"



1-1

Client VEPCO Location N.A 1&2 Est. No J.O. No 11715/12050

Subject SEISMIC DESIGN MARGINS - AUX. FW PUMPS MOTOR DRIVEN Date JULY 12, 1977 By R. FAUST

Checked 7/19/77 By RJ Bologna

Based on Revised By

CHECK CRITICAL BOLT LOADINGS: 1-FW-P-3A

A) ØBE CASE:

$F_y \Rightarrow 9584/8 = 1198^{\#} \downarrow$

$F_x \Rightarrow 1000/8 = 125^{\#}$

$F_z \Rightarrow 1699/8 = 212.4^{\#}$

$M_x \Rightarrow 7918/4 \times 45/12 = 527.9^{\#} \uparrow\downarrow$

$M_z \Rightarrow 17403/4 \times 90''/12 = 580.1^{\#} \uparrow\downarrow$ (ok conservative)

$M_y: 2800(12) = S(71.07)(4) + S\left(\frac{31.67}{71.07}\right)(31.67)(4)$

$2800(12) = S(284.28 + 56.45)$

$S = 2800(12)/340.73$

$S = 98.6^{\#}$ ✓

NET TENSION ON ANCHORS:

$T = -1198 + 527.9 + 580.1$

$T = -90^{\#}$/ANCHOR COMPRESSION

NO TENSION ∴ SHEAR ONLY

$S = \left[(125)^2 + (212.4)^2\right]^{1/2} + 98.6$ (ok conservative)

$= 345.1^{\#}$/ANCHOR MAXIMUM

3/4" A307 $V_{ALL} = 4.42^k$

MARGIN = 12.8

B) DBE CASE

$F_y = 9527/8 = 1190.9^{\#} \downarrow$

$F_x = 838/8 = 104.8^{\#}$

$F_z = 2589/8 = 323.6^{\#}$

$M_x = 7587/4 \times 45/12 = 505.8^{\#} \uparrow\downarrow$

$M_z = 17560/4 \times 90/12 = 585.3^{\#} \uparrow\downarrow$

$M_y: 3652(12) = \ldots$

$3652(12) = S(284.28 + 56.45)$

$S = 3652(12)/340.73$

$S = 128.6^{\#}$

NET TENSION ON ANCHORS:

$T = -1190.9 + 505.8 + 585.3$

$T = -99.8^{\#}$/ANCHOR COMPRESSION

NO TENSION ∴ SHEAR ONLY

$S_{MAX} = \left[(104.8)^2 + (323.6)^2\right]^{1/2} + 128.6$

$= 468.7^{\#}$/ANCHOR MAX.

$MARGIN = \frac{4420}{468.7} = 9.43$

check note: By inspection, the magnitude of the loads for 1-FW-P-3B are essentially the same as 1-FW-P-3A, and since the magnitude of the F.S. for 1-FW-P-3A is so high, the F.S. for 3B will not be calc.

Client VEPCO Location N.A. 1&2 Est. No. J.O. No. 11715/12050

Subject SEISMIC DESIGN MARGINS - AUX. FEEDWATER PUMPS MOTOR DRIVEN Date JULY 12, 1977 By R. FAUST

Checked 7/19/77 By J. Belanger

Based on Revised By

2-FW-P-3A: (SEE SKETCH P.21) (See Note P.2/ line 14)

	Fx	Fy	Fz	Mx	My	Mz
ØBE	2194	-9391	2086	9792	6564	18769
DBE	1042	-9431	2133	6370	3881	15323

1) CASE ØBE

$F_y = 9391/8 = 1174$ # ↓

$F_x = 2194/8 = 274.2$ #

$F_z = 2086/8 = 260.8$ #

$M_x = \frac{9792(12)}{180} = 652.8$ # ↓↑

$M_z = \frac{18769(12)}{360} = 625.6$ # ↓↑

$M_y = \frac{6564(12)}{340.73} = 230.1$ #

CRITICAL ANCHOR LOADINGS:

$T = -1174 + 652.8 + 625.6$

$T = 104.4$ # TENSION

$S = [274.2^2 + 260.8^2]^{1/2} + 230.1$

$S = 608.5$ #

MARGINS

SHEAR ONLY $SF = \frac{4420}{608.5} = 7.26$

$f_v = \frac{608.5}{.4418} = 1.38$ ksi

$f_t = 28 - 1.6(1.38) = 25.8$ USE 20 ✓

TENSION $\frac{20.0}{104.4/.3345} = 64.1$

2) CASE DBE

$F_y = 9431/8 = 1178.9$ # ↓

$F_x = 1042/8 = 130.25$ #

$F_z = 2133/8 = 266.6$ #

$M_x = \frac{6370(12)}{180} = 424.7$ # ↓↑

$M_z = \frac{15323(12)}{360} = 510.8$ # ↓↑

$M_y = \frac{3881(12)}{340.73} = 136.7$ #

CRITICAL ANCHOR LOADINGS

$T = -1178.9 + 424.7 + 510.8$

$T = -243.4$ # COMPRESSION ✓

$S = [130.25^2 + 266.6^2] + 136.7$

$S = 433.4$ #

MARGIN = $\frac{4420}{433.4} = 10.2$ ✓

Client VEPCO   Location N.A. 1&2   Est. No.   J.O. No. 11715/12050

Subject SEISMIC DESIGN MARGINS - AUX FW PUMPS MOTOR-DRIVEN   Date JULY 12, 1977   By R FAUST

Checked 7/19/77   By RJ Bologna

Based on   Revised   By

2-FW-P-3B (SEE SKETCH P.21)

	Fx	Fy	Fz	Mx	My	Mz
OBE	-1342	-9524	2198	-7183	7302	16731
DBE	-653	-9526	2575	-5220	5224	15381

1) CASE OBE

$F_y = 9524/8 = 1190.5$ # ↓

$F_x = 1342/8 = 167.8$ #

$F_z = 2198/8 = 274.8$ #

$M_x = \frac{7183(12)}{180} = 478.9$ # ↑↓

$M_z = \frac{16731(12)}{360} = 545.7$ # ↑↓

$M_y = \frac{7302(12)}{340.73} = 257.2$ #

CRITICAL ANCHOR LOADINGS

$T = -1190.5 + 478.9 + 545.7$

$T = -165.9$ # COMPRESSION

$S = [(167.8)^2 + (274.8)^2]^{1/2} + 257.2$

$S = 579.2$ #

MARGIN ON SHEAR:

$S.F. = \frac{4420}{579.2} = 7.63$

2) CASE DBE

$F_y = 9526/8 = 1190.8$ # ↓

$F_x = 653/8 = 81.6$ #

$F_z = 2575/8 = 321.9$ #

$M_x = \frac{5220(12)}{180} = 348$ # ↑↓

$M_z = \frac{15381(12)}{360} = 512.7$ # ↑↓

$M_y = \frac{5224(12)}{340.73} = 184.0$ #

CRITICAL ANCHOR LOADINGS:

$T = -1190.8 + 348 + 512.7$

$T = -330.1$ # COMPRESSION

$S = [(81.6)^2 + (321.9)^2]^{1/2} + 184$

$S = 516.1$ #

MARGIN ON SHEAR:

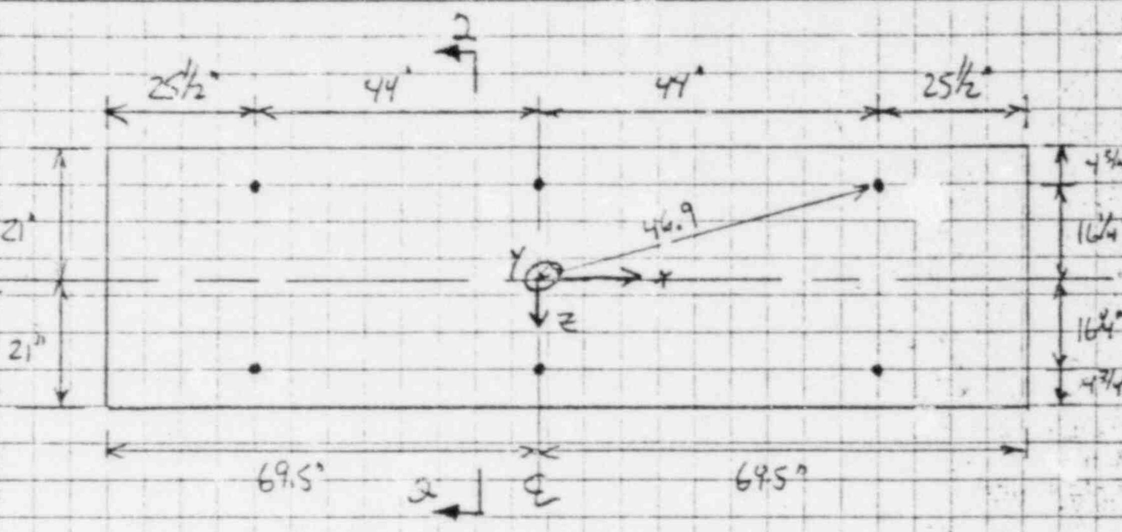
$SF = \frac{4420}{516.1} = 8.56$

Client VEPCO Location N.A. 1&2 Est. No. J.O. No 11715/12050

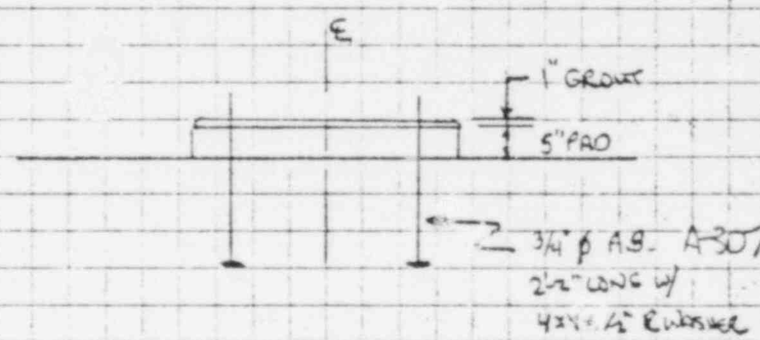
Subject SEISMIC DESIGN MARGINS - AUX. FW PUMPS TURBINE DRIVEN Date JULY 12, 1977 By R. FAUST

