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ENGINEERING DATA TRANSMITTAL

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2. To: (Receiving Organization) Distribution	3. From: (Originating Organization) TWRS Projects/SST Retrieval	4. Related EDT No.: n/a
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		10. System/Bldg./Facility: 241-C-106
11. Receiver Remarks: 11A. Design Baseline Document? [X] Yes [] No		12. Major Assm. Dwg. No.: n/a
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15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	HNF-2468	-	0	Project W-320, 241-C-106 Sluicing, Civil/Structural Calculations, Vol. 8	NA			-

16. KEY

Approval Designator (F)	Reason for Transmittal (G)	Disposition (H) & (I)
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)	1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION
(See Approval Designator for required signatures)

(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN
2	1	Design Authority JW Bailey	John W Bailey	7/20/98	S2-48						
		Design Agent									
2	1	Cog.Eng. ~~GE Graves~~ M C DAVENPORT	M C Davenport	7/19/98	S2-48						
2	1	Cog. Mgr. JW Bailey			S2-48						
		QA									
		Safety									
		Env.									

18. M C DAVENPORT ~~G.E. Graves~~ ~~3/24/98~~ M C Davenport 7/19/98 Signature of EDT Originator Date	19. Authorized Representative for Receiving Organization Date	20. John W Bailey 7/20/98 J.W. Bailey ~~3/24/98~~ Design Authority/ Cognizant Manager Date	21. DOE APPROVAL (if required) Ctrl. No. [] Approved [] Approved w/comments [] Disapproved w/comments

BD-7400-172-2 (05/96) GEF097

BD-7400-172-1

Project W-320, 241-C-106 Sluicing Civil/Structural Calculations, Vol. 8

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U.S. Department of Energy Contract DE-AC09-96RL13200

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Key Words: W-320, Sluicing, Tank 241-C-106, Tank 241-AY-102, WRSS, calculations, civil/structural.

Abstract: This supporting document has been prepared to make the FDNW calculations for Project W-320, readily retrievable.

DATE:
STA: 4
HANFORD RELEASE
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JUL 23 1998

Release Stamp

Kara Broz 7/23/98
Release Approval Date

Approved for Public Release

Project W-320, 241-C-106 Sluicing Civil/Structural Calculations, Vol. 8

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W320-24-025

Cover Block Lifting Bail Calculation

KAISER ENGINEERS HANFORD	CALCULATION IDENTIFICATION AND INDEX	Page i of iii Date 7/6/95

This sheet shows the status and description of the attached Design Analysis sheets.

Discipline Structural WO/Job No. ER4319/W-320 Calculation No. W320-24-025

Project No. & Name W-320, Tank 241-C-106 Sluicing

Calculation Item Cover Block Lifting Bail Calculation

These calculations apply to:

Dwg. No. H-2-818448 SH.2, 3, & 5 Rev. No. 0

Dwg. No. H-2-818450 and H-2-818454, SH. 2 & 3 Rev. No. 0

Other (Study, CDR) NA Rev. No.

The status of these calculations is:

[] Preliminary Calculations

[X] Final Calculations

[] Check Calculations (On Calculation Dated)

[] Void Calculation (Reason Voided)

Incorporated in Final Drawings? [X] Yes [] No

This calculation verified by independent "check" calculations? [] Yes [X] No

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	James R. Booth James R Booth 7/6/95 Michael B. Lasota 7/21/95	H. B. LASOTA 4/28/97	
Checked by	8/01/95 James R Booth 8/1/95	5/8/97	
Approved by	8/1/95	5/8/97	
Checked Against Approved Vendor Data		N/A	

INDEX

5/8/97

⚠ REV 1; REVISED SH 6; REPLACED SH 7, 8 & 9 & Attach 2; ADDED SH 8a,b,c

DESIGN VERIFICATION SCREENING CRITERIA

Project/Document No. W-320/W320-24-025

When the design or design change affects hardware, formal design verification must be performed if one or more of the following questions must be answered affirmatively (YES).

YES	NO		
___	✓	1.	Does the design or design change involved meet the established criteria to be considered Safety Class 1 or 2?
___	✓	2.	Does this design or design change cause or permit changes to Safety Class 1 or 2 instrument or alarm setpoints outside of previously approved operational limits?
___	✓	3.	Does this design or design change significantly affect the nuclear safety consequences of a malfunction or failure of the structure, system, or component?
___	✓	4.	Does this design or design change involve or change design that has previously undergone formal design verification?

[signature] 8/1/95
Assigned Lead Engineer Date

[signature] 8/1/95
Responsible Discipline Manager Date

Original Design Package Distribution:

Project Engineer

Chief Design Engineer

Engineering Document Control

Design Change Distribution:

Attach to Engineering Change Notice

KEH-1981.00 (02/90)

CALCULATION CROSS INDEX (Typical)

Subject Calculation No. W320-24-025

Subject Calculation Revision No.	Superceded by Calculation No.	These interfacing calculation/documents provide input to the subject calculation, and if revised may require revision of the subject calculation.		Results and conclusions of the subject calculation are used in these interfacing calculations and/or documents.		Does the output interface calculation/ documents require revision?		Has the output interface calculation/ documents been revised?		Discipline manager's signature and date indicating evaluation complete.
		Calculation/Document No.	Revision No.	Calculation/Document No.	Revision No.	Yes	No	Yes	No	
Ø	N/A			H-2-818448 sh. 2,3,5	Ø		✓		✓	RW Davidson 8/1/95
				H-2-818450, sh. 2&3	Ø		✓		✓	
				H-2-818454, sh. 2&3	Ø		✓		✓	

KEH 1975.00 (12/88)

KAISER ENGINEERS HANFORD

DESIGN ANALYSIS

Calc. No. W320-24-025
Revision 0
Page No. 1 of 11

Client: Westinghouse Hanford Company	WO/Job No. ER4319/W-320
Subject Cover Block Lifting Bail Calculations	Date 7/6/95 By JR Booth JRB
	Checked 7/28/95 By H. BLASOTE HJB
Location: C-Farm & AY- Farm	Revised By

OBJECTIVE: To perform a stress analysis of the lifting bail shown on page 2, used for lifting of all new cover blocks to be installed on project W-320. The analysis will apply a factor of safety of at least 5 and will assume a impact force to be added to the load. The lifting bails will be rotated 20 degrees from vertical and loaded in the direction shown on page 2. Additionally, a table will be added listing the weights and type of lifting bail of the various port plugs on the cover blocks for inspection and the lifting bail for the steel plug of the Pump Penetraion will be designed.

CRITERIA:
1. Functional Design Criteria, WHC-SD-W320-FDC-001, Rev. 2.
2. Hanford Site Hoisting and Rigging Manual, DOE-RL-92-36, January 1993.

GIVEN DATA:
1. Greatest cover block weight appears at the west side Pump Pit (C-06A) cover block at 28,700 lbs with an additional 2,500 lbs for the Pump Penetration Plug for a total weight of 31,200 lbs. (See H-2-818448, sh. 2 & 5)
2. Minimum design factor of 5, based on yield strength, for load bearing structural components. (Ref. 4, section 8.2.1.1). (Nominal strength/rated load)
3. $f_c := 4000\ \text{psi}$ Construction specifictions W-320-C5 & C6 of Project W-320.

   $f_{yt} := 36 \cdot \text{ksi}$ Minimum Yield Strength for A36 Steel. (Ref. 8)

   $f_{ys} := 21 \cdot \text{ksi}$ Shear Yield Strength for A36 Steel. (Ref. 6, pg. 584)

   $f_{us} := 58000 \cdot \text{psi}$ Ultimate Tensile Strength for A36 Steel. (Ref. 8)

   $f_{uw} := 72 \cdot \text{ksi}$ Ultimate Tensile Strength for E70XX (AWS A5.1) electrode. (Ref. 2, Table 4.1)

4. Safety class of the cover blocks is SC-3. (Ref. 7)

ASSUMPTIONS: See body of calculation.

REFERENCES:

1. ACI Manual of Concrete Practice (ACI 349-94). American Concrete Institute.
2. Structural Welding Code, Steel. ANSI/AWS D1.1-94. American Welding Society.
3. GC-ANCB-01. Kaiser Engineers Hanford Architectural/Civil Standard.
4. Hanford Site Hoisting and Rigging Manual (DOE-RL-92-36). Hanford Hoisting and Rigging Safety Committee. January 1993.
5. Load and Resistance Factor Design (LRFD). Manual of Steel Construction, First Edition. American Institute of Steel Construction.
6. Mechanics of Materials. Beer and Johnston. McGraw-Hill Book Company. 1981.
7. White Paper on Seismic Design Approach for Safety Related Structures, Systems, Components, and Equipment Provided or Modified by the Project. (W-320/ER4319) Transmittal Number TR-W-320-253.
8. American Society for Testing and Materials (ASTM A-36). 1995

CONCLUSION:

Four lifting bails per cover block at pits C-06A, C-06C, & AY-02E will be suffient. It is required that the covers blocks are lifted with a rigging system that applies a lifting force at a 20 degree orientation form vertical(See figure on page 2). The lifting bail system analyzed will be the same for all new cover blocks constructed for Tank 241-C-106 and Tank 241-AY-102 pits. By inspection, the lifing bails listed on page 9 are adequately designed for lifting the port plugs. The allowable lifting force per cover block lifting bail is 9271 LBS directed 20 degrees from vertical.

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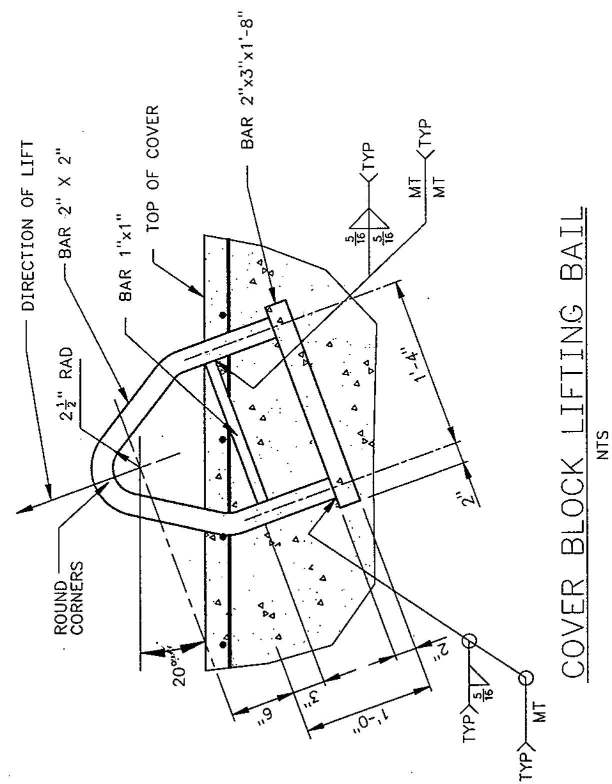
DESIGN ANALYSIS

Calc. No.: W320-24-025
Revision: 0
Page No.: 2 of 11

Client: WHC
Subject: COVER BLOCK LIFTING BAIL CALCULATION
Location: C-FARM & AY-FARM

WO/Job No.: ER4319/W-320
Date: 7/6/95
Checked: 7/28/95
Revised:

By: JR BOOTH JRB
By: M. B. LASOTA
By:



ACAD FILE: COVBAIL2

KAISER ENGINEERS HANFORD

DESIGN ANALYSIS

Calc. No. W320-24-025
Revision 0

Client: Westinghouse Hanford Company	WO/Job No. ER4319/W-320	
Subject Cover Block Lifting Bail Calculations	Date 7/6/95	By JR Booth JRB
	Checked 7/28/95	By M.B. LASOTA
Location: C-Farm & AY-Farm	Revised	By

1. Determine Load on Individual Lifting Bail:
   a. The heaviest cover block was found to be the west block of the Pump Pit at approximately 31,200 lbs. (See H-2-818448, sh. 2)
   b. There will be four lifting bails per cover block at each pit.
   c. An impact load will be determined from an assumed lift speed.
   d. The Dead Weight of the Cover Block plus the impact load will be increased by a factor of five to account for the safety factor. The requirement from Ref. 4, sec. 11.3.1 is a Safety Factor of 3 but a S.F. of 5 is more commonly used as a factor of safety for such devices and is used here for added conservatism.

$C_b := 31.2\cdot kips$ Cover Block Weight

Determine impact force on lifting bail from lifting. Ref. 9, page 2.8-9.

$V_2 := 500\cdot\frac{ft}{min}$ Speed of Lift $\qquad V_1 := 0\cdot\frac{ft}{min}$ At Rest Speed

$g := 32.2\cdot\frac{ft}{sec^2}$ Acceleration do to Gravity $\qquad t := 5\cdot sec$ Time to accelerate to V2.

$$a := \frac{\dfrac{V_2 - V_1}{60\cdot\dfrac{sec}{min}}}{t} \qquad a = 1.667\cdot\frac{ft}{sec^2}$$ Acceleration

$F_a := \frac{C_b\cdot a}{g}$ Force From Acceleration $\qquad F_a = 1.615\cdot kips$

$SF := 5$ Factor of Safety

$\theta := 20\cdot deg$

$$W := \frac{\dfrac{SF\cdot(C_b + F_a)}{4}}{\cos(\theta)}$$

Factored Weight of Cover Block per Lifting Bail acting in the direction shown on page 2.

$W = 43.651\cdot kips$

$W_n := W\cdot\cos(\theta) \qquad W_n = 41.019\cdot kips$ Force normal to the surface of the cover block used as input into the IMAGES run.

$W_p := W\cdot\sin(\theta) \qquad W_p = 14.93\cdot kips$ Force parallel to the surface of the cover block used as input into the IMAGES run.

KAISER ENGINEERS HANFORD

DESIGN ANALYSIS

Client: Westinghouse Hanford Company	WO/Job No. ER4319/W-320	
Subject Cover Block Lifting Bail Calculations	Date 7/6/95	By JR Booth JRB
	Checked 7/28/95	By M.B. LaBota MBL
Location: C-Farm & AY-Farm	Revised	By

3. Determine Lift Bail Strength: Lifting bails are designed to be loaded in the strong direction only. NO BENDING ABOUT WEAK AXIS. Based on the lifting bail design shown on page 2, tension, shear, and moment stresses were determined using IMAGES and are shown in attachment 1. page 7.