Checked 7/19/77 By RJ BaCo-jr

Based on Revised By



PLAN @ EL 272'-5"



2-2

LOADINGS:

		Fx	Fy	Fz	[illegible]	My	Mz
1-FW-P-2	OBE	-4206	-7541	2695	11750	-12998	-14636
	DBE	-4298	-8407	2554	9166	-12778	-14679 ✓
2-FW-P-2	OBE	5301	-6572	-2682	-16095	16475	14719
	DBE	5395	-7690	-1959	-10839	10859	11628 ✓

{forces in lbs.
moments in ft-lbs}

$$M_y = S(46.9)(4) + S\,\frac{16.25}{46.9}(16.25)(2)$$

$$= S(187.6 + 11.26) = 198.9\,S \checkmark$$

Client VEPCO Location NA 1&2 Est. No. J.O. No. 11715/12050
Subject SEISMIC DESIGN MARGINS - AUX FW PUMPS TURBINE DRIVEN Date JULY 12, 1977 By R. FAUST
Checked 7/19/77 By [signature]
Based on Revised By

FW-P-2

A) OBE CASE

$F_y = 7541/6 = 1256.8^{\#}\downarrow$

$F_x = 4206/6 = 701^{\#}$

$F_z = 2695/6 = 449.2^{\#}$

$M_x = \frac{11750(12)}{3 \times 32.5} = 1446.2^{\#} \uparrow\downarrow$

$M_z = \frac{14636(12)}{2(88)} = 997.9^{\#} \uparrow\downarrow$

$M_y = \frac{12998(12)}{198.9} = 784.2^{\#}$

CRITICAL BOLT LOADING

$T = -1256.8 + 1446.2 + 997.9$

$T = 1187.3^{\#}$ TENSION

$S = \left[(701)^2 + (449.2)^2\right]^{1/2} + 784.2$

$S = 1616.8^{\#}$ SHEAR

∴ CASE (A) CONTROLS ✓

$f_v = \frac{1.6168}{.4418} = 3.66$ ksi

$F_T = 28 - 1.6(3.66) = 22$ USE 20 ksi ✓

MARGIN ON SHEAR:

$SF = 4420/1616.8 = 2.73$

MARGIN ON TENSION

$SF = \frac{20}{1.1873/.3345} = 5.63$

B) DBE CASE

$F_y = 8407/6 = 1401.2^{\#}\downarrow$

$F_x = 4298/6 = 716.3^{\#}$

$F_z = 2554/6 = 425.7^{\#}$

$M_x = \frac{9166(12)}{3 \times 32.5} = 1128.1^{\#} \uparrow\downarrow$

$M_z = \frac{14679(12)}{2(88)} = 1000.8^{\#} \uparrow\downarrow$

$M_y = \frac{12778(12)}{198.9} = 770.9^{\#}$

CRITICAL BOLT LOADING:

$T = -1401.2 + 1128.1 + 1000.8$

$T = 727.7^{\#}$ TENSION

$S = \left[(716.3)^2 + (425.7)^2\right]^{1/2} + 770.9$

$S = 1604.2^{\#}$ SHEAR

A 5010.1D

STONE & WEBSTER ENGINEERING CORPORATION

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Client VEPCO Location N.A. 1&2 Est. No J.O. No. 11715/120SC
Subject SEISMIC DESIGN MARGINS - AUX. FW PUMPS TURBINE DRIVEN Date JULY 12, 1977 By R FAUST
Checked 7/19/77 By RJ Belanger
Based on Revised By

2-FW-P-2

A) OBE CASE

$F_y = 6572/6 = 1095.3^{\#} \downarrow$

$F_x = 5301/6 = 883.5^{\#}$

$F_z = 2682/6 = 447^{\#}$

$M_x = \frac{16095(12)}{3(32.5)} = 1980.9^{\#} \downarrow\uparrow$

$M_y = \frac{16475(12)}{198.9} = 994^{\#}$

$M_z = \frac{14719(12)}{2(88)} = 1003.6^{\#} \downarrow\uparrow$

CRITICAL ANCHOR LOADINGS

$T = -1095.3 + 1980.9 + 1003.6$

$T = 1889.2^{\#}$ ✓

$S = [(883.5)^2 + (447)^2]^{1/2} + 994$

$S = 1984^{\#}$

∴ CASE (A) CONTROLS ✓

$f_v = 1984/.4418 = 4.49$ KSI ✓

$F_T = 28 - 1.6(4.49) = 20.8$ USE 20 KSI ✓

MARGINS:

SHEAR $SF = \frac{4420}{1984} = 2.23$ ✓

TENSION $SF = \frac{20}{1.8892/.3345} = 3.54$ ✓

B) DBE CASE

$F_y = \frac{7690}{6} = 1281.7^{\#} \downarrow$

$F_x = \frac{5395}{6} = 899.2^{\#}$

$F_z = \frac{1959}{6} = 326.5^{\#}$

$M_x = \frac{10839(12)}{3(32.5)} = 1334^{\#} \uparrow\downarrow$

$M_y = \frac{10859(12)}{198.9} = 655^{\#}$

$M_z = \frac{11628(12)}{2(88)} = 792.8^{\#} \uparrow\downarrow$

CRITICAL ANCHOR LOADINGS

$T = -1281.7 + 1334 + 792.8$

$T = 845.1^{\#}$ ✓

$S = [(899.2)^2 + (326.5)^2]^{1/2} + 655$

$S = 1611.6^{\#}$ ✓

11715-STR-059

A 5010.1D

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

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Client VEPCO   Location NA 1&2   Est. No.   J.O. No 11715/12050

Subject SEISMIC DESIGN MARGINS   Date JULY 19, 1977   By R. J. FAUST

AUXILIARY FEEDWATER PUMPS   Checked 7/19/77   By RJ Bulenz

Based on   Revised   By

CHECK SHEAR FRICTION CAPACITY OF SUPPORT :

$$A_{vf} = \frac{V_u}{\phi f_y \mu}$$ ACI 318-71 (11.15.4)

$V_u = \phi \mu (A_{vf} f_y)$ — USE T_{ALL} — where $\phi = .85$ ✓, $\mu = .7$ ✓, $f_y = 33$ ksi ✓, $A_{vf} = 0.3345$ in² (3/4" φ ANCHORS) ✓

I) 1-FW-P-2 (OBE) Turbine Driven

$T_{ALL} = 0.3345 (20) = 6.69^k$ ✓

$T_{ACT} = 1.1873^k$ ✓
$V_{ACT} = 1.6168^k$ ✓

T' = RESIDUAL TENSILE CAPACITY $= 6.69 - 1.1873 = 5.5027^k$

$V_u = 0.85 (0.7)(5.5027) = 3.2741^k > 1.6168^k$ OK

$A_{REQ} = \frac{3271.4}{.2(3000)} = 5.46$ in² OK (AREA OF CONCRETE)

COMPUTE MARGIN ON TENSION FOR SHEAR $= 1.6168^k$

$T'' = \frac{1.6168}{.85(.7)} = 2.7173^k$

$T_{TOT} = 2.7173 + 1.1873 = 3.9046^k$

$MARGIN = \frac{6.69}{3.9046} = \underline{\underline{1.71}}$ ∴ CONTROLS

∴ S.F = 1.71 BASED ON TENSION IN A-307 BOLT FROM OBE CASE

Client VEPCO Location NA 1&2 Est No. J.O. No 11715/12050
Subject SEISMIC DESIGN MARGINS Date JULY 19, 1977 By RJ FAUST
AUXILIARY FEEDWATER PUMPS Checked 7/19/77 By RJ Belanger
Based on Revised By

II) 2-FW-P-2 (OBE) { T_{APP} = 1889.2# ; V_{APP} = 1984# } TURBINE DRIVEN

T' = RESIDUAL TENSILE CAPACITY = $6.69 - 1.8892 = 4.8008^{K}$

$V_u = 0.85(0.7)(4.8008) = 2.8565^{K} > 1.984^{K}$ OK

$A_{REQ} = \frac{2856.5}{.2(3000)} = 4.76 \text{ in}^2$ OK

COMPUTE MARGIN:

$T'' = \frac{1.984}{.85(.7)} = 3.3344^{K}$

$T_{TOT} = 1.8892 + 3.3344 = 5.2236^{K}$

$\text{MARGIN} = \frac{6.69}{5.2236} = 1.28$ ∴ CONTROLS

∴ SF = 1.28 BASED ON TENSION IN A-307 BOLT FROM OBE CASE !

Client VEPCO Location NA 1&2 Est. No. J.O. No. 11715/12050

Subject SEISMIC DESIGN MARGINS Date JULY 21, 1977 By R. FUST

AUXILIARY FEEDWATER PUMPS Checked 7/21/77 By RJ Balogh

Based on Revised By

III) 2-FW-P-3A

A) OBE CASE

$C_{APP} = 90^{\#}$
$V_{APP} = 345^{\#}$

$T_{ALL} = 0.3345(20) = 6.69^{K}$

V_u = POSSIBLE SHEAR FRICTION FORCE
= 0.85(0.7)(6.69)
= 3.98 K OK

$T'' = \frac{345}{.7(.85)} = 579.8^{\#}$

$\text{MARGIN} = \frac{6690}{579.8} = 11.5$ ON TENSION

B) DBE CASE

$C_{APP} = 97.8^{\#}$
$V_{APP} = 468.7^{\#}$

$T_{ALL} = .3345(20)(1.33) = 8.92^{K}$

$V_u = 0.85(0.7)(8.92)$
$= 5.31^{K}$ OK

IV) 2-FW-P-3A

A) OBE-CASE

$T_{APP} = 104.9^{\#}$
$V_{APP} = 608.5^{\#}$

$V_u = 3.98^{K}$ OK

$T' = \frac{608.5}{.85(.7)} = 1022$

$T_{OT} = 1022 + 104 = 1127^{\#}$

$\text{MARGIN} = \frac{6690}{1127} = 5.94$ ON TENSION

D.C. DISTRIBUTION PANELS

A 5010.1D

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

Preliminary

Item

Client VEPCO Location NA #1 & #2 Est No. J.O. No. 11715

Subject D.C. Distribution Panels Date 5/10/77 By E.R. Stefani

Checked 5/10/77 By R. [illegible]

Based on Revised By

Max. Bolt Lds. (Wall Mounted Equipment)

Weight 300 lbs.

ATTACHMENT S

DBE .98(300) = 294 ↓ + 300 ↓ = 594 ↓ shear

DBE 1.95(300) = 585 Ten.

$$\text{Shear / bolt} = \frac{594}{4} = 149 \text{ lbs.}$$

ATTACHMENT T

$$\text{Ten / bolt} = \frac{585}{4} = 146 \text{ lbs}$$

$$\frac{T}{T_A} = \frac{146}{700} = .21; \quad \frac{S}{S_A} = .95; \quad S = .95(700) = 665$$

$$\text{Margin} = \frac{665}{149} = 4.46 \checkmark$$

$$\frac{S}{S_A} = \frac{149}{700} = .21; \quad \frac{T}{T_A} = .95 \quad T = .95(700) = 665$$

$$\text{Margin} = \frac{665}{1.46} = 4.56 \checkmark$$

Panels bolted to horz. unistrut. 3/8" bolts to unistrut are fully developed for rt. ∠ loads based on test data from N. Penn. Unistrut connected to conc. by ½"φ drop in anchors.

CALCULATION SHEET

A5010.61

J.O./W.O./CALCULATION NO.	REVISION	PAGE
11715-STR-059		71/11_

PREPARER/DATE	REVIEWER/CHECKER/DATE	INDEPENDENT REVIEWER/DATE

SUBJECT/TITLE	QA CATEGORY/CODE CLASS

15 & 20 KVA STATIC INVERTERS

Client VEPCO Location No ANNA Est. No. J.O. No. 11715
Subject SEISMIC MARGINS OF 15KVA + 20KVA STATIC INVERTERS - ANCHORS Date 5/3/77 By RDB
Checked 6/1/77 By [illegible]
Based on Revised By

PURPOSE - TO CALCULATE THE SEISMIC MARGIN OF THE BOLTS THAT ANCHOR THE 15KVA AND 20KVA STATIC INVERTERS LOCATED IN THE SERVICE BLDG @ EL 254'

REFERENCE:

① ~~IOC TO J.G. DYKMAN/R.B. BRADBURY FROM S.A. LEHRMAN / S.N. CARUSO DTD 4/29/77 (ATTACHED)~~

② S&W FILE DWG (MFG PRINT) 11715-1.17-190 (20KVA)

③ " " " " 11715-1.17-200 (15KVA)

④ 11715-FM-5C

⑤ 11715-FC-6E

⑥ 11715-FE-27 SERIES

⑦ 12050-FE-27A

⑧ 11715-FE-37 SERIES

⑨ IOC To R. BRADBURY FROM S. LEHRMAN DTD 5/12/77 - THESE LOADS SUPERSEDE THOSE ON Ref ①

→ ATTACHMENT "U"

⑩ Field as-built sketches showing ⊓ locations 2 sheets, T. Devine 5-14-77 ATTACHMENT "W"

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(S)

GO TO PAGE 79

15 KVA

SHEAR : (DBE)

$f_v/_{BOLT} = \frac{3.41^k}{4} = .85^k/BOLT$

TENSION :

a) UPLIFT = $-1.75 + 1.72 \cong 0$

b) OVERTURNING - ABOUT A LINE IN THE FRONT $(22 + \frac{3}{2})$ inches FROM THE BOLTS IN THE REAR:

M = 143 in-kip

$TENSION = \frac{143 \text{ in-kip}}{(22 + \frac{3}{2})} = 6.1^k$

$TENSION/_{BOLT} = \frac{6.1}{2} = 3.0^k$

11715-STR-059

Client VEPCO Location No. ANNA Est. No. J.O. No. 11715

Subject Date 5/3/77 By RJ Bo[illegible]

Checked By

Based on Revised By

SUMMARY 15 KVA (OBE)

TENSION = 3.0^K
SHEAR = $.85^K$

THE MANUFACTURER PROVIDES HOLES FOR 1/2" ϕ BOLTS TO ANCHOR THIS EQUIPMENT TO THE FLOOR.

ASSUMING 1/2" HILTI KWIK BOLTS - N.G.

PER STD-MS-13-3-1 1/2" ϕ HILTI'S ARE GOOD FOR 1000 # TENSION OR 1000 # SHEAR.

PER FIELD THERE ARE 4 CHANNELS UNDER THE INVERTER. ASSUME 8 BOLTS CAN BE USED:

$$SHEAR = \frac{3.41^K}{8} = .43^K/BOLT$$

$$TENSION = \frac{6.1}{4} = 1.5^K/BOLT$$

} STILL N.G.

Redesign Req'd.

S

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Client VEPCO Location No. ANNA Est. No J.O. No. 11715
Subject SEISMIC MARGINS Date 5/9/77 By RJBalogan
Checked By
Based on 15 KVA INVERTER Revised By

S

15 KVA DESIGN

TOTAL SHEAR = 3.41^k (ON ALL BOLTS) (TOTAL)

TOTAL TENSION (DUE TO OVERTURNING) = 6.1^k

S

EXISTING ½" ∅ BOLTS ARE MOST PROBABLY ANCHORED INTO HILTI-DROP IN ANCHORS (HDI). CHECK THEIR CAPACITY:
USING THE ABBOT A. HANKS REPORT

GOOD

FOR 2000 PSI CONCRETE: T = 3997 #, S = 5873 #
" 3850 PSI CONCRETE: T = 6751 #, S = 6224 #

T = ultimate tension capacity
S = ultimate shear capacity

LINEARLY INTERPOLATING FOR 3000 PSI CONCRETE:

$$T_u = 3997 + \frac{1000}{1850}(6751 - 3997)$$

$$= 3997 + 1489$$

$$= 5486^{\#}$$

$$S_u = 5873 + \frac{1000}{1850}(6224 - 5873)$$

$$= 5873 + 190$$

$$= 6063^{\#}$$

USING A FACTOR OF SAFETY OF 4 WRT ULTIMATE:

$$T_A = \frac{5486}{4} = 1372^{\#}$$

$$S_A = \frac{6063}{4} = 1516^{\#}$$

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A 5010.1D

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

Client VEPCO Location No. ANNA Est. No J.O. No. 11715
Subject SEISMIC MARGINS Date 5/9/77 By RJBolenz
Checked By
Based on 15 KVA INVERTERS Revised By

USING 8 BOLTS:

SHEAR/BOLT = $\frac{3410^{\#}}{8}$ = $426^{\#}$

USING STD-MS-13-3-1 TO CALCULATE
ALLOWABLE TENSION ON OUTSIDE BOLTS:

$$\left(\frac{426}{758}\right)^{5/3} + \left(\frac{T}{686}\right)^{5/3} = 1$$

$$.383 + \left(\frac{T}{686}\right)^{5/3} = 1$$

$$\frac{T}{686} = (1-.383)^{3/5} = .749$$

$$T = 514^{\#}$$

∴ TENSION REQ'D BY ADDITIONAL BOLTS:

$6100^{\#} - (2 \times 514) = 5072^{\#}$

THIS IS TOO HIGH - TRY ANOTHER APPROACH

ASSUME "FRONT" BOLTS TAKE OUT THEIR FULL CAPACITY IN SHEAR

$2 \times 758 = 1516^{\#}$ (½"ϕ HDI ANCHOR - EXIST)
$2 \times 1000 = 2000^{\#}$ (½"ϕ HILTI-KWIK BOLTS - TO BE ADDED)
$\Sigma\ 3516^{\#}$

SHEAR LOAD IS $3410^{\#} < 3516^{\#}$ ∴ OK
NOW LET "REAR" BOLTS HOLD DOWN OVERTURNING LOAD. (2-½"ϕ HDI & 2-½"ϕ HILTI KWIK BOLTS)

TENSION = $6100^{\#}$
-2-HDI = $2 \times 686 = 1372^{\#}$ REMAINDER = 6100 - 1372 = 4728

THIS IS STILL TOO HIGH

TRY 8 HILTI-KWIK BOLTS. (¾"ϕ) 5" EMBED.

$T_A = 2200^{\#}$ $S_A = 1800^{\#}$ (Per STD-MS-13-3-1)

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STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

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Client VEPCO	Location No. Anna	Est No	J.O. No. 11715
Subject SEISMIC MARGINS		Date 5/9/77	By RJ Bak
		Checked	By
Based on 15 KVA INVERTERS		Revised	By

SHEAR/BOLT = 426#

TENSION/BOLT = $\frac{6100}{4}$ = 1525#

$$\left(\frac{462}{1800}\right)^{5/3} + \left(\frac{1525}{2200}\right)^{5/3} = .63 \text{ — OK}$$

HAVE FIELD USE CENTER-HOLE JACK WITH AN A-325 BOLT + PULL OUT EXISTING ANCHORS. THEN DRILL HOLES FOR 3/4" ϕ HILTI-KWIK BOLTS. DO NOT USE A PERCUSSION DRILL TO PREVENT SPALLING OF CONCRETE BENEATH SLAB.