$\sigma_t := 33.9\cdot ksi$ — Maximum combined tensile stress in outer fiber of lifting bail which is less than 36 ksi; therefore, it is <u>OK</u>.

$SF_t := 5\cdot\frac{f_{yt}}{\sigma_t}$ $\quad SF_t = 5.31$

$\sigma_s := 16.9\cdot ksi$ — Combined shear stress which is less than 21 ksi (Shear Yield Strength); therefore, it is <u>OK</u>.

$SF_s := 5\cdot\frac{f_{ys}}{\sigma_s}$ $\quad SF_s = 6.213$

4. Determine the maximum allowable lifting force per bail.

$$W_a := \frac{\left(\frac{f_{yt}}{\sigma_t}\right)\cdot W}{SF}$$

$W_a = 9.271\cdot kips$

5. Check Weld Strength of Bail to 2" x 3" x 1'-8" Bar:

$t_e := \left(\frac{5}{16}\cdot in\right)\cdot 0.707$ $\quad t_e = 0.221\cdot in$ — Effective Throat Thickness (Ref. 5, sec J.2.2.a)

$\phi := 0.75$ — Resistance Factor (Ref.5, Table J2.3) $\quad t := 2\cdot in$ — Bail thickness

$\phi R_n := \phi\cdot t_e\cdot(0.6\cdot f_{uw})$ $\quad \phi R_n = 7.158\cdot\frac{kips}{in}$ — Design Strength of Fillet Weld

$\phi := 0.9$ — Resistance Factor for metal in tension

$\phi R_n := \phi\cdot t_e\cdot\left(\frac{f_{yt}}{\sqrt{3}}\right)$ $\quad \phi R_n = 4.133\cdot\frac{kips}{in}$ — Design Strength of Base Metal — CONTROLS

$T_n := 1.4\cdot 21.83\cdot kips$ $\quad T_n = 30.56\cdot kips$ — 1.4 x Reaction at node 8 page 7.

$T_u := \phi R_n\cdot 4\cdot t$

$T_u = 33.063\cdot kips \quad > \quad T_n$ — Tensile Strength of Weld for each leg of Bail. — OK!!

6. Concrete Pullout/Shear Strength at Lifting Bail Location.

$D := 2\cdot in$ — Nominal Dimension of Bent Bar

$f_{us} := 58000$

$$m_t := D\cdot\sqrt{\frac{f_{us}}{73\cdot\sqrt{f_c}}}$$ — Edge Distance for Tension Load (Ref. 1, sec. B.5.1.1 of 349R)

$m_t = 7.089\cdot in$

Edge distance for shear will not be a consideration for three reasons:

a. The Lifting Bails will be positioned so the stress cones will be developed within the reinforcing cage.

b. The lifting force applied will be oriented no greater than 20 degress from vertical toward the center of the cover block. (See H-2-818448, sh. 2 & 3).

<u>Use 12 inch spacing from edge of cover block to centerline of lifting bail.</u>

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Revision: 0
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DESIGN ANALYSIS

Client: WHC
Subject: Cover Block Lifting Bail Calculations
Location: C Tank Farm and AY Tank Farm

WO/Job No.: ER4319/W320
Date: 7/6/95
Checked: 7/28/95
Revised:

By: J. R. Booth JRB
By: M. B. Lasota MBL
By:

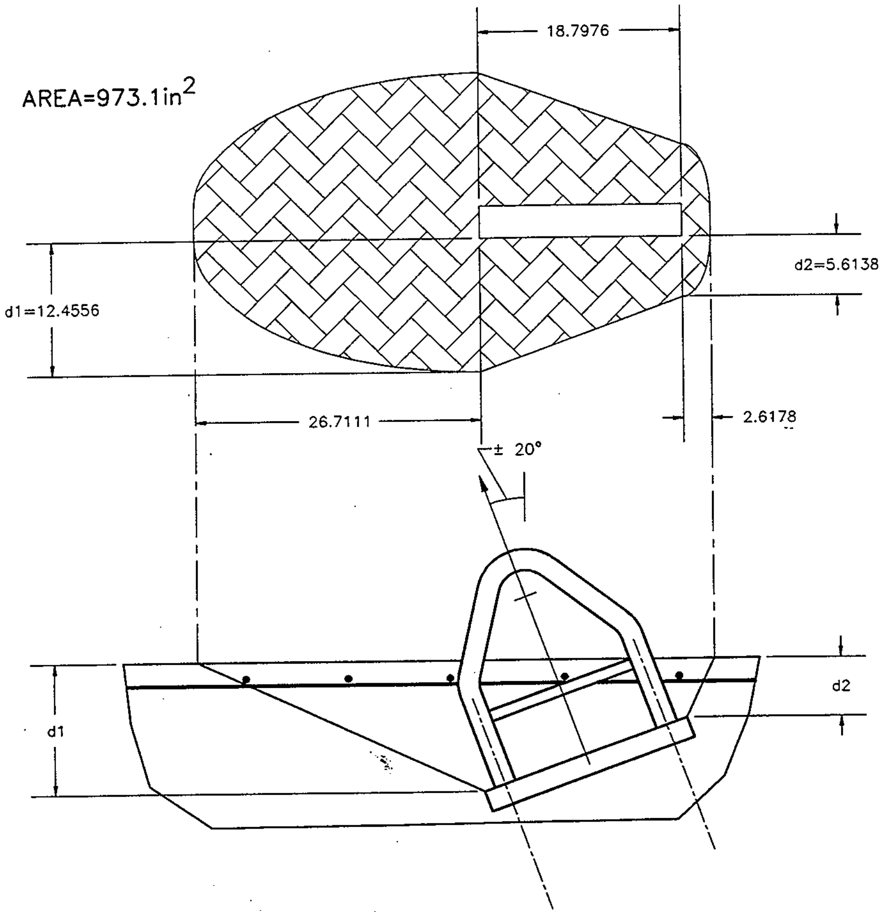


FIGURE 3
Effective projected area of the shear cone

ACAD FILE: BAIL02

Client: WHC
Subject: Cover Block Lifting Bail Calculations.

Location: C-Farm & AY-Farm

WO/Job No.: ER4319/W 320
Date: 7/6/95 By: J. R. Booth
Checked: 8/1/95 By: M. B. Lasota
Revised:03/05/96 By: M. B. Lasota

$\phi := 0.65$ Strength reduction Factor for concrete anchorage. (Ref. 1 sec. B.4.2)

$P_u := 4 \cdot \phi \sqrt{f_c} \cdot A_e \cdot \sqrt{psi}$ Design strength of concrete anchorage. The Strength Reduction Factor is for additional conservatism above the load factor that will be used to reduce the overall ultimate strength of the lifting bail. (Ref 3, pg.4)

$P_u = 160.015 \cdot kips$

$SF := \dfrac{P_u}{1.4 \cdot \dfrac{W}{5}}$ $SF = 13.092$ $SF \geq 5.0$ OK!!!

Note: The concrete pullout strength (Pu) has a factor of safety greater than 2 times the factor of safety that was used to obtain the allowable load for the lifting bail and more than offsets the difference between designing the lifting bail based on yield stress and concrete being analyzed with ultimate stress method.

7. Check Concrete Bearing:

$\phi := 0.70$ Strength Reduction Factor, ACI 318, Sec. 9.3.2.4

$A_1 := (2 \cdot in)^2 \cdot 2$

$A_1 = 8 \cdot in^2$ Multiplied by two since supporting surface is much wider than the loaded area, ACI 318, Sec. 10.15.1.

$\phi P_p := \phi\, 0.85 \cdot (f_c) \cdot A_1$

$\phi P_p = 19.04 \cdot kips$ lbs Ultimate Bearing Strength of concrete.

$\phi P_p > \dfrac{12.94 \cdot kips}{2}$ OK, 12.94 kips is from attachment 1, page 7 reaction at node 8. Actual bearing is significantly smaller since 1 sq. in. crossbar will tend to balance horizontal reaction from both supports.

8. Check the lifting bail of the Pump Penetration Port Plug.

RD 5/30/96 ⚠1

$S := 490 \cdot pcf$ Weight density of steel

Weight of plug...

$$V_{plug} := \left[\left(6.5^2 - 5^2\right) \cdot in^2 \cdot \frac{\pi}{2} + 2 \cdot 2 \cdot in \cdot 6 \cdot in \right] \cdot 2 \cdot in + 3 \cdot in \cdot \frac{\pi}{4} \cdot (48 \cdot in)^2 + (6 \cdot in + 5 \cdot in) \cdot \frac{\pi}{4} \cdot (45.25 \cdot in)^2 \ldots$$
$$+ 0.5 \cdot in \cdot \frac{\pi}{4} \cdot \left(52.25^2 - 45.25^2\right) \cdot in^2 + \frac{\pi}{3} \cdot 12 \cdot in \cdot \frac{45.25^2 + 43.125^2 + 45.25 \cdot 43.125}{4} \cdot in^2 - 18 \cdot in \cdot \frac{\pi}{4} \cdot (35.25 \cdot in)^2$$

$W_{plug} := V_{plug} \cdot S$ $W_{plug} = 6899 \cdot lbf$

In further calculations use weight of the plug:

$W_{plug} := 7000 \cdot lbf$

Client: WHC
Subject: Cover Block Lifting Bail Calculations.

Location: C-Farm & AY-Farm

WO/Job No.: ER4319/W 320
Date: 03/05/96 By: M. B. Lasota MBL
Checked: 5/30 RU By: R. W. Davidson RWD
Revised: By:

$V_2 := 500 \cdot \frac{ft}{min}$ Speed of Lift $V_1 := 0 \cdot \frac{ft}{min}$ At Rest Speed

$g = 32.17 \cdot \frac{ft}{sec^2}$ Acceleration do to Gravity $t := 5 \cdot sec$ Time to accelerate to V2.

$a := \frac{V_2 - V_1}{t}$ $a = 1.667 \cdot \frac{ft}{sec^2}$ Acceleration

$W := W_{plug} \cdot \left(1 + \frac{a}{g}\right)$ $W = 7363 \cdot lbf$ Lifting Load acting on the Bail

From the attachment 2. the critical section of the lifting bail is at the load application ie node 11. The magnitude of the load used in analysis is 1000 lbf. Since the bail is loaded by single vertical load, and analysis is linear elastic, the stresses as well as the internal forces are proportional to the applied load. The following are the internal forces at node 11:

$P_{1000} := 1000 \cdot lbf$

Due to unit load:

$p_{x11} := \frac{0.1791 \cdot 10^3 \cdot lbf}{P_{1000}}$ $v_{y11} := \frac{0.500 \cdot 10^3 \cdot lbf}{P_{1000}}$ $m_{z11} := \frac{1.393 \cdot 10^3 \cdot lbf \cdot in}{P_{1000}}$

$p_{x11} = 0.1791$ $v_{y11} = 0.5000$ $m_{z11} = 1.3930 \cdot in$

Internal forces in the Bail (node 11) resulting from application of the load W are:

$P_{x11} := W \cdot p_{x11}$ $P_{x11} = 1318.64 \cdot lbf$

$V_{y11} := W \cdot v_{y11}$ $V_{y11} = 3681.31 \cdot lbf$

$M_{z11} := W \cdot m_{z11}$ $M_{z11} = 10256.12 \cdot lbf \cdot in$

From Ref. 4 Safety Factors required for the under the hook devices are:
FS= 5 - against the ultimate strength, and
FS=3 - against the yield strength

Allowable stress with respect to ultimate strength of the Bail is:

$f_{au} := \frac{f_{yt}}{5}$ $f_{au} = 7200 \cdot psi$ Shape factor for rectangular section is: $\nu := 1.5$

$f_{bu} := \frac{f_{yt} \cdot \nu}{5}$ $f_{bu} = 10800 \cdot psi$

$f_{vu} := \frac{f_{yt}}{5 \cdot \sqrt{3}}$ $f_{vu} = 4157 \cdot psi$

Assuming, the cross-section of the Bail is square with the leg "a", the section properties are as follow:

$$A_x = d^2 \qquad S_z = \frac{d^3}{6}$$

Interaction formula for the axial and bending stress is:

$$IF = \frac{P_{x11}}{A_x \cdot f_{au}} + \frac{M_{z11}}{S_z \cdot f_{bu}} \le 1.0$$

After substitution for variables the equation with respect to a is:

$$m_1 := \frac{P_{x11}}{f_{au}} \cdot \frac{1}{in^2} \qquad m_1 = 0.1831 \qquad m_2 := \frac{M_{z11} \cdot 6}{f_{bu}} \cdot \frac{1}{in^3} \qquad m_2 = 5.6978$$

$$f(x) := x^3 - m_1 \cdot x - m_2 \qquad x := 1$$

$$d := root\left(x^3 - m_1 \cdot x - m_2, x\right) \qquad d \cdot in = 1.8202 \cdot in$$

<u>Use 2" square bar:</u> $d := 2 \cdot in$

Actual Factor of Safety using 2" sqare bar is:

With respect to bail's ultimate strength

$$SF_u := d^2 \cdot f_{yt} \left(P_{x11} + \frac{6 \cdot M_{z11}}{d \cdot v}\right)^{-1} \qquad SF_u = 6.596 \qquad SF_u \ge 5 \qquad OK$$

With respect to bail's yield strength

$$SF_y := d^2 \cdot f_{yt} \left(P_{x11} + \frac{6 \cdot M_{z11}}{d}\right)^{-1} \qquad SF_y = 4.488 \qquad SF_y \ge 3 \qquad OK$$

With respect to bail's shear strength

$$SF_v := \frac{d^2 \cdot f_{yt}}{V_{y11} \cdot \sqrt{3}} \qquad SF_v = 22.584 \qquad SF_v \ge 3 \qquad OK$$

Check Weld Strength of Bail to steel plate...

Due to unit load at node 1 (in member local coordinate system):

$$p_{x01} := \frac{0.5 \cdot 10^3 \cdot lbf}{P_{1000}} \qquad v_{z01} := \frac{0.1791 \cdot 10^3 \cdot lbf}{P_{1000}} \qquad m_{y01} := \frac{0.6223 \cdot 10^3 \cdot lbf \cdot in}{P_{1000}}$$

$$p_{x01} = 0.5000 \qquad v_{z01} = 0.1791 \qquad m_{y01} = 0.6223 \cdot in$$

Internal forces in the Bail (node 1) resulting from application of the load W are:

$$P_{x01} := W \cdot p_{x01} \qquad P_{x01} = 3681.31 \cdot lbf$$

$$V_{z01} := W \cdot v_{z01} \qquad V_{z01} = 1318.64 \cdot lbf$$

$$M_{y01} := W \cdot m_{y01} \qquad M_{y01} = 4581.75 \cdot lbf \cdot in$$

ICF KAISER HANFORD COMPANY

DESIGN ANALYSIS

Client: WHC
Subject: Cover Block Lifting Bail Calculations.
Location: C-Farm & AY-Farm

WO/Job No.: ER4319/W 320
Date: 03/06/96 By: M. B. Lasota
Checked: 5/30/96 By: R. W. Davidson
Revised: By:

$d = 2 \cdot in$

$A_w := 4 \cdot d \quad A_w = 8 \cdot in$ — Weld area subject to tension.

$A_{ws} := 2 \cdot d \quad A_{ws} = 4 \cdot in$ — Weld area subject to shear.

$S_w := d^2 + \frac{d^2}{3} \quad S_w = 5.33 \cdot in^2$ — Weld section modulus.

$$R := \left[\left(\frac{P_{x01}}{A_w} + \frac{M_{y01}}{S_w}\right)^2 + \left(\frac{V_{z01}}{A_{ws}}\right)^2\right]^{\frac{1}{2}}$$

$R = 1.3598 \cdot \frac{kips}{in}$

$t_e := \left(\frac{3}{8} \cdot in\right) \cdot \frac{1}{\sqrt{2}} \quad t_e = 0.27 \cdot in$ — Effective Throat Thickness (Ref. 5, sec J.2.2.a)

$\phi := 0.75$ — Resistance Factor (Ref.5, Table J2.3)

$\phi R_{wm} := \phi \cdot t_e \cdot (0.6 \cdot f_{uw}) \quad \phi R_{wm} = 8.35 \cdot \frac{kips}{in}$ — Design Strength of Fillet Weld

$SF_{wm} := \frac{\phi R_{wm}}{R} \quad SF_{wm} = 6.14$ — $SF_{wm} \geq 5$ OK.

$\phi_v := 0.9$ — Resistance Factor (Ref.5, F2.2)

$f_{yt} = 36 \cdot ksi$ — Yield Strength of Base Metal

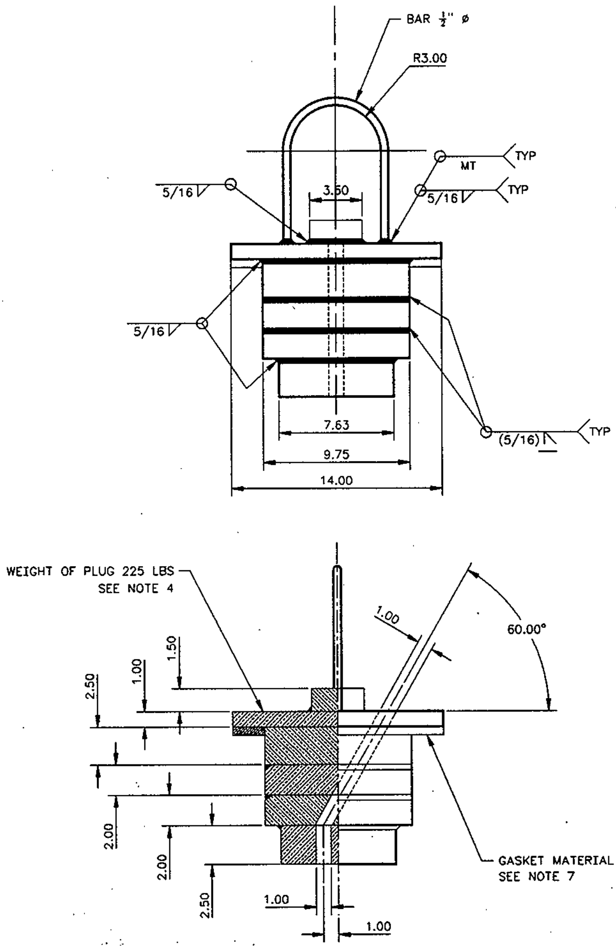
$\phi R_{bm} := \phi_v \cdot t_e \cdot (0.6 \cdot f_{yt}) \cdot \sqrt{2} \quad \phi R_{bm} = 7.29 \cdot \frac{kips}{in}$ — Design Strength of Base Metal CONTROLS

$SF_{bm} := \frac{\phi R_{bm}}{R} \quad SF_{bm} = 5.36$ — $SF_{bm} \geq 5$ OK.

Use 3/8" fillet weld. It satisfies minimum weld requirements. (Ref. 5, Table J2.5)

The 2" square bar used as the lifting bail for the Pump Penetration Plug is sufficient to provide the Safety Factor of 5 during lifting.

MCAD FILE: 3202425A.MCD



REPLACEMENT PLUG ACCOMMODATING LEAK DETECTOR WIRING REQUIREMENTS

MATERIAL ASTM A36 STEEL

FLUOR DANIEL
NORTHWEST INC.

DESIGN ANALYSIS

Client: *Numatec Hanford Company*
Subject: *Cover Block Lifting Bail Calculations.*
Location: *C-Farm and AY- Farm*

WO/Job No.: *ER4319/W320*
Date: *4/25/97* By: *MB Casota*
Checked: 5/8/97 By:
Revised By

The replacement Plug consist of 6 circular discs and the bail constructed from the round stock 1/2" diameter. The following is a calculation of the weight of the Plug:

$i := 0..6$

$d_i :=$	$t_i :=$
$7.625 \cdot in$	$2.5 \cdot in$
$9.75 \cdot in$	$2 \cdot in$
$9.75 \cdot in$	$2 \cdot in$
$9.75 \cdot in$	$2.5 \cdot in$
$14.0 \cdot in$	$1 \cdot in$
$3.5 \cdot in$	$1.5 \cdot in$

The length of the round stock is:

$t_6 := 2 \cdot 6 \cdot in + \pi \cdot 3.25 \cdot in$ $\quad t_6 = 22.21 \cdot in$ $\quad d_6 := 0.5 \cdot in$

Volume of the steel used in construction of the Plug is:

$$V_s := \frac{\pi}{4} \cdot \left[\sum_i (d_i)^2 \cdot t_i - \left[t_1 + \frac{\sum_{i=1}^{4} t_i}{\sin(60)} \right] \cdot (1 \cdot in)^2 \right]$$

$V_s = 789.95 \cdot in^3$ $\quad \gamma_s := 490 \cdot pcf$

$W_{pl} := V_s \cdot \gamma_s$ $\quad W_{pl} = 224 \cdot lbf$ $\quad$ use $\quad W_{pl} := 225 \cdot lbf$

Check shielding properties of the plug at the least thickness in terms of equivalent concrete thickness.

$\gamma_c := 140 \cdot pcf$ $\quad t_{min} := 7.13 \cdot in$

$t_{con} := t_{min} \cdot \frac{\gamma_s}{\gamma_c}$ $\quad t_{con} = 24.95 \cdot in$ $\quad t_{con} \geq 24 \cdot in$ $\quad$ OK

FLUOR DANIEL NORTHWEST INC.	DESIGN ANALYSIS	Calc. No.: W-320-24-025
		Revision No.: 1
		Page No.: 9 of 11

Client:	Numatec Hanford Company	WO/Job No.:	ER4319/W-320		
Subject:	Cover Block Lifting Bail Calculations	Date:	4/28/1997	By:	M.B. Lasota
		Checked:	5/8/97	By:	R.W. Davidson
Location:	C-Farm and AY-Farm	Revised:		By:	

Cover Block Port Plug Evaluation

	Weight (lbf)	Bail Type	By Inspection
Pump Pit (241-C06A)			
3" Dia Valve Port Plug	40	BAR 1/2" Dia.	OK
(3) 8" Dia Camera Port Plug	220	BAR 1/2" Dia.	OK
(1) 8" Dia Leak Detector Access Plug	225	BAR 1/2" Dia.	OK
Winch Port Shielding Plug	100	BAR 1/2" Dia.	OK
Slot Plug, Block A	590	BAR 3/4" Dia.	OK
Slot Plug, Block B	653	BAR 3/4" Dia.	OK
Sluice Pit (241-C-06C)			
8" Dia Camera Port Plug	220	BAR 1/2" Dia.	OK
(1) 8" Dia Leak Detector Access Plug	225	BAR 1/2" Dia.	OK
Sluicer Port Plug			Existing
3" Dia Valve Port Plug	40	BAR 1/2" Dia.	OK
Slot Plug, Block A	460	BAR 3/4" Dia.	OK
Pump Pit (241-AY-02A)			
12" Dia Valve Port	350	BAR 3/4" Dia.	OK
Sluice Pit (241-AY-02E)			
12" Dia Valve Port	350	BAR 3/4" Dia.	OK
(2) 8" Dia Camera Port Plug	220	BAR 1/2" Dia.	OK
Winch Port Shielding Plug	100	BAR 1/2" Dia.	OK
(3) Slot Plugs, Block A	365	BAR 3/4" Dia.	OK

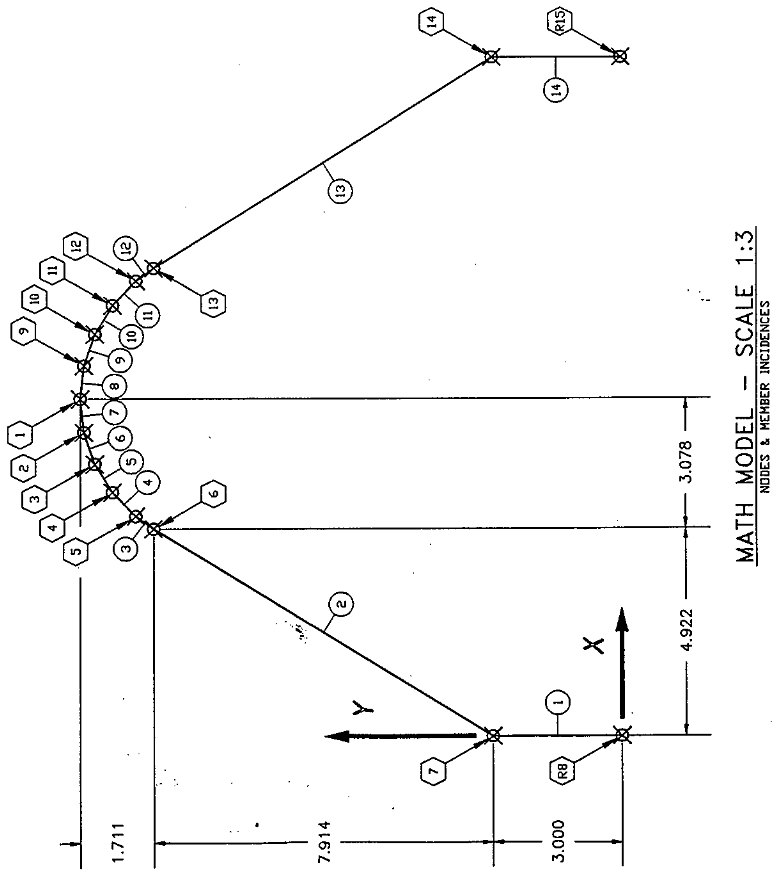
ICF KAISER HANFORD

DESIGN ANALYSIS

Calc. No.: W320-24-025
Revision: 0
Page No.: 10 of 11

Client: WHC
Subject: Cover Block Lifting Bail Calculations
Location: C Tank Farm and AY Tank Farm

WO/Job No.: ER4319/W320
Date: 7/21/95 By: M.B. Lasota
Checked: 8/1/95 By: J.R. Booth
Revised: By:



ACAD FILE: BAIL03

ICF KAISER HANFORD

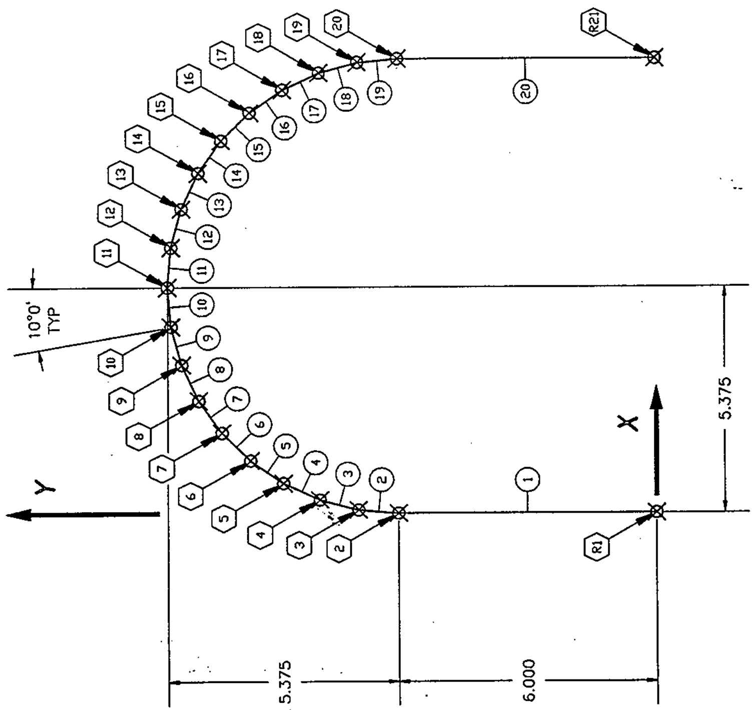
DESIGN ANALYSIS

Calc. No.: W320-24-025
Revision: 0
Page No.: 11 of 11

Client: WHC
Subject: Cover Block Lifting Bail Calculations
Location: C Tank Farm and AY Tank Farm