(S)

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Client VEPCO Location No. ANNA Est. No. J.O. No 11715

Subject SEISMIC MARGINS Date 5/3/77 By RJBaley

Checked By

Based on 20 KVA INVERTERS Revised By

20 KVA

SHEAR : (DBE)

$f_v/\text{BOLT} = 4.58/4 = 1.15^k/\text{BOLT}$

TENSION:

a) UPLIFT = $-2.35 + 2.30 \cong 0$

b) OVERTURNING :

$\text{TENSION} = \dfrac{193 \text{ in-kip}}{(22 + \frac{3}{2})''} = 8.2^k$

$\text{TENSION/BOLT} = \dfrac{8.2}{2} = 4.1^k$

SUMMARY 20 KVA (DBE)

TENSION = 4.1^k } PER BOLT
SHEAR = 1.15^k }

BASED ON 1/2" Ø HDI - N.G

FIELD INDICATES THERE ARE 6 CHANNELS BENEATH INVERTER. ASSUME 12 BOLTS CAN BE PLACED :

$\text{SHEAR} = \dfrac{4.58}{12} = .38^k/\text{BOLT}$ }
$\text{TENSION} = \dfrac{8.2}{6} = 1.36^k/\text{BOLT}$ } STILL N.G.

REDESIGN REQ'D

A 5010.1D

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CALCULATION SHEET

Client VEPCO Location No. ANNA Est. No. J.O. No. 117..
Subject SEISMIC MARGINS Date 5/9/77 By RGBaker
Checked By
Based on 20 KVA INVERTER Revised By

TOTAL SHEAR = 4.58^K (TOTAL ON ALL BOLTS)

TOTAL TENSION DUE TO OVERTURNING = 8.2^K

EXISTING ½" ϕ BOLTS ARE MOST PROBABLY ANCHORED INTO HILTI-DROP IN ANCHORS. PER PG 2A:

$T_A = 686^{\#}$ $S_A = 758^{\#}$

ASSUME ADDITIONAL CHANNELS ANCHORED WITH ¾" ϕ HILTI-KWIK BOLTS:

ASSUME "FRONT" BOLTS TAKE THEIR FULL SHEAR CAPACITY.

2(758) + 4(1800) = 1516 + 7200 = 8716#

SHEAR LOAD = 4580# ∴ OK

TENSION: (8200#) ("REAR" BOLTS)

2(686) + 4(2200) = 1372 + 8800 = 10,172# - OK

HAVE FIELD INSTALL ¾" ϕ HILTI-KWIK BOLTS W/5" EMBED IN EACH OF THE 4 "INTERIOR" CHANNELS, IN THE SAME RELATIVE POSITION AS THE EXISTING BOLTS. (I.E. 3" FROM EACH END OF THE CHANNELS)

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Client VEPCO   Location No. Anna   Est. No   J.O. No 11715
Subject SEISMIC MARGINS   Date 5/.../77   By ...
Checked 6/1/77   By ...
Based on 15 KVA INVERTER   Revised   By

NEW ANCHOR (See Ref 9) ATTACHMENT U

SHEAR (DBE)

$\frac{f_v}{BOLT} = \frac{2.1^k}{4} = .525^k/BOLT = \underline{525}\ lb/BOLT$ ✓

TENSION

OVERTURNING ABOUT A LINE IN THE FRONT (22+½) INCHES FROM THE ...
(DBE)

M = 65.52 in-k

$TE = \frac{(-1.75+.82)}{4} + \frac{65.52\ in\text{-}k}{(23.5)(2)} - \frac{(1.75-.82)(\ldots)}{(\ldots)2}$

= −.23 + 1.39 − .23

= .94 k/B... = $\underline{940}$ lb/B... ✓

← ATTACHMENT "V"

FOR HDI ... USING A FACTOR OF SAFETY OF 4 WITH ... CRITERIA ...

$T_A = \frac{5488}{4} = 1372$ lb ✓

$S_A = \frac{6063}{4} = 1516$ lbs ✓

$\left(\frac{T}{T_A}\right)^{5/3} + \left(\frac{S}{S_A}\right)^{5/3} = ...$

$\left(\frac{940}{1372}\right)^{5/3} + \left(\frac{525}{1516}\right)^{5/3} = ...$

.532 + .171 = .703 ...

SAFETY FACTOR = $\frac{1}{.703}$ = 1.42 ✓

Client VEPCO Location No. Anna J.O. No. [illegible]

Subject SEISMIC MARGIN Date 6/1[illegible]/90 By [illegible]

Checked By

Based on 15 KVA [illegible] Revised By

CALCULATE MARGIN BASED [illegible] SHEAR [illegible]

$T = 940$ lb/bolt $S = 525$ lb/bolt

$T_A = 1372$ lb/bolt $S_A = 1516$ lb/bolt

FOR ALLOWABLE SHEAR $\bar{S}$

$$\left(\frac{T}{T_A}\right)^{5/3} + \left(\frac{\bar{S}}{S_A}\right)^{5/3} = 1$$

$$\bar{S} = \left[1 - \left(\frac{T}{T_A}\right)^{5/3}\right]^{3/5} S_A$$

$$\bar{S} = \left[1 - \left(\frac{940}{1372}\right)^{5/3}\right]^{3/5} 1516 = 961 \text{ lb}$$

Shear Margin [illegible] $= \frac{\bar{S}}{S} = \frac{961}{525} = \underline{\underline{1.8}}$

FOR ALLOWABLE TENSION $\bar{T}$

$$\left(\frac{\bar{T}}{T_A}\right)^{5/3} + \left(\frac{S}{S_A}\right)^{5/3} = 1$$

$$\bar{T} = \left[1 - \left(\frac{S}{S_A}\right)^{5/3}\right]^{3/5} T_A$$

$$\bar{T} = \left[1 - \left(\frac{525}{1516}\right)^{5/3}\right]^{3/5} 1372 = 1226 \text{ lb}$$

Tension Margin [illegible] $= \frac{\bar{T}}{T} = \frac{1226}{940} = \underline{\underline{1.3}}$

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STONE & WEBSTER ENGINEERING CORPORATION

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Item

Client: VEP[illegible] | Location: No Anna | Est. No | J.O. No. 11715[illegible]

Subject: SEISMIC MARGINS | Date: 6/15/77 | By: [illegible]

Checked: 6/15/77 | By: [illegible]

Based on: 15 KVA INVERTERS | Revised | By: ✓

ASSUME THAT THE BOLTS [illegible] COMPRESSION Z[illegible] TAKE ALL THE SHEAR LOAD, WHILE THE BOLTS [illegible] THE TENSION [illegible] TAKE ALL THE TENSION LOAD FROM [illegible]

[illegible]/BOLT = $\frac{2.1^k}{2}$ = 1.05^k/BOLT = 1050 lb/[illegible]

TENSION/BOLT = [illegible] lb/[illegible] (SEE [illegible] 27)

FOR HDI'S USING A FACTOR OF SAFETY OF 4 WITH [illegible] CREEP [illegible] (PG 28)

T_A = $\frac{5[illegible]}{4}$ = [illegible] lbs

S_A = [illegible]

Margin [illegible]

SHEAR = $\frac{1516}{10[illegible]}$ = 1.44

TE[illegible] $\frac{1372}{940}$ = 1.46

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STONE & WEBSTER ENGINEERING CORPORATION

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Item

Client VEPCO Location No. Anna Est. No. J.O. No. 11715

Subject SEISMIC MARGINS Date 5/23/77 By

Checked 6/1/77 By

Based on 20 KVA Revised By

NEW LOADS

SHEAR (OBE)

$= \frac{2.8}{4} = .705$ k/bolt = 705 lb/bolt

TENSION (OBE)

M = 71.9

T = $\frac{(-2.85 - 1.12)}{4} + \frac{71.97}{(23.)(2)} - \frac{(2.85 - 1.12)(35)}{23.5(2)}$

= -.21 + 1.53 - ...

= ... ✓

... HDI ... OF 4 ...

T_A = 1392 ... ✓

S_A = ... ✓

$\left(\frac{T}{T_A}\right)^{5/3} + \left(\frac{S}{S_A}\right)^{5/3} = ?$

$\left(\frac{...}{1392}\right)^{5/3} + \left(\frac{705}{...}\right)^{5/3} =$

.519 + .279 = .798 ≤ 1 OK

SAFETY ... $\frac{1}{.798}$ = 1.25 ✓

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Item

Client VEPCO	Location No ANNA	Est. No	J.O. No 11715
Subject SEISMIC MARGINS		Date 6/13/77	By RAF
		Checked	By
Based on 20 KVA INVERTERS		Revised	By

CALCULATE MARGINS BASED ON SHEAR OR TENSION ALLOWABLES

$T = 926$ lb/bolt $\quad S = 705$ lb/bolt

$T_A = 1372$ lbs/bolt $\quad S_A = 1516$ lb/bolt

FOR ALLOWABLE SHEAR $\bar{S}$

$$\left(\frac{T}{T_A}\right)^{5/3} + \left(\frac{\bar{S}}{S_A}\right)^{5/3} = 1$$

$$\bar{S} = \left[1 - \left(\frac{T}{T_A}\right)^{5/3}\right]^{3/5} S_A$$

$$\bar{S} = \left[1 - \left(\frac{926}{1372}\right)^{5/3}\right]^{3/5} 1516 = 977 \text{ lb}$$

Shear Margin of Safety = $\frac{\bar{S}}{S} = \frac{977}{705} = \underline{\underline{1.4}}$

FOR ALLOWABLE TENSION $\bar{T}$

$$\left(\frac{\bar{T}}{T_A}\right)^{5/3} + \left(\frac{S}{S_A}\right)^{5/3} = 1$$

$$\bar{T} = \left[1 - \left(\frac{S}{S_A}\right)^{5/3}\right]^{3/5} T_A$$

$$\bar{T} = \left[1 - \left(\frac{705}{1516}\right)^{5/3}\right]^{3/5} 1372 = 1127 \text{ lbs}$$

Tension Margin of Safety = $\frac{\bar{T}}{T} = \frac{1127}{926} = \underline{\underline{1.2}}$

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Preliminary

Item

Client: VEPCO Location: No. Anna Est. No. J.O. No. [illegible]

Subject: [illegible] Date: [illegible] By: [illegible]

Checked: [illegible] By: [illegible]

Based on: 20 KVA INVERTER Revised By

ASSUME [illegible] THE
COMPRE[illegible] TAKE [illegible] THE [illegible] AR
LOAD, [illegible]
[illegible]
[illegible]

SHEAR/BOLT = [illegible] = 1.411^K = [illegible]

TENSION/BOLT = 920 [illegible] ([illegible])

FOR [illegible]
[illegible]

Tr = [illegible]

[illegible]

[illegible]

SHEAR [illegible] $\frac{1.5?}{1.411}$ = 1.07

TENSION [illegible] $\frac{1.3??}{920}$ = 1.4?