WO/Job No.: ER4319/W320
Date: 7/21/95
Checked: 8/1/95
Revised:

By: M.B. Lasota
By: J.R. Booth
By:



MATH MODEL – SCALE 1:3
PLUG – NODES & MEMBER INCIDENCES

ACAD FILE: BAIL04

ATTACHMENT 1

TOTAL OF 10 PAGES
RUN ID#: AA77104
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CHECK GEOMETRY Version 2.0 07/01/90

MATERIAL PROPERTIES

Material No	Modulus of Elasticity	Weight Density	Coeff of Thermal Exp.	Poisson's Ratio	Shear Web Modulus
1	3.00000E+07	2.83000E-01	6.33000E-06	3.00E-01	0.00000E+00

NODE COORDINATES

Node	X-Coord.	Y-Coord.	Z-Coord.
1	8.00000E+00	1.26250E+01	0.00000E+00
2	7.21541E+00	1.25391E+01	0.00000E+00
3	6.46801E+00	1.22854E+01	0.00000E+00
4	5.79324E+00	1.18759E+01	0.00000E+00
5	5.22309E+00	1.13301E+01	0.00000E+00
6	4.92200E+00	1.09140E+01	0.00000E+00
7	0.00000E+00	3.00000E+00	0.00000E+00
8	0.00000E+00	0.00000E+00	0.00000E+00
9	8.78459E+00	1.25391E+01	0.00000E+00
10	9.53199E+00	1.22854E+01	0.00000E+00
11	1.02068E+01	1.18759E+01	0.00000E+00
12	1.07769E+01	1.13301E+01	0.00000E+00
13	1.10780E+01	1.09140E+01	0.00000E+00
14	1.60000E+01	3.00000E+00	0.00000E+00
15	1.60000E+01	0.00000E+00	0.00000E+00

BEAM PROPERTIES

Multiplier = 1 (For AISC database properties only)

Prop No	X-Section Area	Moment of Inertia Iy	Moment of Inertia Iz	Torsional Const.- J
1	4.000E+00	1.333E+00	1.333E+00	2.667E+00

Prop No	Max. Fiber Dist Cy	Max. Fiber Dist Cz	Shear Shape Fact SSFy	Shear Shape Fact SSFz	Ctors	Shear Stress Factor SSTRFy	Shear Stress Factor SSTRFz
1	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.50E+00	1.50E+00

CHECK GEOMETRY Version 2.0 07/01/90

BEAM CONNECTIVITY

Beam No	Nodes From/	To /	Ref	Prop No	Mat No	pincodes I / J	Rigid End Offset I	/ J	Length	Beam Type
1	8	7	0	1	1		0.00E+00	0.00E+00	0.30E+01	Beam
2	7	6	0	1	1		0.00E+00	0.00E+00	0.93E+01	Beam
3	6	5	0	1	1		0.00E+00	0.00E+00	0.51E+00	Beam
4	5	4	0	1	1		0.00E+00	0.00E+00	0.79E+00	Beam
5	4	3	0	1	1		0.00E+00	0.00E+00	0.79E+00	Beam
6	3	2	0	1	1		0.00E+00	0.00E+00	0.79E+00	Beam
7	2	1	0	1	1		0.00E+00	0.00E+00	0.79E+00	Beam
8	1	9	0	1	1		0.00E+00	0.00E+00	0.79E+00	Beam
9	9	10	0	1	1		0.00E+00	0.00E+00	0.79E+00	Beam
10	10	11	0	1	1		0.00E+00	0.00E+00	0.79E+00	Beam
11	11	12	0	1	1		0.00E+00	0.00E+00	0.79E+00	Beam
12	12	13	0	1	1		0.00E+00	0.00E+00	0.51E+00	Beam
13	13	14	0	1	1		0.00E+00	0.00E+00	0.93E+01	Beam
14	14	15	0	1	1		0.00E+00	0.00E+00	0.30E+01	Beam

RESTRAINTS

Node No	Global/Local	Restraint Directions
8	GLOBAL	X Y Z RX RY RZ
15	GLOBAL	X Y Z RX RY RZ

SOLVE DISPLACEMENTS Version 2.0 07/01/90

L O A D C A S E 1

VERTICAL LOAD

GRAVITY LOADING

Direction	Gravity Factor	Load Factor
X	.0000E+00	.1000E+01
Y	.0000E+00	.1000E+01
Z	.0000E+00	.1000E+01

INERTIA LOADING

Direction	Translational Accel.	Rotational Accel.	Rotational Velocity	Origin
X	.0000E+00	.0000E+00	.0000E+00	.0000E+00
Y	.0000E+00	.0000E+00	.0000E+00	.0000E+00
Z	.0000E+00	.0000E+00	.0000E+00	.0000E+00

Gravity Acceleration = .3864E+03

CONCENTRATED LOADS

Node	Fx	Fy	Fz	Mx	My	Mz
1	.0000E+00	.4365E+05	.0000E+00	.0000E+00	.0000E+00	.0000E+00

REFERENCE TEMPERATURE = .0000E+00

SOLVE DISPLACEMENTS Version 2.0 07/01/90

L O A D C A S E 2

INCLINED LOAD

GRAVITY LOADING

Direction	Gravity Factor	Load Factor
X	.0000E+00	.1000E+01
Y	.0000E+00	.1000E+01
Z	.0000E+00	.1000E+01

INERTIA LOADING

Direction	Translational Accel.	Rotational Accel.	Rotational Velocity	Origin
X	.0000E+00	.0000E+00	.0000E+00	.0000E+00
Y	.0000E+00	.0000E+00	.0000E+00	.0000E+00
Z	.0000E+00	.0000E+00	.0000E+00	.0000E+00

Gravity Acceleration = .3864E+03

CONCENTRATED LOADS

Node	Fx	Fy	Fz	Mx	My	Mz
10	.1493E+05	.4102E+05	.0000E+00	.0000E+00	.0000E+00	.0000E+00

REFERENCE TEMPERATURE = .0000E+00

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L O A D C A S E 1

VERTICAL LOAD

APPLIED LOAD VECTOR

Node	Fx	Fy	Fz	Mx	My	Mz
1	.0000E+00	.4365E+05	.0000E+00	.0000E+00	.0000E+00	.0000E+00

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L O A D C A S E 1

VERTICAL LOAD

DISPLACEMENTS

Node	Translations X	Translations Y	Translations Z	Rotations X	Rotations Y	Rotations Z
1	.2347E-09	.7316E-02	.0000E+00	.0000E+00	.0000E+00	.4595E-10
2	-.3236E-04	.6691E-02	.0000E+00	.0000E+00	.0000E+00	.6337E-03
3	.1486E-03	.5763E-02	.0000E+00	.0000E+00	.0000E+00	.9807E-03
4	.5623E-03	.4798E-02	.0000E+00	.0000E+00	.0000E+00	.1106E-02
5	.1130E-02	.3973E-02	.0000E+00	.0000E+00	.0000E+00	.1085E-02
6	.1528E-02	.3551E-02	.0000E+00	.0000E+00	.0000E+00	.1030E-02
7	.2630E-02	.5456E-03	.0000E+00	.0000E+00	.0000E+00	-.7075E-03
8	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00
9	.3236E-04	.6691E-02	.0000E+00	.0000E+00	.0000E+00	-.6337E-03
10	-.1486E-03	.5763E-02	.0000E+00	.0000E+00	.0000E+00	-.9807E-03
11	-.5623E-03	.4798E-02	.0000E+00	.0000E+00	.0000E+00	-.1106E-02
12	-.1130E-02	.3973E-02	.0000E+00	.0000E+00	.0000E+00	-.1085E-02
13	-.1528E-02	.3551E-02	.0000E+00	.0000E+00	.0000E+00	-.1030E-02
14	-.2630E-02	.5456E-03	.0000E+00	.0000E+00	.0000E+00	.7075E-03
15	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00	.0000E+00

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          SOLVE DISPLACEMENTS        Version 2.0  07/01/90

                          L O A D   C A S E   2
      INCLINED LOAD

                          APPLIED LOAD VECTOR

 Node      Fx          Fy          Fz          Mx          My          Mz
 ----  ----------  ----------  ----------  ----------  ----------  ----------
   10  .1493E+05   .4102E+05   .0000E+00   .0000E+00   .0000E+00   .0000E+00
```

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KAISER ENGINEERS HANFORD  S/N:801854                                07/21/95
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          SOLVE DISPLACEMENTS        Version 2.0  07/01/90

                          L O A D   C A S E   2
      INCLINED LOAD

                             DISPLACEMENTS

          T r a n s l a t i o n s       /        R o t a t i o n s
 Node       X           Y           Z       /     X           Y           Z
 ----  ----------  ----------  ---------- / ----------  ----------  ----------
    1  .1368E-01   .5365E-02   .0000E+00 /  .0000E+00   .0000E+00   .3003E-02
    2  .1384E-01   .2602E-02   .0000E+00 /  .0000E+00   .0000E+00   .3011E-02
    3  .1451E-01   .1237E-03   .0000E+00 /  .0000E+00   .0000E+00   .2724E-02
    4  .1546E-01  -.1806E-02   .0000E+00 /  .0000E+00   .0000E+00   .2228E-02
    5  .1642E-01  -.3093E-02   .0000E+00 /  .0000E+00   .0000E+00   .1620E-02
    6  .1692E-01  -.3614E-02   .0000E+00 /  .0000E+00   .0000E+00   .1208E-02
    7  .5711E-02   .5935E-03   .0000E+00 /  .0000E+00   .0000E+00  -.2272E-02
    8  .0000E+00   .0000E+00   .0000E+00 /  .0000E+00   .0000E+00   .0000E+00
    9  .1408E-01   .8025E-02   .0000E+00 /  .0000E+00   .0000E+00   .2627E-02
   10  .1488E-01   .1016E-01   .0000E+00 /  .0000E+00   .0000E+00   .1829E-02
   11  .1539E-01   .1084E-01   .0000E+00 /  .0000E+00   .0000E+00   .9067E-03
   12  .1563E-01   .1095E-01   .0000E+00 /  .0000E+00   .0000E+00   .1585E-03
   13  .1559E-01   .1083E-01   .0000E+00 /  .0000E+00   .0000E+00  -.2569E-03
   14  .1335E-02   .4320E-03   .0000E+00 /  .0000E+00   .0000E+00  -.1218E-02
   15  .0000E+00   .0000E+00   .0000E+00 /  .0000E+00   .0000E+00   .0000E+00
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SOLVE BEAM LOADS/STRESSES Version 2.0 07/01/90

Load Case 1:VERTICAL LOAD

BEAM LOADS AND/OR STRESSES

LLoads Stress Stress	Node Node Node	Axial Axial Maximum	Y-Shear Y-Shear Minimum	Z-Shear Z-Shear Cmb. Shear	Torsion Torsion	Y-Bending Y-Bending	Z-Bending Z-Bending
				BEAM NO. 1			
Stress	8	.5456E+04	.0000E+00	-.4851E+04	.0000E+00	-.2163E+05	.0000E+00
Stress	8	.2709E+05	-.1618E+05	.1354E+05			
Stress	-7	.5456E+04	.0000E+00	-.4851E+04	.0000E+00	.7483E+04	.0000E+00
Stress	7	.1294E+05	-.2027E+04	.6470E+04			
				BEAM NO. 2			
Stress	7	.6341E+04	-.2029E+03	.0000E+00	.0000E+00	.0000E+00	.7483E+04
Stress	7	.1382E+05	-.1142E+04	.6912E+04			
Stress	6	.6341E+04	-.2029E+03	.0000E+00	.0000E+00	.0000E+00	.3700E+04
Stress	6	.1004E+05	.2641E+04	.5021E+04			
				BEAM NO. 3			
Stress	6	.6316E+04	-.8677E+03	.0000E+00	.0000E+00	.0000E+00	.3700E+04
Stress	6	.1002E+05	.2616E+04	.5008E+04			
Stress	5	.6316E+04	-.8677E+03	.0000E+00	.0000E+00	.0000E+00	.2809E+04
Stress	5	.9125E+04	.3508E+04	.4563E+04			
				BEAM NO. 4			
Stress	5	.6109E+04	-.2557E+04	.0000E+00	.0000E+00	.0000E+00	.2809E+04
Stress	5	.8918E+04	.3301E+04	.4459E+04			
Stress	4	.6109E+04	-.2557E+04	.0000E+00	.0000E+00	.0000E+00	-.1229E+04
Stress	4	.7339E+04	.4880E+04	.3669E+04			
				BEAM NO. 5			
Stress	4	.5596E+04	-.4480E+04	.0000E+00	.0000E+00	.0000E+00	-.1229E+04
Stress	4	.6825E+04	.4366E+04	.3412E+04			
Stress	3	.5596E+04	-.4480E+04	.0000E+00	.0000E+00	.0000E+00	-.8304E+04
Stress	3	.1390E+05	-.2708E+04	.6950E+04			
				BEAM NO. 6			
Stress	3	.4816E+04	-.6191E+04	.0000E+00	.0000E+00	.0000E+00	-.8304E+04
Stress	3	.1312E+05	-.3487E+04	.6560E+04			
Stress	2	.4816E+04	-.6191E+04	.0000E+00	.0000E+00	.0000E+00	-.1808E+05
Stress	2	.2290E+05	-.1326E+05	.1145E+05			
				BEAM NO. 7			
Stress	2	.3809E+04	-.7608E+04	.0000E+00	.0000E+00	.0000E+00	-.1808E+05
Stress	2	.2189E+05	-.1427E+05	.1094E+05			
Stress	1	.3809E+04	-.7608E+04	.0000E+00	.0000E+00	.0000E+00	-.3009E+05
Stress	1	.3390E+05	-.2628E+05	.1695E+05			
				BEAM NO. 8			
Stress	1	.3809E+04	.7608E+04	.0000E+00	.0000E+00	.0000E+00	-.3009E+05
Stress	1	.3390E+05	-.2628E+05	.1695E+05			

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SOLVE BEAM LOADS/STRESSES Version 2.0 07/01/90

Load Case 1:VERTICAL LOAD

LLoads Stress Stress	Node Node Node	Axial Axial Maximum	Y-Shear Y-Shear Minimum	Z-Shear Z-Shear Cmb. Shear	Torsion Torsion	Y-Bending Y-Bending	Z-Bending Z-Bending
Stress	9	.3809E+04	.7608E+04	.0000E+00	.0000E+00	.0000E+00	-.1808E+05
Stress	9	.2189E+05	-.1427E+05	.1094E+05			
				BEAM NO. 9			
Stress	9	.4816E+04	.6191E+04	.0000E+00	.0000E+00	.0000E+00	-.1808E+05
Stress	9	.2290E+05	-.1326E+05	.1145E+05			
Stress	10	.4816E+04	.6191E+04	.0000E+00	.0000E+00	.0000E+00	-.8304E+04
Stress	10	.1312E+05	-.3487E+04	.6560E+04			
				BEAM NO. 10			
Stress	10	.5596E+04	.4480E+04	.0000E+00	.0000E+00	.0000E+00	-.8304E+04
Stress	10	.1390E+05	-.2708E+04	.6950E+04			
Stress	11	.5596E+04	.4480E+04	.0000E+00	.0000E+00	.0000E+00	-.1229E+04
Stress	11	.6825E+04	.4366E+04	.3412E+04			
				BEAM NO. 11			
Stress	11	.6109E+04	.2557E+04	.0000E+00	.0000E+00	.0000E+00	-.1229E+04
Stress	11	.7339E+04	.4880E+04	.3669E+04			
Stress	12	.6109E+04	.2557E+04	.0000E+00	.0000E+00	.0000E+00	.2809E+04
Stress	12	.8918E+04	.3301E+04	.4459E+04			
				BEAM NO. 12			
Stress	12	.6316E+04	.8677E+03	.0000E+00	.0000E+00	.0000E+00	.2809E+04
Stress	12	.9125E+04	.3508E+04	.4563E+04			
Stress	13	.6316E+04	.8677E+03	.0000E+00	.0000E+00	.0000E+00	.3700E+04
Stress	13	.1002E+05	.2616E+04	.5008E+04			
				BEAM NO. 13			
Stress	13	.6341E+04	.2029E+03	.0000E+00	.0000E+00	.0000E+00	.3700E+04
Stress	13	.1004E+05	.2641E+04	.5021E+04			
Stress	14	.6341E+04	.2029E+03	.0000E+00	.0000E+00	.0000E+00	.7483E+04
Stress	14	.1382E+05	-.1142E+04	.6912E+04			
				BEAM NO. 14			
Stress	14	.5456E+04	.0000E+00	.4851E+04	.0000E+00	.7483E+04	.0000E+00
Stress	14	.1294E+05	-.2027E+04	.6470E+04			
Stress	15	.5456E+04	.0000E+00	.4851E+04	.0000E+00	-.2163E+05	.0000E+00
Stress	15	.2709E+05	-.1618E+05	.1354E+05			

```
KAISER ENGINEERS HANFORD  S/N:801854                        07/21/95
PAGE   11                  Run ID=AA77104                   09:58:09
          =============== I M A G E S  3 D ===============
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          =================================================

         SOLVE BEAM LOADS/STRESSES     Version 2.0  07/01/90


Load Case   1:VERTICAL LOAD

                MAXIMUM STRESS SUMMARY FOR BEAMS/TRUSSES
                   WITHIN SPECIFIED RANGE     1-    14

         Maximum (absolute) Stress =  .3390E+05 at BEAM     8

  Beam    Axial      Y-Shear    Z-Shear    Torsion   Y-Bending  Z-Bending
  ----  ---------- ---------- ---------- ---------- ---------- ----------
     8   .3809E+04  .7608E+04  .0000E+00  .0000E+00  .0000E+00 -.3009E+05
          Maximum    Minimum   Cmb. Shear
        ---------- ---------- ---------- ----------
         .3390E+05 -.2628E+05  .1695E+05
```

```
KAISER ENGINEERS HANFORD  S/N:801854                        07/21/95
PAGE   12                  Run ID=AA77104                   09:58:09
          =============== I M A G E S  3 D ===============
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          =================================================

         SOLVE REACTIONS               Version 2.0  07/01/90


Load Case   1:VERTICAL LOAD

                               REACTIONS

  Node      Fx         Fy         Fz         Mx         My         Mz
  ----  ---------- ---------- ---------- ---------- ---------- ----------
     8  -.1294E+05 -.2183E+05  .0000E+00  .0000E+00  .0000E+00  .2884E+05
    15   .1294E+05 -.2183E+05  .0000E+00  .0000E+00  .0000E+00 -.2884E+05
```

```
KAISER ENGINEERS HANFORD  S/N:801854                        07/21/95
PAGE   13                     Run ID=AA77104                09:58:09
             =============== I M A G E S  3 D ===============
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             ================================================

          SOLVE BEAM LOADS/STRESSES    Version 2.0  07/01/90


Load Case  2:INCLINED LOAD

                           BEAM LOADS AND/OR STRESSES

LLoads Node   Axial      Y-Shear    Z-Shear    Torsion    Y-Bending  Z-Bending
Stress Node   Axial      Y-Shear    Z-Shear    Torsion    Y-Bending  Z-Bending
Stress Node  Maximum     Minimum   Cmb. Shear
------ ---- ---------- ---------- ---------- ---------- ---------- ----------
                               ***BEAM  NO.    1***
Stress   8  .5935E+04  .0000E+00 -.7122E+04  .0000E+00 -.4409E+05  .0000E+00
Stress   8  .5002E+05 -.3815E+05  .2501E+05
Stress   7  .5935E+04  .0000E+00 -.7122E+04  .0000E+00 -.1348E+04  .0000E+00
Stress   7  .7282E+04  .4587E+04  .3641E+04
                               ***BEAM  NO.    2***
Stress   7  .7547E+04  .1346E+04  .0000E+00  .0000E+00  .0000E+00 -.1348E+04
Stress   7  .8895E+04  .6199E+04  .4447E+04
Stress   6  .7547E+04  .1346E+04  .0000E+00  .0000E+00  .0000E+00  .2375E+05
Stress   6  .3130E+05 -.1621E+05  .1565E+05
                               ***BEAM  NO.    3***
Stress   6  .7591E+04  .5512E+03  .0000E+00  .0000E+00  .0000E+00  .2375E+05
Stress   6  .3134E+05 -.1616E+05  .1567E+05
Stress   5  .7591E+04  .5512E+03  .0000E+00  .0000E+00  .0000E+00  .2432E+05
Stress   5  .3191E+05 -.1673E+05  .1595E+05
                               ***BEAM  NO.    4***
Stress   5  .7534E+04 -.1505E+04  .0000E+00  .0000E+00  .0000E+00  .2432E+05
Stress   5  .3185E+05 -.1679E+05  .1593E+05
Stress   4  .7534E+04 -.1505E+04  .0000E+00  .0000E+00  .0000E+00  .2194E+05
Stress   4  .2948E+05 -.1441E+05  .1474E+05
                               ***BEAM  NO.    5***
Stress   4  .7138E+04 -.3916E+04  .0000E+00  .0000E+00  .0000E+00  .2194E+05
Stress   4  .2908E+05 -.1480E+05  .1454E+05
Stress   3  .7138E+04 -.3916E+04  .0000E+00  .0000E+00  .0000E+00  .1576E+05
Stress   3  .2290E+05 -.8621E+04  .1145E+05
                               ***BEAM  NO.    6***
Stress   3  .6403E+04 -.6140E+04  .0000E+00  .0000E+00  .0000E+00  .1576E+05
Stress   3  .2216E+05 -.9355E+04  .1108E+05
Stress   2  .6403E+04 -.6140E+04  .0000E+00  .0000E+00  .0000E+00  .6063E+04
Stress   2  .1247E+05  .3401E+03  .6233E+04
                               ***BEAM  NO.    7***
Stress   2  .5366E+04 -.8074E+04  .0000E+00  .0000E+00  .0000E+00  .6063E+04
Stress   2  .1143E+05 -.6977E+03  .5715E+04
Stress   1  .5366E+04 -.8074E+04  .0000E+00  .0000E+00  .0000E+00 -.6685E+04
Stress   1  .1205E+05 -.1319E+04  .6025E+04
                               ***BEAM  NO.    8***
Stress   1  .4074E+04 -.9624E+04  .0000E+00  .0000E+00  .0000E+00 -.6685E+04
Stress   1  .1076E+05 -.2611E+04  .5379E+04
```

BAIL2.30U 7-21-95 9:58a

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KAISER ENGINEERS HANFORD  S/N:801854                        07/21/95
PAGE   14                     Run ID=AA77104                09:58:09
             =============== I M A G E S  3 D ===============
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             ================================================

          SOLVE BEAM LOADS/STRESSES    Version 2.0  07/01/90


Load Case  2:INCLINED LOAD

LLoads Node   Axial      Y-Shear    Z-Shear    Torsion    Y-Bending  Z-Bending
Stress Node   Axial      Y-Shear    Z-Shear    Torsion    Y-Bending  Z-Bending
Stress Node  Maximum     Minimum   Cmb. Shear
------ ---- ---------- ---------- ---------- ---------- ---------- ----------
Stress   9  .4074E+04 -.9624E+04  .0000E+00  .0000E+00  .0000E+00 -.2188E+05
Stress   9  .2595E+05 -.1781E+05  .1298E+05
                               ***BEAM  NO.    9***
Stress   9  .2588E+04 -.1072E+05  .0000E+00  .0000E+00  .0000E+00 -.2188E+05
Stress   9  .2447E+05 -.1929E+05  .1223E+05
Stress  10  .2588E+04 -.1072E+05  .0000E+00  .0000E+00  .0000E+00 -.3881E+05
Stress  10  .4139E+05 -.3622E+05  .2070E+05
                               ***BEAM  NO.   10***
Stress  10  .3109E+04  .4750E+04  .0000E+00  .0000E+00  .0000E+00 -.3881E+05
Stress  10  .4191E+05 -.3570E+05  .2096E+05
Stress  11  .3109E+04  .4750E+04  .0000E+00  .0000E+00  .0000E+00 -.3131E+05
Stress  11  .3441E+05 -.2820E+05  .1721E+05
                               ***BEAM  NO.   11***
Stress  11  .3721E+04  .3628E+04  .0000E+00  .0000E+00  .0000E+00 -.3131E+05
Stress  11  .3503E+05 -.2758E+05  .1751E+05
Stress  12  .3721E+04  .3628E+04  .0000E+00  .0000E+00  .0000E+00 -.2558E+05
Stress  12  .2930E+05 -.2186E+05  .1465E+05
                               ***BEAM  NO.   12***
Stress  12  .4095E+04  .2565E+04  .0000E+00  .0000E+00  .0000E+00 -.2558E+05
Stress  12  .2967E+05 -.2148E+05  .1484E+05
Stress  13  .4095E+04  .2565E+04  .0000E+00  .0000E+00  .0000E+00 -.2294E+05
Stress  13  .2704E+05 -.1885E+05  .1352E+05
                               ***BEAM  NO.   13***
Stress  13  .4205E+04  .2129E+04  .0000E+00  .0000E+00  .0000E+00 -.2294E+05
Stress  13  .2715E+05 -.1874E+05  .1357E+05
Stress  14  .4205E+04  .2129E+04  .0000E+00  .0000E+00  .0000E+00  .1675E+05
Stress  14  .2096E+05 -.1255E+05  .1048E+05
                               ***BEAM  NO.   14***
Stress  14  .4320E+04  .0000E+00  .1523E+04  .0000E+00  .1675E+05  .0000E+00
Stress  14  .2107E+05 -.1243E+05  .1054E+05
Stress  15  .4320E+04  .0000E+00  .1523E+04  .0000E+00  .7612E+04  .0000E+00
Stress  15  .1193E+05 -.3292E+04  .5966E+04
```

Page 8 of 9

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KAISER ENGINEERS HANFORD  S/N:801854                              07/21/95
PAGE   15                          Run ID=AA77104                 09:58:10
            =============== I M A G E S  3 D ===============
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            ================================================

          SOLVE BEAM LOADS/STRESSES     Version 2.0  07/01/90


Load Case  2:INCLINED LOAD

                 MAXIMUM STRESS SUMMARY FOR BEAMS/TRUSSES
                    WITHIN SPECIFIED RANGE    1-   14

          Maximum (absolute) Stress =  .5002E+05 at BEAM      1

  Beam    Axial     Y-Shear    Z-Shear    Torsion   Y-Bending  Z-Bending
  ----  ---------- ---------- ---------- ---------- ---------- ----------
     1  -.5935E+04 .0000E+00 -.7122E+04 .0000E+00 -.4409E+05  .0000E+00
          Maximum    Minimum  Cmb. Shear
        ---------- ---------- ---------- ----------
         .5002E+05 -.3815E+05  .2501E+05
```

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KAISER ENGINEERS HANFORD  S/N:801854                              07/21/95
PAGE   16                          Run ID=AA77104                 09:58:10
            =============== I M A G E S  3 D ===============
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          SOLVE REACTIONS             Version 2.0  07/01/90


Load Case  2:INCLINED LOAD

                                  REACTIONS

  Node      Fx         Fy         Fz         Mx         My         Mz
  ----  ---------- ---------- ---------- ---------- ---------- ----------
     8  -.1899E+05 -.2374E+05 .0000E+00  .0000E+00  .0000E+00  .5877E+05
    15   .4061E+04 -.1728E+05 .0000E+00  .0000E+00  .0000E+00  .1015E+05
```

Attachment 2.