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4160V SWITCHGEAR

Client VEPCO
Location N.A. #1
J.O. No. 11715

Subject 4160V SWITCHGEAR SUPPORT ANCHORAGE
Date 6/2/77
By R. F[illegible]

Checked 6/3/77
By E.L. [illegible]

Based on
Revised
By

PROBLEM STATEMENT:

DETERMINE THE ALLOWABLE MARGIN OF SAFETY UNDER SEISMIC CONDITIONS FOR THE 4160V SWITCHGEAR SUPPORT ANCHORAGE IN THE EMERGENCY SWITCHGEAR ROOM OF THE SERVICE BUILDING.

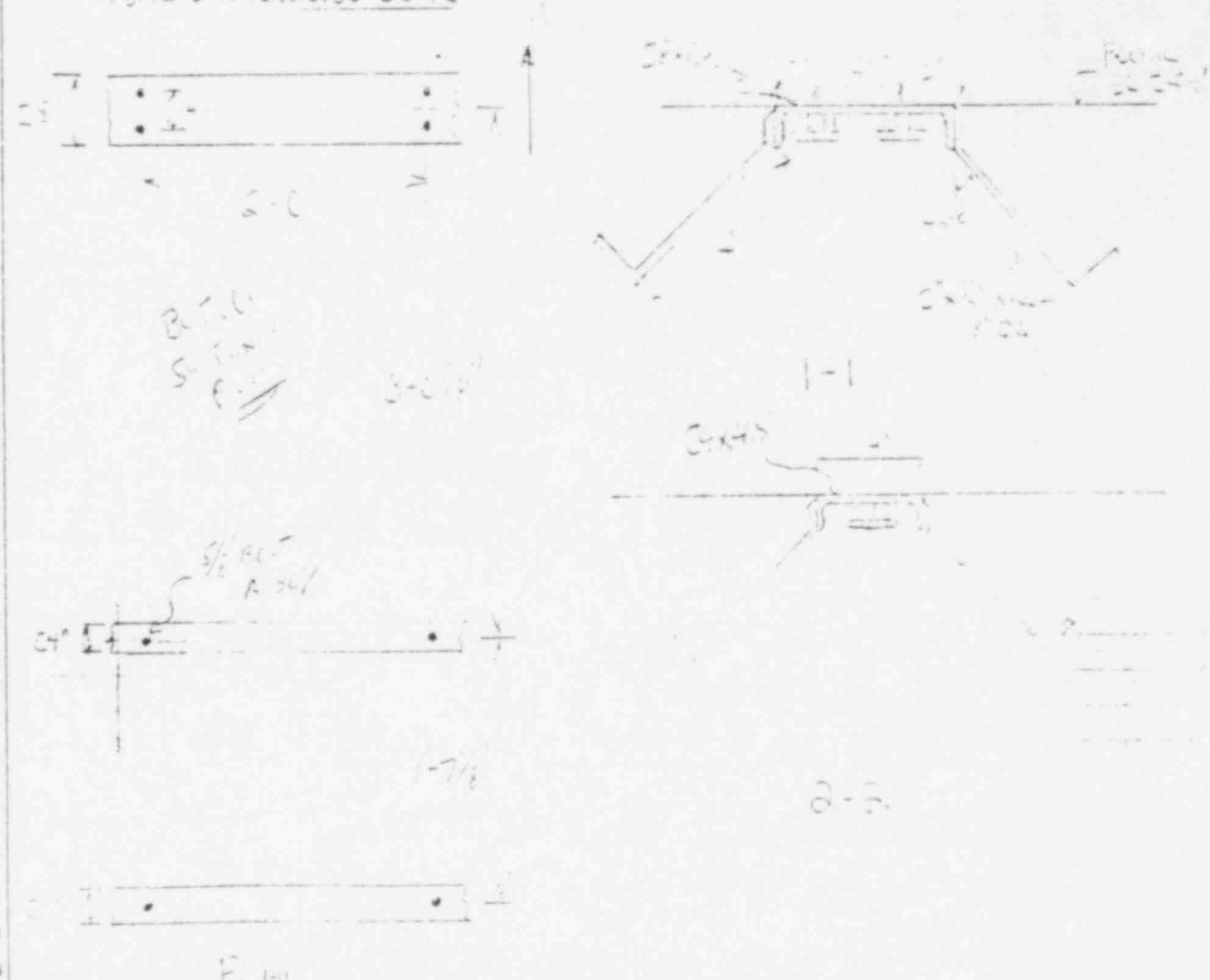
[illegible] ATTACHMENT X

REFERENCES: I.O.C. S. LEHRMAN TO I. [illegible] 5/24/77

11715-FC-

11715-FE-27A, 38B

TYPICAL ANCHORAGE DETAIL



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STONE & WEBSTER ENGINEERING CORPORATION

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Client [illegible] — Location [illegible] — Est. No. — J.O. No. [illegible]
Subject [illegible] — Date [illegible] — By [illegible]
Checked 5/3/77 — By S. R. [illegible]
Based on — Revised — By

CHECK A[illegible]

8 - 5/8" A307 [illegible]

F = -23 + 1.15 = -1.15^k
V = 8.7^k
M = 99.36 [illegible]

SHEAR/BOLT = 8.7/8 = [illegible]

TENSION = $-\frac{1.15}{8} + \frac{99.36}{2(12)[illegible]}$ = 1.2[illegible]
[illegible] 3 [illegible]

[illegible] BOLTS [illegible]

T[illegible] [illegible] [illegible] 3.07^k

F_t = 2[illegible] - 1.6 f_v ≤ 20 [illegible]

= 28 - 1.6 ($\frac{[illegible]}{.3[illegible]}$) = 2[illegible] [illegible] 20 [illegible]

[illegible] = 3.3 [illegible] [illegible] = [illegible]

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Client

Location

Est. No.

J.O. No.

Subject

Date

By

Checked 6/3/77

By

Revised 6/4/77

By

Based on

CHECK [illegible]

[illegible] [illegible]

$(F_v)_a = 0.35\sqrt{f'c}$

$= 0.35(\ldots)$ [illegible]

$= 17.\ldots$ [illegible]

[illegible] $= \ldots(1.38) = \ldots$

$= \ldots$

[illegible] $= 27\ldots$

[illegible]

[illegible] $2(.47) \ldots (.244)$

$= 5\ldots$

[illegible]

Resistance of 5/8" sq. nut width = 1", height = 5/8", $K = .625$

$K = f_c(\ldots) = 1.8(.625) = 1.13^k$ /bolt or $\underline{4.52^k}$ / switchgear, Margin $= \frac{4.52}{2.72} = 1.66$

[illegible] 8 bolt. = 9.04K [illegible] 3.27 margin

1.55 [illegible] II

[illegible]

[illegible]

Strap Capacity

$T = \ldots(\ldots)\ldots 12^k$ @ 45° or $12(.707) = 8.5$ [illegible] 17^k resistance

$(d = 1.24$ $\frac{17}{1.24} = 13.7 \leftarrow$

CALCULATION SHEET

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STATION BATTERY RACKS

11715-STR-0 5-1

A 5010.10

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

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Preliminary

Item

Client VEPCO   Location NA #1&2   Est. No   J.O. No. 11715

Subject Battery Racks   Date 5/10/77   By

Checked 5/10/77   By

Based on   Revised   By

C & D Station Battery Racks (1-BY-B-01 as shown on 11715-FE-27A-11, -27G-4) Battery Rack File No. 11715/12050-130-356C.

Racks are Floor Mounted - ½"φ drilled in anchors. IOC from S.H. Lehrman to W.G. Hyckman dated 5/5/77.

Lds. DBE Ten = 520# } ½"φ Hilty
Shear = 260# }
← ATTACHMENT 1

Based on STD-ME-12-2-1

$T_A = 1000 \quad S_A = 1000$

$\frac{T}{T_A} = \frac{520}{1000} = .520$, $\frac{S}{S_A} = .77$; S = 770, Margin = $\frac{770}{260}$ = 2.9

$\frac{S}{S_A} = \frac{260}{1000} = .260$, $\frac{T}{T_A} = .94$, T = 940, Margin = $\frac{940}{520}$ = 1.81

Anchors - ½"φ Red Heads (see phone conversation S.R. Stefanik - Chas. Cronan. 5/16/77

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CALCULATION SHEET

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SUBJECT/TITLE	QA CATEGORY/CODE CLASS

[illegible] INSTRUMENTATION RACKS

Client VEPCO	Location N.A. 1&2	File No	J.O. No. 11715
Subject SEISMIC DESIGN MARGINS		Date 5/10/77	By R.F. [illegible]
PROCESS INSTRUMENTATION RACKS		Checked 5/11/77	By S.R. [illegible]
Based on		Revised	By

PROBLEM STATEMENT:

DETERMINE THE ALLOWABLE BOLT FORCES AND SEISMIC DESIGN MARGINS OF THE PROCESS INSTRUMENTATION RACK HOLD-DOWN ANCHORAGE.

REFERENCES:

11715 - FK-1 SERIES
- FK-6 SERIES

SPECIFICATION FOR ERECTION OF INSTRUMENTATION

[illegible], [illegible], & [illegible]
SEISMIC ANALYSIS OF INSTRUMENT [illegible] [illegible]

5-TS-[illegible] "ALLOWABLE LOADS AND DESIGN CRITERIA FOR [illegible] IN [illegible] [illegible] BOLTS"

PROCEDURE

EACH INSTRUMENT RACK IS [illegible] ANCHORED BY 4-1/2" BOLTS [illegible] (MAXIMUM), [illegible] AND [illegible] (COMBINED) [illegible] TENSION [illegible] OF THE BOLTS. IT WAS [illegible] ABOVE REFERENCED [illegible] FOR THE LOADS [illegible] IN THE SEISMIC ANALYSIS OF THE RACKS. SINCE [illegible] WAS [illegible] REFERENCED LOADS WERE USED.

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RESULTS

MINIMUM SEISMIC DESIGN MARGIN = 5.3 (BASED ON COMBINED TENSION & SHEAR)

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▲ 5010 1D

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Client [illegible]	Location [illegible]	File No	J.O. No. 11715
Subject [illegible]		Date 5/11/77	By [illegible]
[illegible] DISTRIBUTION ON RACKS		Checked 5/11/77	By C.R. [illegible]
Based on		Revised	By

RACK [illegible] : (FK-[illegible]) [illegible] BY [illegible]]

[illegible] = 1570#/4 = 34[illegible]#/ft

T[illegible] DISTRIBUTE [illegible] (4 [illegible])

[illegible] TRANSVERSE [illegible]

$F = 3[illegible]25^{\#}$ / 4 [illegible] = 85.065# [illegible]

$V = \frac{545'}{4\ [illegible] \times 4\ [illegible]}$, [illegible]

[illegible] = 27,[illegible] in-lbs [illegible]

[illegible]

$T = \frac{[illegible]}{2 \times [illegible]} = 903.33^{\#}/[illegible]$

[illegible] by scale from Dwg. 11715-FK-6A, 6.5

$T/[illegible] = 903.33/4 = 225.83^{\#}$

ADDITIONAL T FROM [illegible] MOMENT = $\frac{545/4 \cdot 1/2"}{4 [illegible]}$ = 9.30#/bolt

∴ [illegible] T = −85.065 + 225.83 + 9.30 = 150#

[illegible]

ASSUME [illegible] IN CONCRETE • 4" [illegible] USE S&W ALLOWABLES FROM EMTG-22-0

$T_{[illegible]} = [illegible]$ .150 → [illegible] = 9[illegible] [illegible] $\frac{9[illegible]}{.037}$ [illegible] !

$V_{[illegible]} = [illegible] = [illegible]$ .037 → [illegible] .99 [illegible] = 6.6 ! ✓

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Client [illegible] Location [illegible] Est. No. J.O. No. [illegible]

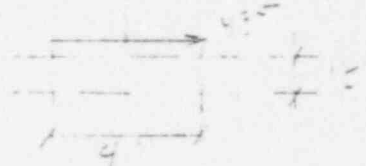
Subject [illegible] Date 5/[illegible]/77 By [illegible]

[illegible] Checked 5/11/77 By E. R. Alejandro

Based on Revised By

B) [illegible] (CONT.)

^{435} ([illegible] LOADS APPLIED TO [illegible])



$T/_{ANCHOR}$ = 435/4 = 109#

$V/_{ANCHOR}$ = 435/4 = 109#

T_{ADD} = $\frac{435 \times 2}{2 \times 4}$ = [illegible]#

T_T = 1362# → $T/_A$ = .1362

V_T = 109# → $V/_A$ = .109

[illegible] $T/_A$ = .1362 → [illegible] = .96 [illegible] = 8.4

[illegible] $V/_A$ = .109 → [illegible] = .97 [illegible] = 7.7

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Client
Location
File No.
J.O. No.

Subject: Seismic Design Margins — Process Eq. Containment Racks
Date 5/ /77
By R F
Checked 5/11/77
By S. R. Hefemialz
Based on
Revised
By

RACK 2-307:

Weight = 82 # (R.5)

A) Transverse (R.33)

$F = \frac{828}{4x?} = 51.8^{\#}$ / racking

$V = \frac{354}{4 \times 4} = 88.125^{\#}$ / racking

$T = \frac{1810}{8 \times 5} = 113.5^{\#}$ / racking

$\frac{354 \times ½}{3 \times 4} = 22.125^{\#}$

$T_{R} = 113^{\#}$ $V_{R} = 22^{\#}$

using $\frac{T}{T_R} = .113 \longrightarrow \left(\frac{f}{F_t}\right)_{allow} = 0.98$ ∴ margin = 44.5

using $\frac{V}{V_R} = .022 \longrightarrow \left(\frac{T}{T_R}\right)_{allow} = 0.99$ ∴ margin = 2?

B) Longitudinal (R.33)

T = 978/?? = ?#/racking

V = 5??/? = 140.75 #/racking

$T_{total} = \frac{5?? \cdot ?}{2 \times ?} = 307^{\#}$ ∴ $T_R = 180.7^{\#}$

using $\frac{T}{T_R} = .181 \Rightarrow \left(\frac{f}{F_t}\right)_{allow} = 0.95$ margin = 5.5

using $\frac{V}{V_R} = .147 \Rightarrow \left(\frac{?}{?}\right) = 0.96$ margin = 5.3

Margins ... ...

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SUBJECT/TITLE	QA CATEGORY/CODE CLASS

STEAM GENERATOR & REACTOR COOLANT PUMP SUPPORTS

Client VEPCO | Location N.A. #1 | Est. No | J.O. No. 11715

Subject LOAD CARRYING CAPACITY OF STEAM GENERATOR SUPPORT ANCHORS. | Date APRIL 6, 1977 | By R. Ellis

Checked 4/9/77 | By [illegible]

Based on | Revised | By

SEISMIC SAFETY MARGINS FOR ANCHORS:

$$MARGIN = \frac{ALLOWABLE\ LOAD}{MAX.\ ACTUAL\ LOAD}$$

NODE #	TENSION	COMPRESSION	SHEAR
52	2.02	2.40	—
61	3.00	2.83	—
71	—	—	2.71
82	—	—	1.66
88	1.64	1.37	—
[illegible]7	2.12	1.97	—
[illegible]9	2.58	1.11	—
[illegible]13	3.77	2.16	—
[illegible]16	1.32	2.05	—
[illegible]12	2.87	7.72	—
[illegible]14	4.42	3.90	—
[illegible]70	11.40	1.75	—
[illegible]122	16.2	1.50	—

NODES 94A&B, & 109 ARE NOT INCLUDED IN THIS REVIEW

NODE LOADS ATTACHMENT Z

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CALCULATION SHEET

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Client	VEPCO	Location	N.A. #1	Est. No	J.O. No. 11715
Subject	LOAD CARRYING CAPACITY OF STEAM GENERATOR SUPPORT ANCHORS	Date	APRIL 6, 1977	By	R. J. Frost
		Checked	4/9/77	By	[signature]
Based on		Revised		By	

I) EL 242'-6": { REF. DWGS: 11715 - FC-16F ; " - FC-16H }

(A) NODES 52, 61, 88, 97:

6 - 2¼" ø ANCHOR BOLTS (ASTM A490) PER NODE

REFER ASTM DESIGNATION A-490-67 TABLE NO. 4

F_y = TENSILE YIELD STRENGTH = 130,000 PSI

ALLOWABLE TENSION $F_T = 0.9 F_y$
$= 0.9(130) = 117$ KSI ✓

TENSILE AREA OF 2¼" ø ANCHOR: (FROM AISC 152.1)

$A_S = 0.7854 \left(D - .9743/n\right)^2$

$= 0.7854 \left(2.25 - .9743/4.5\right)^2$

$A_S = 3.25$ in²/ANCHOR ✓

∴ ALLOW. ANCHOR TENSION = 117(3.25) = 380.25^K

TENSION CASE:

(52) T_{max} = DEAD + SEISMIC (DBE) + SG OUTLET BREAK #4
= 232 - 557.3 - 807.0
= -1132.3^K ✓

T/ANCHOR = 1132.3/6 = 188.7^K ∴ MARGIN = 380.25/188.7 = 2.02

(61) T_{max} = DEAD + SEISMIC + SG OUTLET BREAK #4
= 218 - 461.2 - 520.3
= -763.5 ✓

T/ANCHOR = 763.5/6 = 127.25^K ∴ MARGIN = 380.25/127.25 = 3.0

(88) T_{max} = DEAD + SEISMIC + CLOSURE WELD BREAK #12
= 307 - 753.6 - 943.3 = -1389.9^K

T/ANCHOR = 231.65^K ∴ MARGIN = 380.25/231.65 = 1.64

Client VEPCO	Location N.A.#1	Est. No.	J.O. No. 11715
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		Checked 4/9/77	By [illegible]
Based on		Revised	By

(97) T_{MAX} = DEAD + SEISMIC + CLOSURE WELD BREAK #12
= 281 + 633.5 + 723.4
= 1074.9

$T/_{ANCHOR}$ = 1074.9/6 = 179.15^K ∴ MARGIN = 2.12 ✓

COMPRESSION CASE: (FOR ALLOWABLES, REFER BOOK 11715-BK-50 Tab 4 *ULT. CAPACITIES Design Division N Penn

(52) C_{MAX} = DEAD + SEISMIC + SG INLET BREAK #7
= 232 + 557.3 + 577
= 1366.3^K

C_{ALL} = 3278^K ∴ MARGIN = $\frac{3278}{1366.3}$ = 2.4 ✓

(61) C_{MAX} = DEAD + SEISMIC + SG INLET BREAK #7
= 218 + 461.2 + 478.1
= 1157.3^K

C_{ALL} = 3278^K ∴ MARGIN = $\frac{3278}{1157.3}$ = 2.83 ✓

(88) C_{MAX} = DEAD + SEISMIC + SG OUTLET BREAK #4
= 307 + 753.6 + 1112.4
= 2173^K

C_{ALL} = 2982^K ∴ MARGIN = $\frac{2982}{2173}$ = 1.37 ✓

([illegible]) C_{MAX} = DEAD + SEISMIC + SG INLET BREAK #7
= 281 + 6335 + 595.4
= 1509.9