1 5/30/96

Analysis of the bail for Port Plug - Run ID=YD04897

Date: 03-05-1996; Time: 08:49:49

KAISER ENGINEERS HANFORD S/N:801854 03/05/96
PAGE 1 RUN ID=YD04897 08:49:49

=============== I M A G E S 3 D ===============

CHECK GEOMETRY Version 2.0 07/01/90

Analysis of the lifting bail for the Pump Penetration Port P

MATERIAL PROPERTIES

Material No	Modulus of Elasticity	Weight Density	Coeff of Thermal Exp.	Poisson's Ratio	Shear Web Modulus
1	3.00000E+07	2.83000E-01	6.33000E-06	3.00E-01	0.00000E+00

NODE COORDINATES

Node	X-Coord.	Y-Coord.	Z-Coord.
1	0.00000E+00	0.00000E+00	0.00000E+00
2	0.00000E+00	6.00000E+00	0.00000E+00
3	8.73555E-02	6.99848E+00	0.00000E+00
4	3.46768E-01	7.96662E+00	0.00000E+00
5	7.70355E-01	8.87500E+00	0.00000E+00
6	1.34525E+00	9.69603E+00	0.00000E+00
7	2.05397E+00	1.04048E+01	0.00000E+00
8	2.87500E+00	1.09796E+01	0.00000E+00
9	3.78339E+00	1.14032E+01	0.00000E+00
10	4.75152E+00	1.16626E+01	0.00000E+00
11	5.75000E+00	1.17500E+01	0.00000E+00
12	6.74848E+00	1.16626E+01	0.00000E+00
13	7.71662E+00	1.14032E+01	0.00000E+00
14	8.62500E+00	1.09796E+01	0.00000E+00
15	9.44603E+00	1.04047E+01	0.00000E+00
16	1.01547E+01	9.69603E+00	0.00000E+00
17	1.07296E+01	8.87500E+00	0.00000E+00
18	1.11532E+01	7.96661E+00	0.00000E+00
19	1.14126E+01	6.99848E+00	0.00000E+00
20	1.15000E+01	6.00000E+00	0.00000E+00
21	1.15000E+01	0.00000E+00	0.00000E+00

BEAM PROPERTIES

Multiplier = 1 (For AISC database properties only)

Prop No	X-Section Area	Moment of Inertia Iy / Iz		Torsional Const.- J

KAISER ENGINEERS HANFORD S/N:801854 03/05/96
PAGE 2 RUN ID=YD04897 08:49:49

=============== I M A G E S 3 D ===============

CHECK GEOMETRY Version 2.0 07/01/90

Analysis of the lifting bail for the Pump Penetration Port P

Prop No	X-Section Area	Moment of Inertia Iy	/ Iz	Torsional Const.- J
1	4.000E+00	1.330E+00	1.330E+00	2.670E+00

Prop No	Max. Fiber Dist Cy	/ Cz	Shear Shape Fact SSFy	/ SSFz	Ctors	Shear Stress Factor SSTRFy	/ SSTRFz
1	1.00E+00	1.00E+00	1.33E+00	1.33E+00	1.42E+00	1.50E+00	1.50E+00

BEAM CONNECTIVITY

Beam No	Nodes From/	To /	Ref	Prop No	Mat No	pincodes I / J	Rigid End Offset I	/ J	Length	Beam Type
1	1	2	0	1	1		0.00E+00	0.00E+00	0.60E+01	Beam
2	2	3	0	1	1		0.00E+00	0.00E+00	0.10E+01	Beam
3	3	4	0	1	1		0.00E+00	0.00E+00	0.10E+01	Beam
4	4	5	0	1	1		0.00E+00	0.00E+00	0.10E+01	Beam
5	5	6	0	1	1		0.00E+00	0.00E+00	0.10E+01	Beam
6	6	7	0	1	1		0.00E+00	0.00E+00	0.10E+01	Beam
7	7	8	0	1	1		0.00E+00	0.00E+00	0.10E+01	Beam
8	8	9	0	1	1		0.00E+00	0.00E+00	0.10E+01	Beam
9	9	10	0	1	1		0.00E+00	0.00E+00	0.10E+01	Beam
10	10	11	0	1	1		0.00E+00	0.00E+00	0.10E+01	Beam
11	11	12	0	1	1		0.00E+00	0.00E+00	0.10E+01	Beam
12	12	13	0	1	1		0.00E+00	0.00E+00	0.10E+01	Beam
13	13	14	0	1	1		0.00E+00	0.00E+00	0.10E+01	Beam
14	14	15	0	1	1		0.00E+00	0.00E+00	0.10E+01	Beam
15	15	16	0	1	1		0.00E+00	0.00E+00	0.10E+01	Beam
16	16	17	0	1	1		0.00E+00	0.00E+00	0.10E+01	Beam
17	17	18	0	1	1		0.00E+00	0.00E+00	0.10E+01	Beam
18	18	19	0	1	1		0.00E+00	0.00E+00	0.10E+01	Beam
19	19	20	0	1	1		0.00E+00	0.00E+00	0.10E+01	Beam
20	20	21	0	1	1		0.00E+00	0.00E+00	0.60E+01	Beam

RESTRAINTS

Node No	Global/Local	Restraint Directions
1	GLOBAL	X Y Z RX RY RZ

```
KAISER ENGINEERS HANFORD   S/N:801854                      03/05/96
PAGE    3                       RUN ID=YD04897             08:49:50
          =============== I M A G E S  3 D ===============
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          ================================================

          CHECK GEOMETRY               Version 2.0  07/01/90

      Analysis of the lifting bail for the Pump Penetration Port P

              Node                        Restraint
               No      Global/Local       Directions
              ----     ------------    ---------------
               21         GLOBAL        X Y Z RX RY RZ
```

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KAISER ENGINEERS HANFORD   S/N:801854                      03/05/96
PAGE    4                       Run ID=YD04897             08:52:07
          =============== I M A G E S  3 D ===============
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          ================================================

          SOLVE DISPLACEMENTS          Version 2.0  07/01/90

      Analysis of the lifting bail for the Pump Penetration Port P

                          L O A D   C A S E   1
      LIFT LOAD

                             GRAVITY LOADING

                                  Gravity        Load
                    Direction     Factor        Factor
                    ---------   ----------    ----------
                        X       .0000E+00     .1000E+01
                        Y       .0000E+00     .1000E+01
                        Z       .0000E+00     .1000E+01

                             INERTIA LOADING

               Translational  Rotational    Rotational
    Direction      Accel.       Accel.       Velocity       Origin
    ---------   ----------    ----------    ----------    ----------
        X        .0000E+00     .0000E+00     .0000E+00     .0000E+00
        Y        .0000E+00     .0000E+00     .0000E+00     .0000E+00
        Z        .0000E+00     .0000E+00     .0000E+00     .0000E+00

               Gravity Acceleration =  .3864E+03

                           CONCENTRATED LOADS

 Node      Fx          Fy          Fz          Mx          My          Mz
 ----  ----------  ----------  ----------  ----------  ----------  ----------
  11   .0000E+00   .1000E+04   .0000E+00   .0000E+00   .0000E+00   .0000E+00