C_{ALL} = 2982^K ∴ MARGIN = $\frac{2982}{1509.9}$ = 1.97 ✓

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		Checked 4/9/77	By [signature]
Based on		Revised	By

(B) NODES 71 & 82 (SHEAR ONLY)

FOR SHEAR CAPACITY, REFER BOOK 2D-2 "ULT. CAPACITIES"

(71) V_{MAX} = SEISMIC + SG OUTLET BREAK #4
= 627.1 + 1030.7
= 1657.8

V_{ALL} = 4500 ∴ MARGIN = $\frac{4500}{1657.8}$ = 2.71 ✓

(82) V_{MAX} = SEISMIC + CLOSURE WELD BREAK #12
= 538.7 + 315.9
= 854.6ᵏ

V_{ALL} = 1415ᵏ ∴ MARGIN = $\frac{1415}{854.6}$ = 1.66 ✓

(C) LOWER COOLANT PUMP SUPPORTS - NODES 9, 13, & 16

6 - 2½" ANCHORS (A490) / SUPPORT ✓

ULT CAPACITY IN TENSION = 2815/6 = 469.2ᵏ } REFER BOOK 2D-2
ULT CAPACITY IN COMPRESSION = VARIES }

(9) T_{MAX} = DEAD + SEISMIC + PUMP INLET BREAK #5
= 131 - 608.6 - 611.3 = 1088.9

T/ANCHOR = 181.5 ∴ MARGIN = $\frac{469.2}{181.5}$ = 2.58 ✓

C_{MAX} = DEAD + SEISMIC + SG OUTLET BREAK #4
= 131 + 608.6 + 1155.8 = 1895.4

C_{ALL} = 2106 ∴ MARGIN = $\frac{2106}{1895.4}$ = 1.11 ✓

(13) T_{MAX} = DEAD + SEISMIC + PUMP INLET BREAK #5
= 108 - 184.6 - 670.6 = -747.2

T/ANCHOR = 124.5 ∴ MARGIN = $\frac{469.2}{124.5}$ = 3.77 ✓

C_{MAX} = DEAD + SEISMIC + SG OUTLET BREAK #4
108 + 184.6 + 574.3 = 866.9

C_{ALL} = 1875 ∴ MARGIN = $\frac{1875}{866.9}$ = 2.16 ✓

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Client VEPCO Location N.A. #1 Ext. No J.O. No. 11715

Subject LOAD CARRYING CAPACITY OF STEAM GENERATOR SUPPORT ANCHORS Date APRIL 6, 1977 By R. Frost

Checked 4/9/77 By [signature]

Based on Revised By

(16) T_{max} = DEAD + SEISMIC + CLOSURE WELD BREAK #12
= 77 - 849.8 - 1365.8
= -2138.6ᵏ

T/ANCHOR = 356.4ᵏ ∴ MARGIN = $\frac{469.2}{356.4}$ = 1.32 ✓

C_{max} = DEAD + SEISMIC + RPV OUTLET BREAK #1
= 77 + 849.8 + 199
= 1125.8ᵏ

C_{ALL} = 2304ᵏ ∴ MARGIN = $\frac{2304}{1125.8}$ = 2.05 ✓

II) STEAM GENERATOR SUPPORTS IN PRIMARY SHIELD WALL
(NODES 12, 14, 70, 122)

(12) 8 - 1½"ϕ ANCHORS T_{ALL} = 102.5ᵏ/ANCHOR OR 820ᵏ TOTAL

T_{max} = SEISMIC + SG OUTLET BREAK #4
= -57.1 - 228.9 = 286ᵏ → MARGIN = $\frac{820}{286}$ = 2.87 ✓

C_{max} = SEISMIC + RPV OUTLET BREAK #1
= 57.1 + 76 = 133.1ᵏ

C_{ALL} = 1028ᵏ ∴ MARGIN = $\frac{1028}{133.1}$ = 7.72 ✓

(14) 8 - 1½ ϕ ANCHORS T_{ALL} = 820ᵏ TOT = 102.5ᵏ/ANCHOR

T_{max} = SEISMIC + CLOSURE WELD BREAK #12
= -16.8 - 168.5
= -185.3 ∴ MARGIN = $\frac{820}{185.3}$ = 4.42 ✓

C_{max} = SEISMIC + SG OUTLET BREAK #4
= 16.8 + 247
= 263.8ᵏ

C_{ALL} = 1028ᵏ ∴ MARGIN = $\frac{1028}{263.8}$ = 3.90 ✓

Client VEPCO Location N.A. #1 Est. No. J.O. No. 11715

Subject LOAD CARRYING CAPACITY OF STEAM GENERATOR SUPPORT ANCHORS Date APRIL 6, 1977 By R. FAUST

Checked 4/9/77 By [signature]

Based on Revised By

(70) 8 - $2\frac{1}{2}"\phi$ ANCHORS

$(T_{ALL})_{TOT} = 3744^{k} = 468^{k}/\text{ANCHOR}$

T_{MAX} = SEISMIC + SG OUTLET BREAK #4
= -108.6 - 220.4
= 329 ∴ MARGIN: $\frac{3744}{329} = 11.40$

C_{MAX} = SEISMIC + RPV OUTLET BREAK #1
= 108.6 + 790
= 898.6

$C_{ALL} = 1577^{k}$ ∴ MARGIN $\frac{1577}{898.6} = 1.75$

(122) 8 - $2\frac{1}{2}"\phi$ ANCHORS $T_{ALL} = 3744^{k}$ TOT.

T_{MAX} = SEISMIC + CLOSURE WELD BREAK #12
= -94.9 - 136.2
= -231.1^{k} ∴ MARGIN = $\frac{3744}{231.2} = 16.2$

C_{MAX} = SEISMIC + RPV OUTLET BREAK #1
= 94.9 + 957.0
= 1051.9

$C_{ALL} = 1577$ ∴ MARGIN = $\frac{1577}{1051.9} = 1.50$

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SUBJECT/TITLE	QA CATEGORY/CODE CLASS

RESIDUAL HEAT REMOVAL HEAT EXCHANGERS

(Main Supports EL 231'-6")
(Upper Supports EL 257±)

Client Vepco Location NA1&2 Est. No. J.O. No 11715/12050
Subject Seismic Design Margin Date 6/15/77 By
Checked 6/15/77 By
Based on Revised By

RHR Heat Exchanger Main Supports

References

1. 11715-FC-16E "Detached Plan A" (12050-FC-16E)
2. 11715-FC-16C Sect's 100 & 101 (12050-FC-16C)
3. 11715-4.12-3C Joseph Oat & Sons Inc. drawing for RHR Heat Exchanger Det "F"
4. Design Computations by C. Torres, Calc Book 5B Section 3

ATTACHMENT AA

Problem

Compute the "seismic design margin" available in the RHR Heat Exchanger main support. This means that during a seismic event of DBE intensity, we want to find the ratio of allowable stress over actual stress.

Method

The shear friction provisions of Sect 11.15 of ACI 318-71 will be used to compute the margin available.

Assumptions

1. Grout under RHR HE support is dry packed and thus consistent with a $\mu = .7$ per ACI 318-71 11.15.4
2. The reinforced concrete support itself is adequate to carry the loads applied by the RHRHE
3. The anchor bolts are embedded sufficiently to develop yield

Analysis

Direct Tension per bolt

$T_o = 10.57$ k

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Client Vepco　Location NA 1 & 2　Est. No.　J.O. No. 11715/12050

Subject Seismic Design Margin　Date 6/15/77　By [signature]

Checked 6/15/77　By [signature]

Based on　Revised　By

Induced Tension per bolt from shear

$$T_v = \frac{V_u}{\Phi \mu} = \frac{35.4 \div 4}{.85 \times .7} = 14.87\,K \text{ / "per bolt"}$$

Total Tension per bolt

$$T = T_D + T_v = 25.44\,K$$

Tension stress per bolt

$$\sigma_t = \frac{25.44}{.969} = 26.26\ K/in^2$$

Allowable Tensile stress = .9 F_y

ASTM A 307 does not define F_y therefore use AISC code to back figure as follows

spec Sect 1.5.1.1 $F_T = .6 F_y$

7th Edition Manual Ch 4 p 4-3 $F_T = 20\,ksi$ (A307

$$\therefore F_y = \frac{F_T}{.6} = 33\,ksi$$

$$\sigma_a = .9 F_y = 30\,ksi$$

Seismic Design Margin

$$\text{Margin} = \frac{\sigma_a}{\sigma} = \frac{30}{26.26} = 1.14$$

Check shear stress

$$v = \frac{V_u}{A} = \frac{35,400}{28 \times 5.5 - 4\pi(\frac{11}{16})^2} = 238\,psi < .2 f'_c$$

ok

see ref 3 for bearing area of RHR supports

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JGDyckman 5/26/78	RJ Belanger 5/26/78	

SUBJECT/TITLE	QA CATEGORY/CODE CLASS

RHR Heat Exchanger Upper Supports

References
1. 11715 CONC. STRUC. DESIGN BK 5B Tab 3
2. 11715-FC-16AT
3. 12050-FC-16E
4. 12050-CONC STRUC. DESIGN BK

Problem

Compute the seismic design margin available in the upper restraints for the RHRHE. By inspection the most critical portion of the restraint design is the drilled-in anchor detail shown on SECT 23-23 of Ref 3 for the Unit 2 RHRHE's.