                   REFERENCE TEMPERATURE = .0000E+00
```

KAISER ENGINEERS HANFORD S/N:801854 03/05/96
PAGE 5 Run ID=YD04897 08:52:08

=============== I M A G E S 3 D ===============

===

SOLVE DISPLACEMENTS Version 2.0 07/01/90

Analysis of the lifting bail for the Pump Penetration Port P

L O A D C A S E 1

LIFT LOAD

APPLIED LOAD VECTOR

Node	Fx	Fy	Fz	Mx	My	Mz
11	.0000E+00	.1000E+04	.0000E+00	.0000E+00	.0000E+00	.0000E+00

KAISER ENGINEERS HANFORD S/N:801854 03/05/96
PAGE 6 Run ID=YD04897 08:52:08

=============== I M A G E S 3 D ===============

===

SOLVE DISPLACEMENTS Version 2.0 07/01/90

Analysis of the lifting bail for the Pump Penetration Port P

L O A D C A S E 1

LIFT LOAD

DISPLACEMENTS

Node	Translations X	Translations Y	Translations Z	/	Rotations X	Rotations Y	Rotations Z
1	.0000E+00	.0000E+00	.0000E+00	/	.0000E+00	.0000E+00	.0000E+00
2	.1501E-03	.2500E-04	.0000E+00	/	.0000E+00	.0000E+00	-.1279E-04
3	.1609E-03	.2836E-04	.0000E+00	/	.0000E+00	.0000E+00	.2609E-06
4	.1557E-03	.3434E-04	.0000E+00	/	.0000E+00	.0000E+00	.1556E-04
5	.1351E-03	.4880E-04	.0000E+00	/	.0000E+00	.0000E+00	.3079E-04
6	.1035E-03	.7619E-04	.0000E+00	/	.0000E+00	.0000E+00	.4364E-04
7	.6750E-04	.1178E-03	.0000E+00	/	.0000E+00	.0000E+00	.5187E-04
8	.3476E-04	.1709E-03	.0000E+00	/	.0000E+00	.0000E+00	.5338E-04
9	.1154E-04	.2281E-03	.0000E+00	/	.0000E+00	.0000E+00	.4628E-04
10	.7204E-06	.2782E-03	.0000E+00	/	.0000E+00	.0000E+00	.2892E-04
11	.8525E-09	.3077E-03	.0000E+00	/	.0000E+00	.0000E+00	.3614E-11
12	-.7187E-06	.2782E-03	.0000E+00	/	.0000E+00	.0000E+00	-.2892E-04
13	-.1153E-04	.2281E-03	.0000E+00	/	.0000E+00	.0000E+00	-.4628E-04
14	-.3476E-04	.1709E-03	.0000E+00	/	.0000E+00	.0000E+00	-.5338E-04
15	-.6750E-04	.1178E-03	.0000E+00	/	.0000E+00	.0000E+00	-.5187E-04
16	-.1035E-03	.7619E-04	.0000E+00	/	.0000E+00	.0000E+00	-.4364E-04
17	-.1351E-03	.4880E-04	.0000E+00	/	.0000E+00	.0000E+00	-.3079E-04
18	-.1557E-03	.3434E-04	.0000E+00	/	.0000E+00	.0000E+00	-.1556E-04
19	-.1609E-03	.2836E-04	.0000E+00	/	.0000E+00	.0000E+00	-.2611E-06
20	-.1501E-03	.2500E-04	.0000E+00	/	.0000E+00	.0000E+00	.1279E-04
21	.0000E+00	.0000E+00	.0000E+00	/	.0000E+00	.0000E+00	.0000E+00

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SOLVE BEAM LOADS/STRESSES Version 2.0 07/01/90

Analysis of the lifting bail for the Pump Penetration Port P

Load Case 1:LIFT LOAD

BEAM LOADS AND/OR STRESSES

GLoads LLoads Stress Stress	Node Node Node Node	Fx Axial Axial Maximum	Fy Y-Shear Y-Shear Minimum	Fz Z-Shear Z-Shear Cmb. Shear	Mx Torsion Torsion	My Y-Bending Y-Bending	Mz Z-Bending Z-Bending
			***BEAM	NO. 1***			
GLoads	1	-.1791E+03	-.5000E+03	.0000E+00	.0000E+00	.0000E+00	.6223E+03
GLoads	2	.1791E+03	.5000E+03	.0000E+00	.0000E+00	.0000E+00	.4521E+03
LLoads	1	-.5000E+03	.0000E+00	-.1791E+03	.0000E+00	.6223E+03	.0000E+00
LLoads	2	.5000E+03	.0000E+00	.1791E+03	.0000E+00	.4521E+03	.0000E+00
Stress	1	.1250E+03	.0000E+00	-.6715E+02	.0000E+00	-.4679E+03	.0000E+00
Stress	1	.5929E+03	-.3429E+03	.2964E+03			
Stress	2	.1250E+03	.0000E+00	-.6715E+02	.0000E+00	.3399E+03	.0000E+00
Stress	2	.4649E+03	-.2149E+03	.2325E+03			
			***BEAM	NO. 2***			
GLoads	2	-.1791E+03	-.5000E+03	.0000E+00	.0000E+00	.0000E+00	-.4521E+03
GLoads	3	.1791E+03	.5000E+03	.0000E+00	.0000E+00	.0000E+00	.5872E+03
LLoads	2	-.5137E+03	.1348E+03	.0000E+00	.0000E+00	.0000E+00	-.4521E+03
LLoads	3	.5137E+03	-.1348E+03	.0000E+00	.0000E+00	.0000E+00	.5872E+03
Stress	2	.1284E+03	.5055E+02	.0000E+00	.0000E+00	.0000E+00	.3399E+03
Stress	2	.4684E+03	-.2115E+03	.2342E+03			
Stress	3	.1284E+03	.5055E+02	.0000E+00	.0000E+00	.0000E+00	.4415E+03
Stress	3	.5700E+03	-.3131E+03	.2850E+03			
			***BEAM	NO. 3***			
GLoads	3	-.1791E+03	-.5000E+03	.0000E+00	.0000E+00	.0000E+00	-.5872E+03
GLoads	4	.1791E+03	.5000E+03	.0000E+00	.0000E+00	.0000E+00	.6309E+03
LLoads	3	-.5293E+03	.4356E+02	.0000E+00	.0000E+00	.0000E+00	-.5872E+03
LLoads	4	.5293E+03	-.4356E+02	.0000E+00	.0000E+00	.0000E+00	.6309E+03
Stress	3	.1323E+03	.1633E+02	.0000E+00	.0000E+00	.0000E+00	.4415E+03
Stress	3	.5739E+03	-.3092E+03	.2869E+03			
Stress	4	.1323E+03	.1633E+02	.0000E+00	.0000E+00	.0000E+00	.4744E+03
Stress	4	.6067E+03	-.3420E+03	.3033E+03			
			***BEAM	NO. 4***			
GLoads	4	-.1791E+03	-.5000E+03	.0000E+00	.0000E+00	.0000E+00	-.6309E+03
GLoads	5	.1791E+03	.5000E+03	.0000E+00	.0000E+00	.0000E+00	.5818E+03
LLoads	4	-.5288E+03	-.4902E+02	.0000E+00	.0000E+00	.0000E+00	-.6309E+03
LLoads	5	.5288E+03	.4902E+02	.0000E+00	.0000E+00	.0000E+00	.5818E+03
Stress	4	.1322E+03	-.1838E+02	.0000E+00	.0000E+00	.0000E+00	.4744E+03
Stress	4	.6066E+03	-.3422E+03	.3033E+03			
Stress	5	.1322E+03	-.1838E+02	.0000E+00	.0000E+00	.0000E+00	.4374E+03
Stress	5	.5696E+03	-.3052E+03	.2848E+03			

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SOLVE BEAM LOADS/STRESSES Version 2.0 07/01/90

Analysis of the lifting bail for the Pump Penetration Port P

Load Case 1:LIFT LOAD

GLoads LLoads Stress Stress	Node Node Node Node	Fx Axial Axial Maximum	Fy Y-Shear Y-Shear Minimum	Fz Z-Shear Z-Shear Cmb. Shear	Mx Torsion Torsion	My Y-Bending Y-Bending	Mz Z-Bending Z-Bending
			***BEAM	NO. 5***			
GLoads	5	-.1791E+03	-.5000E+03	.0000E+00	.0000E+00	.0000E+00	-.5818E+03
GLoads	6	.1791E+03	.5000E+03	.0000E+00	.0000E+00	.0000E+00	.4413E+03
LLoads	5	-.5123E+03	-.1401E+03	.0000E+00	.0000E+00	.0000E+00	-.5818E+03
LLoads	6	.5123E+03	.1401E+03	.0000E+00	.0000E+00	.0000E+00	.4413E+03
Stress	5	.1281E+03	-.5254E+02	.0000E+00	.0000E+00	.0000E+00	.4374E+03
Stress	5	.5655E+03	-.3094E+03	.2827E+03			
Stress	6	.1281E+03	-.5254E+02	.0000E+00	.0000E+00	.0000E+00	.3318E+03
Stress	6	.4599E+03	-.2038E+03	.2300E+03			
			***BEAM	NO. 6***			
GLoads	6	-.1791E+03	-.5000E+03	.0000E+00	.0000E+00	.0000E+00	-.4413E+03
GLoads	7	.1791E+03	.5000E+03	.0000E+00	.0000E+00	.0000E+00	.2139E+03
LLoads	6	-.4802E+03	-.2269E+03	.0000E+00	.0000E+00	.0000E+00	-.4413E+03
LLoads	7	.4802E+03	.2269E+03	.0000E+00	.0000E+00	.0000E+00	.2139E+03
Stress	6	.1200E+03	-.8510E+02	.0000E+00	.0000E+00	.0000E+00	.3318E+03
Stress	6	.4519E+03	-.2118E+03	.2259E+03			
Stress	7	.1200E+03	-.8510E+02	.0000E+00	.0000E+00	.0000E+00	.1608E+03
Stress	7	.2809E+03	-.4078E+02	.1404E+03			
			***BEAM	NO. 7***			
GLoads	7	-.1791E+03	-.5000E+03	.0000E+00	.0000E+00	.0000E+00	-.2139E+03
GLoads	8	.1791E+03	.5000E+03	.0000E+00	.0000E+00	.0000E+00	-.9367E+02
LLoads	7	-.4335E+03	-.3069E+03	.0000E+00	.0000E+00	.0000E+00	-.2139E+03
LLoads	8	.4335E+03	.3069E+03	.0000E+00	.0000E+00	.0000E+00	-.9367E+02
Stress	7	.1084E+03	-.1151E+03	.0000E+00	.0000E+00	.0000E+00	.1608E+03
Stress	7	.2692E+03	-.5246E+02	.1346E+03			
Stress	8	.1084E+03	-.1151E+03	.0000E+00	.0000E+00	.0000E+00	-.7043E+02
Stress	8	.1788E+03	.3794E+02	.8940E+02			
			***BEAM	NO. 8***			
GLoads	8	-.1791E+03	-.5000E+03	.0000E+00	.0000E+00	.0000E+00	.9367E+02
GLoads	9	.1791E+03	.5000E+03	.0000E+00	.0000E+00	.0000E+00	-.4720E+03
LLoads	8	-.3736E+03	-.3775E+03	.0000E+00	.0000E+00	.0000E+00	.9367E+02
LLoads	9	.3736E+03	.3775E+03	.0000E+00	.0000E+00	.0000E+00	-.4720E+03
Stress	8	.9340E+02	-.1416E+03	.0000E+00	.0000E+00	.0000E+00	-.7043E+02
Stress	8	.1638E+03	.2297E+02	.8192E+02			
Stress	9	.9340E+02	-.1416E+03	.0000E+00	.0000E+00	.0000E+00	-.3549E+03
Stress	9	.4483E+03	-.2615E+03	.2241E+03			
			***BEAM	NO. 9***			
GLoads	9	-.1791E+03	-.5000E+03	.0000E+00	.0000E+00	.0000E+00	.4720E+03

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SOLVE BEAM LOADS/STRESSES Version 2.0 07/01/90

Analysis of the lifting bail for the Pump Penetration Port P

Load Case 1:LIFT LOAD

GLoads LLoads Stress Stress	Node Node Node Node	Fx Axial Axial Maximum	Fy Y-Shear Y-Shear Minimum	Fz Z-Shear Z-Shear Cmb. Shear	Mx Torsion Torsion	My Y-Bending Y-Bending	Mz Z-Bending Z-Bending
GLoads	10	.1791E+03	.5000E+03	.0000E+00	.0000E+00	.0000E+00	-.9096E+03
LLoads	9	-.3024E+03	-.4366E+03	.0000E+00	.0000E+00	.0000E+00	.4720E+03
LLoads	10	.3024E+03	.4366E+03	.0000E+00	.0000E+00	.0000E+00	-.9096E+03
Stress	9	.7559E+02	-.1637E+03	.0000E+00	.0000E+00	.0000E+00	-.3549E+03
Stress	9	.4305E+03	-.2793E+03	.2152E+03			
Stress	10	.7559E+02	-.1637E+03	.0000E+00	.0000E+00	.0000E+00	-.6839E+03
Stress	10	.7595E+03	-.6083E+03	.3798E+03			
			***BEAM	NO. 10***			
GLoads	10	-.1791E+03	-.5000E+03	.0000E+00	.0000E+00	.0000E+00	.9096E+03
GLoads	11	.1791E+03	.5000E+03	.0000E+00	.0000E+00	.0000E+00	-.1393E+04
LLoads	10	-.2220E+03	-.4825E+03	.0000E+00	.0000E+00	.0000E+00	.9096E+03
LLoads	11	.2220E+03	.4825E+03	.0000E+00	.0000E+00	.0000E+00	-.1393E+04
Stress	10	.5549E+02	-.1809E+03	.0000E+00	.0000E+00	.0000E+00	-.6839E+03
Stress	10	.7394E+03	-.6284E+03	.3697E+03			
Stress	11	.5549E+02	-.1809E+03	.0000E+00	.0000E+00	.0000E+00	-.1048E+04
Stress	11	.1103E+04	-.9920E+03	.5515E+03			
			***BEAM	NO. 11***			
GLoads	11	-.1791E+03	.5000E+03	.0000E+00	.0000E+00	.0000E+00	.1393E+04
GLoads	12	.1791E+03	-.5000E+03	.0000E+00	.0000E+00	.0000E+00	-.9096E+03
LLoads	11	-.2220E+03	.4825E+03	.0000E+00	.0000E+00	.0000E+00	.1393E+04
LLoads	12	.2220E+03	-.4825E+03	.0000E+00	.0000E+00	.0000E+00	-.9096E+03
Stress	11	.5549E+02	.1809E+03	.0000E+00	.0000E+00	.0000E+00	-.1048E+04
Stress	11	.1103E+04	-.9920E+03	.5515E+03			
Stress	12	.5549E+02	.1809E+03	.0000E+00	.0000E+00	.0000E+00	-.6839E+03
Stress	12	.7394E+03	-.6284E+03	.3697E+03			
			***BEAM	NO. 12***			
GLoads	12	-.1791E+03	.5000E+03	.0000E+00	.0000E+00	.0000E+00	.9096E+03
GLoads	13	.1791E+03	-.5000E+03	.0000E+00	.0000E+00	.0000E+00	-.4720E+03
LLoads	12	-.3024E+03	.4366E+03	.0000E+00	.0000E+00	.0000E+00	.9096E+03
LLoads	13	.3024E+03	-.4366E+03	.0000E+00	.0000E+00	.0000E+00	-.4720E+03
Stress	12	.7559E+02	.1637E+03	.0000E+00	.0000E+00	.0000E+00	-.6839E+03
Stress	12	.7595E+03	-.6083E+03	.3798E+03			
Stress	13	.7559E+02	.1637E+03	.0000E+00	.0000E+00	.0000E+00	-.3549E+03
Stress	13	.4305E+03	-.2793E+03	.2152E+03			
			***BEAM	NO. 13***			
GLoads	13	-.1791E+03	.5000E+03	.0000E+00	.0000E+00	.0000E+00	.4720E+03
GLoads	14	.1791E+03	-.5000E+03	.0000E+00	.0000E+00	.0000E+00	-.9367E+02
LLoads	13	-.3736E+03	.3775E+03	.0000E+00	.0000E+00	.0000E+00	.4720E+03

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SOLVE BEAM LOADS/STRESSES Version 2.0 07/01/90

Analysis of the lifting bail for the Pump Penetration Port P

Load Case 1:LIFT LOAD

GLoads LLoads Stress Stress	Node Node Node Node	Fx Axial Axial Maximum	Fy Y-Shear Y-Shear Minimum	Fz Z-Shear Z-Shear Cmb. Shear	Mx Torsion Torsion	My Y-Bending Y-Bending	Mz Z-Bending Z-Bending
LLoads	14	.3736E+03	-.3775E+03	.0000E+00	.0000E+00	.0000E+00	-.9367E+02
Stress	13	.9340E+02	.1416E+03	.0000E+00	.0000E+00	.0000E+00	-.3549E+03
Stress	13	.4483E+03	-.2615E+03	.2241E+03			
Stress	14	.9340E+02	.1416E+03	.0000E+00	.0000E+00	.0000E+00	-.7043E+02
Stress	14	.1638E+03	.2297E+02	.8192E+02			
			***BEAM	NO. 14***			
GLoads	14	-.1791E+03	.5000E+03	.0000E+00	.0000E+00	.0000E+00	.9367E+02
GLoads	15	.1791E+03	-.5000E+03	.0000E+00	.0000E+00	.0000E+00	.2139E+03
LLoads	14	-.4335E+03	.3069E+03	.0000E+00	.0000E+00	.0000E+00	.9367E+02
LLoads	15	.4335E+03	-.3069E+03	.0000E+00	.0000E+00	.0000E+00	.2139E+03
Stress	14	.1084E+03	.1151E+03	.0000E+00	.0000E+00	.0000E+00	-.7043E+02
Stress	14	.1788E+03	.3794E+02	.8940E+02			
Stress	15	.1084E+03	.1151E+03	.0000E+00	.0000E+00	.0000E+00	.1608E+03
Stress	15	.2692E+03	-.5246E+02	.1346E+03			
			***BEAM	NO. 15***			
GLoads	15	-.1791E+03	.5000E+03	.0000E+00	.0000E+00	.0000E+00	-.2139E+03
GLoads	16	.1791E+03	-.5000E+03	.0000E+00	.0000E+00	.0000E+00	.4413E+03
LLoads	15	-.4802E+03	.2269E+03	.0000E+00	.0000E+00	.0000E+00	-.2139E+03
LLoads	16	.4802E+03	-.2269E+03	.0000E+00	.0000E+00	.0000E+00	.4413E+03
Stress	15	.1200E+03	.8510E+02	.0000E+00	.0000E+00	.0000E+00	.1608E+03
Stress	15	.2809E+03	-.4078E+02	.1404E+03			
Stress	16	.1200E+03	.8510E+02	.0000E+00	.0000E+00	.0000E+00	.3318E+03
Stress	16	.4519E+03	-.2118E+03	.2259E+03			
			***BEAM	NO. 16***			
GLoads	16	-.1791E+03	.5000E+03	.0000E+00	.0000E+00	.0000E+00	-.4413E+03
GLoads	17	.1791E+03	-.5000E+03	.0000E+00	.0000E+00	.0000E+00	.5818E+03
LLoads	16	-.5123E+03	.1401E+03	.0000E+00	.0000E+00	.0000E+00	-.4413E+03
LLoads	17	.5123E+03	-.1401E+03	.0000E+00	.0000E+00	.0000E+00	.5818E+03
Stress	16	.1281E+03	.5254E+02	.0000E+00	.0000E+00	.0000E+00	.3318E+03
Stress	16	.4599E+03	-.2038E+03	.2300E+03			
Stress	17	.1281E+03	.5254E+02	.0000E+00	.0000E+00	.0000E+00	.4374E+03
Stress	17	.5655E+03	-.3094E+03	.2827E+03			
			***BEAM	NO. 17***			