Method

Extract the bolt tension forces from Ref 1 and divide it into the allowable force per S&W STD-MS-13-3 for 7/8" Ø Hilti bolts

Analysis

Bolt Tension 2.3K / bolt (Ref #4 prelim P22)

Bolt allowable 3K / bolt (STD-MS-13-3)

$$\text{seismic Design Margin} = \frac{3}{2.3} = 1.3$$

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J G Dvckmor 6/8/78	RJB 6/12/78	

SUBJECT/TITLE	QA CATEGORY/CODE CLASS

SAFETY INJECTION ACCUMULATOR TANK

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T G Dyckmar 6/8/78	RJB 6/12/78	

SUBJECT/TITLE	QA CATEGORY/CODE CLASS

This calculation is organized by sections as follows:

section "A" presents the results of the structural design computations for design verification of the anchorage

section "B" adjusts the section "A" results to account for various anomalies in the design verification

section "C" defines the allowable stresses for the anchor bolts

section "D" computes the design margin

section "E" presents conclusions.

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JGDuckmein 6/8/78	RGB 6/9/78	

SUBJECT/TITLE	QA CATEGORY/CODE CLASS

A. Refer To Structural Design Concrete Calc Book 11715-SB Tab 10 for analysis of The anchor bolts for loads developed from Calc# CGN-159. Attachment AB documents The load breakdown extracted by the preparer of Calc# CGN-159 which was Transmitted To Structural Design for analysis. Loadings considered were:

Comb # 1: DEAD + DBE (inertia + nozzle) + THERMAL (nozzle)

Comb # 2: DEAD + DBE (inertia + nozzle) + PIPE BREAK

The Structural Design results are summarized for the Two loadings, but using Two methods for computing section properties of the bolt circle. Page numbers in parenthesis indicate where The result can be found in the structural Design calculations

STRESS (KSI) / LOADING	f_N	* f_{Tmax} METHOD #1 ($S=672in^3$)	* f_{Tmax} METHOD #2 ($S=928in^3$)
Comb # 1	4.1 (P5)	10.92 (P6)	NOT COMPUTED
** Comb # 2	3.6 (P2)	19.63 (P4)	15.2 (P14)

* Computed stresses are based on $A_0 = .785 in^2$ rather than the Tensile stress area of $.606 in^2$ for a 1" Φ bolt

** This combination includes DBE nozzle loads which cannot act concurrently with the guillotine PIPE BREAK

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JC Dickman 6/8/78	RJB 6/9/78	

SUBJECT/TITLE	QA CATEGORY/CODE CLASS

3. To compute the "design margin" the structural Design results must first be adjusted to account for the asterisked items on the previous page. Tensile stresses can be adjusted by multiplying them by $\frac{.785}{.606} = 1.3$. The forces and moments applied to the bolt circle can be adjusted by subtracting out the DBE nozzle loading from the Comb #2 results given on P2 of the structural Design calculations and recomputing $f_{t\,max}$:

$$
\left.\begin{aligned}
P &= 65.9 - 5 = 60.9\text{K} \\
M &= 10858 - 520 = 10338.\ \text{in-k} \\
V &= 64.2 - 8.9 = 55.3\ \text{K} \\
T &= 247 - 247 = 0
\end{aligned}\right\}
$$

DEAD + DBE (inertia) + PIPE BREAK (Revised Comb #2)

The previous table of results will now be reconstructed with the required adjustments discussed above

STRESS (ksi) / LOADING	f_v	$f_{t\,max}$ METHOD #1 ($S = 672 in^3$)	$f_{t\,max}$ METHOD #2 ($S = 926 in^3$)
Comb #1	4.1	14.20	(DOES NOT CONTROL)
Comb #2	2.94	24.2	18.7

$f_{v\,comb\#2} = V/A = 55.3/24 \times .785 = 2.94\ \text{K/in}^2$

$f_{t\,comb\#1} = 1.3 \times 10.92 = 14.2\ \text{K/in}^2$ $\quad f_{t\,comb\#2} = 1.3\left(\frac{60.9}{24 \times .785} + \frac{10338}{S}\right) = \begin{cases} \text{METHOD} \\ 1,\ 24.2 \\ 2\ \ 18.7 \end{cases}$ (3.23 written above $\frac{60.9}{24 \times .785}$)

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J G Durkman 6/8/78	RJB 6/9/78	

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C. Define allowable stress using sections 1.5.6 and 1.6.3 of Reference # 3

$$F_T = 1.33(28 - 1.6 f_v) \leq 1.33(20)$$ ✓

D. Compute the "design margin" as a ratio of allowable tensile stress to actual $F_T/f_{t_{max}}$ for the controlling loading, Comb # 2

$$F_T = 1.33(28 - 1.6 \times 2.94) = 31^k/in^2 \nleq 1.33(20) = 26.6^k/in^2$$

$\therefore F_T = 26.6\ ^k/in^2$ allowable

Design margin

Method # 1 $\quad \frac{26.6}{24.2} = 1.10$

Method # 2 $\quad \frac{26.6}{18.7} = 1.42$

} 1.26 avg SAY 1.3

E. The stresses and design margin given in response to the NRC question do not agree with the numbers above but are, nonetheless substantially correct. The anchorage meets the design criteria based on a conservative evaluation of the loads and anchorage capacity.

Reported results shall be averaged for both method for section properties: $\therefore f_v = 2.9, f_{t_{max\ avg}} = 21.5 \quad \frac{27}{21.5} = 1.3$

R Bradbury agreed that it is not necessary to amend the FSAR Table 3.74 JGD 6-12-78

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Attachments Index

A IOC To JGDyckman from SA Kenrick, 5-2-77, entitled: Vepco, North Anna 1&2, Refueling Water Storage Tank", 4 pages.

B IOC To JGDyckman / RBBradbury from NA.Muni / SA Lehrman 4-22-77, entitled: Embedment Loads for 1) Quench Spray Pumps 2) Component Cooling Water Pumps", 1 page

C IOC To RFaust from SA Lehrman, 6-3-77, entitled Recirc Spray Heat Exchanger", 1 page

D IOC To R Bradbury/JGDyckman from SA Lehrman/SN Caruso, 5-23-77, entitled: Recirc Spray Heat Exchangers Support Reactions", 2 pages

E IOC To JGDyckman/RBradbury from SA Lehrman/SN Caruso, 4-22-77, entitled: Recirc Spray Heat Exchanger Supp. Reactions Calc No. 11715-NM(B)-297-CDD", 8 pages.

F IOC To TTracy from Francisco Morales, 6-1-77, entitled "Information on Bolt Length" 1 page

G Telecopy To RFaust (225/19) from TTracy (FXO) stamped by RJ Faust 6-6-77 (1 page)

H IOC To RFaust / JGDyckman from SA Lehrman/SNCaruso, 5-17-77, entitled "Component Cooling Water Pumps 1-CC-P-1A,B & 1-CC-P-1A,B" (2 pages)

I IOC To JGDyckman/RBBradbury from SALehrman/SN Caruso, 5-9-77, entitled "Comp Cooling Water Pumps 1-CC-P-1A, B & 2-CC-P-1A,B", 2 pages

J IOC To JGDyckman from SA.Lehrman, 3-28-77, entitled "Component Cooling Water Pumps, NAS-124, NA-56", 2 pages.

K IOC To J.G.Dyckman from SA.Lehrman/SN Caruso, 3-22-77, entitled "Main Instrument Air Receivers, NAS-119 NA-75, 2 pages

L. IOC J.G. Dyckman/R Bradbury from SA Lehrman/SN Caruso, 4-25-77, entitled "Service Water Pump Hold Down bolt reactions" 2 pages.

M. IOC To J.G. Dyckman/R Bradbury from SA Lehrman/SN Caruso 4-27-77, entitled "Air Handling Units 1-HV-AC-1, 2 & 2-HV-AC-8, 9" 2 pages.

N. Notes of phonecon, 12-19-73 R Bradbury (head of FXO) to E. Allison (Building Service support engineer), 1 page.

O. IOC To JG Dyckman/R Bradbury from NA Muni/SA Lehrman, 5-6-77, entitled "Support Loads for Radiation Monitoring Equipment", 1 page

P. IOC To JG Dyckman/R Faust from SA Lehrman, 6-29-77, entitled "Aux Feedwater Pump 2-FW-P-2" 1 page.

Q. IOC To J.G. Dyckman from SA Lehrman, 6-24-77, entitled Aux Feedwater Pump 1-FW-P-2", 2 pages

R. IOC To JG Dyckman from SA Lehrman, 6-21-77 entitled "Aux Feedwater Pumps 1-FW-P-3A&B, 2-FW-P-3A&B", 2 pages.

S. IOC To J.G. Dyckman/R.B. Bradbury from SA Lehrman/SN Caruso, 5-5-77, entitled "D.C. Distribution Panel Anchor Loads", 1 page,

T Distribution panel Typical detail (1 page)

U IOC to S Lehrman from R Bradbury, 5-12-77, entitled "15 & 20 KVA Static Inverters", 1 page,

V IOC to RB Bradbury from JG Dyckman/RJ Belanger, 6-4-77, entitled "Seismic Design Margins of 15 & 20 KVA Static Inverters", 1 page.

W Field sketches, inverter mounting details in the emergency switch gear room, to Phil Dinsky from J. Devine, 5-14-77, (2 pages)

X IOC to J.G. Dyckman/R Faust from SA Lehrman/SN Caruso entitled "4160 Switchgear Support Reactions," 1 page

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Y. IOC To JG Dyckman/RB Bradbury from SA Lehrman/SN Caruso 5-5-77, entitled "C&D Station Battery Racks, NAS-254, NA 263/1262", 1 page.

Z. Project structural sketch 11715-SSK-1009F-4 (Originals filed in Project Job Book 15-66)(1 p)

AA. Copies of structural Design Calcs from Conc. Book 11715-SB, Tab 3, 4 pages

A.B. IOC to SN Caruso/BN Roy from Rex Beach entitled "Calc CGN-159", dated 11/24/75 (1 page)