GLoads	17	-.1791E+03	.5000E+03	.0000E+00	.0000E+00	.0000E+00	-.5818E+03
GLoads	18	.1791E+03	-.5000E+03	.0000E+00	.0000E+00	.0000E+00	.6309E+03
LLoads	17	-.5288E+03	.4902E+02	.0000E+00	.0000E+00	.0000E+00	-.5818E+03
LLoads	18	.5288E+03	-.4902E+02	.0000E+00	.0000E+00	.0000E+00	.6309E+03
Stress	17	.1322E+03	.1838E+02	.0000E+00	.0000E+00	.0000E+00	.4374E+03
Stress	17	.5696E+03	-.3052E+03	.2848E+03			

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SOLVE BEAM LOADS/STRESSES Version 2.0 07/01/90

Analysis of the lifting bail for the Pump Penetration Port P

Load Case 1:LIFT LOAD

GLoads	Node	Fx	Fy	Fz	Mx	My	Mz
LLoads	Node	Axial	Y-Shear	Z-Shear	Torsion	Y-Bending	Z-Bending
Stress	Node	Axial	Y-Shear	Z-Shear	Torsion	Y-Bending	Z-Bending
Stress	Node	Maximum	Minimum	Cmb. Shear			
Stress	18	.1322E+03	.1838E+02	.0000E+00	.0000E+00	.0000E+00	.4744E+03
Stress	18	.6066E+03	-.3422E+03	.3033E+03			
			BEAM NO. 18				
GLoads	18	-.1791E+03	.5000E+03	.0000E+00	.0000E+00	.0000E+00	-.6309E+03
GLoads	19	.1791E+03	-.5000E+03	.0000E+00	.0000E+00	.0000E+00	.5872E+03
LLoads	18	-.5293E+03	-.4356E+02	.0000E+00	.0000E+00	.0000E+00	-.6309E+03
LLoads	19	.5293E+03	.4356E+02	.0000E+00	.0000E+00	.0000E+00	.5872E+03
Stress	18	.1323E+03	-.1633E+02	.0000E+00	.0000E+00	.0000E+00	.4744E+03
Stress	18	.6067E+03	-.3420E+03	.3033E+03			
Stress	19	.1323E+03	-.1633E+02	.0000E+00	.0000E+00	.0000E+00	.4415E+03
Stress	19	.5739E+03	-.3092E+03	.2869E+03			
			BEAM NO. 19				
GLoads	19	-.1791E+03	.5000E+03	.0000E+00	.0000E+00	.0000E+00	-.5872E+03
GLoads	20	.1791E+03	-.5000E+03	.0000E+00	.0000E+00	.0000E+00	.4521E+03
LLoads	19	-.5137E+03	-.1348E+03	.0000E+00	.0000E+00	.0000E+00	-.5872E+03
LLoads	20	.5137E+03	.1348E+03	.0000E+00	.0000E+00	.0000E+00	.4521E+03
Stress	19	.1284E+03	-.5055E+02	.0000E+00	.0000E+00	.0000E+00	.4415E+03
Stress	19	.5700E+03	-.3131E+03	.2850E+03			
Stress	20	.1284E+03	-.5055E+02	.0000E+00	.0000E+00	.0000E+00	.3399E+03
Stress	20	.4684E+03	-.2115E+03	.2342E+03			
			BEAM NO. 20				
GLoads	20	-.1791E+03	.5000E+03	.0000E+00	.0000E+00	.0000E+00	-.4521E+03
GLoads	21	.1791E+03	-.5000E+03	.0000E+00	.0000E+00	.0000E+00	-.6223E+03
LLoads	20	-.5000E+03	.0000E+00	.1791E+03	.0000E+00	-.4521E+03	.0000E+00
LLoads	21	.5000E+03	.0000E+00	-.1791E+03	.0000E+00	-.6223E+03	.0000E+00
Stress	20	.1250E+03	.0000E+00	.6715E+02	.0000E+00	.3399E+03	.0000E+00
Stress	20	.4649E+03	-.2149E+03	.2325E+03			
Stress	21	.1250E+03	.0000E+00	.6715E+02	.0000E+00	-.4679E+03	.0000E+00
Stress	21	.5929E+03	-.3429E+03	.2964E+03			

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Analysis of the lifting bail for the Pump Penetration Port P

Load Case 1:LIFT LOAD

MAXIMUM STRESS SUMMARY FOR BEAMS/TRUSSES
WITHIN SPECIFIED RANGE 1- 20

Maximum (absolute) Stress = .1103E+04 at BEAM 11

Beam	Axial	Y-Shear	Z-Shear	Torsion	Y-Bending	Z-Bending
11	.5549E+02	.1809E+03	.0000E+00	.0000E+00	.0000E+00	-.1048E+04
	Maximum	Minimum	Cmb. Shear			
	.1103E+04	-.9920E+03	.5515E+03			

KAISER ENGINEERS HANFORD S/N:801854 03/05/96
PAGE 13 Run ID=YD04897 08:52:10

=============== I M A G E S 3 D ===============

===

SOLVE REACTIONS Version 2.0 07/01/90

Analysis of the lifting bail for the Pump Penetration Port P

Load Case 1:LIFT LOAD

REACTIONS

Node	Fx	Fy	Fz	Mx	My	Mz
1	-.1791E+03	-.5000E+03	.0000E+00	.0000E+00	.0000E+00	.6223E+03
21	.1791E+03	-.5000E+03	.0000E+00	.0000E+00	.0000E+00	-.6223E+03

W320-24-026

Seismic Shutdown System
Pad/Wind Missile Evaluation

KAISER ENGINEERS HANFORD	CALCULATION IDENTIFICATION AND INDEX	Page i of iii Date 10/5/94

This sheet shows the status and description of the attached Design Analysis sheets.

Discipline Structural WO/Job No. ER4319/W-320 Calculation No. W320-24-026

Project No. & Name Project W-320, Tank 241-C-106 Sluicing

Calculation Item Seismic Shutdown System Pad/Wind Missile Evaluation

These calculations apply to:

Dwg. No. H-2-818456 Rev. No. 0

Dwg. No. Rev. No.

Other (Study, CDR) Rev. No.

The status of these calculations is:

[] Preliminary Calculations

[X] Final Calculations

[] Check Calculations (On Calculation Dated)

[] Void Calculation (Reason Voided)

Incorporated in Final Drawings? [X] Yes [] No

This calculation verified by independent "check" calculations? [] Yes [] No

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	James R. Booth/10-5-94 James R Booth 10-5-94		
Checked by	[illegible] 11/1/94 T. B. Rupert 10/27/94		
Approved by	[illegible] 11/3/94		
Checked Against Approved Vendor Data	[illegible] 4/7/98		

INDEX

Design Analysis Page No.	Description
1-2	Objective, Criteria, Data, Assumptions, Method, References, and Conclusion.
3-9	Structural Pad
10-12	Material thickness calculation for missile protection for SC3 enclosure
13	Weld Calculation
Attachment 1	(H-2-818456) Seismic Shutdown System Concrete Pad - Plan & Sections
Attachment 2	Missile Shield Enclosure
Attachment 3	Vendor Information

DESIGN VERIFICATION SCREENING CRITERIA

Project/Document No. W-320 / W320-24-015

When the design or design change affects hardware, formal design verification must be performed if one or more of the following questions must be answered affirmatively (YES).

YES	NO	
✓		1. Does the design or design change involved meet the established criteria to be considered Safety Class 1? SC1 strength requirement & SC 3/1 environmental enclosure considerations.
	✓	2. Does this design or design change cause or permit changes to Safety Class 1 instrument or alarm setpoints outside of previously approved operational limits?
	✓	3. Does this design or design change significantly affect the nuclear or environmental safety consequences of a malfunction or failure of the structure, system, or component?
	✓	4. Does this design or design change involve or change design that has previously undergone formal design verification?

[signature] Assigned Lead Engineer — 11/1/94 Date

[signature] Responsible Discipline Manager — 11/3/94 Date

Original Design Package Distribution:
- Project Manager
- Design Verification Officer
- Engineering Document Control

Design Change Distribution:
- Attach to Engineering Change Notice

CALCULATION CROSS INDEX (Typical)

Subject Calculation No. W320-24-015

Page iii of iii

Subject Calculation Revision No.	Superceded by Calculation No.	These interfacing calculation/documents provide input to the subject calculation, and if revised may require revision of the subject calculation.		Results and conclusions of the subject calculation are used in these interfacing calculations and/or documents.		Does the output interface calculation/ documents require revision?		Has the output interface calculation/ documents been revised?		Discipline manager's signature and date indicating evaluation complete.
		Calculation/Document No.	Revision No.	Calculation/Document No.	Revision No.	Yes	No	Yes	No	
∅	—	—	—	H-2-818456	0		✓	✓		11/3/94

KEH 1975.00 (12/88)

KAISER ENGINEERS HANFORD	Calc. No. W320-24-026
	Revision 0
DESIGN ANALYSIS	Page No. 1 of 13
Client WHC	WO/Job No. ER4319/W-320
Subject Seismic Shutdown System Pad/Wind Missile Evaluation	Date 7-25-94 By J.R. Booth JRB
	Checked By RCD
Location 200E	Revised By

OBJECTIVE: The objective of this calculation is to design a structural concrete pad with embedded plates to secure a SC3 Missile Shield Enclosure. A Safety Class 1 level seismic strength requirement will be imposed on the design of the pad for the support of Safety Class 1 components enclosed within the Safety Class 3 Missile Shield Enclosure. Also, as part of this calculation the material thickness requirements of the enclosure to resist wind missile impact has been determined.

CRITERIA:

1. Functional Design Criteria for Tank 241-C-106 Waste Retrieval, Project W-320; Document No. WHC-W320-FDC-001, Rev.2.
2. SDC 4.1, Rev. 11 & Rev. 12 for clarity of figures.
3. SDC 4.2, Rev. 0.
4. Topical Report: DESIGN OF STRUCTURES FOR MISSILE IMPACT. SEPT. 1974. Rev. 2.
5. UCRL 15910, June 1990.

DATA:

1. f'_c=4000 psi
2. f_y=60 ksi for rebar
3. A36 steel for plates.
4. Type H4L Nelson Weld Studs

ASSUMPTIONS: See body of calc.

METHOD: MATHCAD 4.0

REFERENCES:

1. American Concrete Institute (ACI). ACI 318-89 (Revised 1992).
2. American Concrete Institute (ACI). ACI SP-17(91).
3. American Concrete Institute (ACI). ACI 349-85.
4. American Society of Civil Engineers (ASCE). ASCE 7-88.
5. Final Report of Geotechnical Engineering Studies, W-320 Waste Retrieval and Sluicing System. Prepared by Shannon and Wilson, INC. April 1994.
6. Standard ARCH-Civil Design Criteria, SDC-4.1. Design Loads for Facilities. Rev. 12.

KAISER ENGINEERS HANFORD		Calc. No. W320-24-026
		Revision 0
DESIGN ANALYSIS		Page No. 2 of 13
Client WHC	WO/Job No. ER4319/W-320	
Subject Seismic Shutdown System Pad/Wind Missile Evaluation	Date 7-25-94	By J.R. Booth JRB
	Checked	By [signature]
Location 200E	Revised	By

7. Standard ARCH-Civil Design Criteria, SDC-4.2. Design and Installation of Expansion Anchors, Rev. 0.

8. Uniform Building Code (UBC-91).

9. Design and Evaluation Guidelines for Department of Energy Facilities Subjected to Natural Phenomena Hazards. UCRL 15910, June 1990.

10. Ryerson Stock List. 1991.

11. Embedment Properties of Headed Studs. TRW/Nelson.

CONCLUSION: The concrete slab will be 8" thick and be reinforced with #5 rebar spaced 12" O.C. each way. A 3 1/2" dia. piece of conduit will be embedded in the concrete and stubbed up into the contactor boxes as shown in attachment 1. The embedded plates will be 1/2" thick A36 steel anchored with two 1/2" x 4 1/8" Nelson Studs. From the missile impact analysis it was determined that 12 gage sheet steel would be sufficient to withstand a wind blown missile. By inspection it was determined that the size of the HVAC unit mounted over top of any openings would be sufficient to stop a wind missile.

ICF Kaiser Hanford Company	DOCUMENT TRANSMITTAL	Transmittal No. TR-W-320-531
Date August 15, 1995		Page 1 of 1

To	From
Engineering Document Control	R.W. Davidson RD

Project/Work Order Number W-320/ER4319

Project/Work Order Title Tank 241-C-106 Sluicing

Subject Civil/Structural Calculations for C-Farm - Package 4

No. of Copies	Company and Distribution	Mailing Address
	ICF KH	
0	FW Bradshaw (PM)	S2-47
0	DL Evans (PLE)	S2-47
0	RW Davidson (LE)	S2-47
2	Engineering Document Control	R1-29

Attached Are	Purpose	Comments	Please
[] Prints	[X] Information	[] Preliminary	[] Comment
[] Specifications	[] Action	[] Unchecked	[] Approve
[] Travelers	[] Signature	[] Checked	[] Destroy Previous Issue
[] Appr. Data	[] Update	[] Final	[] Return Previous Issue
[] Forms	[] Review	[X] Approved	[] Note Revision
[] Library Material	[]	[] Working Copies	[] Note Holds
[] Procedures	[]	[] Controlled Copies	[X] File
[X] Other: Calcs	[]	[] Other:	[]

Document Numbers, Titles, and/or Comments

Calculations:

1. W320-24-014, Rev 0, Process Bldg. & Equip. Skid Fdn
2. W320-24-015, Rev 0, 241-C-106 Dome Load Summary Report
3. W320-24-021, Rev 0, Equipment Fdn-Exhaust Air Cleanup Train
4. W320-24-023, Rev 0, Equipment Fdn- Chiller & Pumps
5. W320-24-024, Rev 0, Electrical Equip. Pad, 241-C-51
6. W320-24-025, Rev 0, Cover Block Lifting Bail Calculation
7. W320-24-026, Rev 0, Seismic Shutdown System Pad/Wind Missile Evaluation
8. W320-24-027, Rev 0, Structural Analysis for Safety Related Equip. Attachments
9. W320-24-028, Rev 0, Engineering Evaluation of Commercial Grade Items

[] **Check here if receipt acknowledgment is required.**

Receipt Acknowledgment:

Please sign below acknowledging receipt of documents listed above and return receipt to at .

Signature ____________________ Date ____________

KEH 0001.00 (05/94) KEF003

ICF Kaiser Hanford Company

INTEROFFICE MEMORANDUM

TO C. B. Organ E6-01
Design Verification Officer

DATE March 28, 1995

FROM G. L. Hopkins G3-17

COPIES TO J. R. Booth S3-07
R. W. Davidson S3-07
M. A. Haq G3-17
M. S. Ruben E6-46
Eng Doc Control G3-11

JOB NO. ER4319

SUBJECT STRUCTURAL ANALYSIS OF SYSTEM PAD/WIND MISSILE EVALUATION

REFERENCES
1. Design Calculation Number W320-24-026
2. H-2-818456, ESP Spec - Structural Seismic Shutdown System Long Pads

This memo and attached form KEH 1980.00 (06/91) are in response to your IOM of February 9, 1995, to perform a design verification for the subject project. This design verification is in accordance with "Design Review Method" as define by ICF Kaiser (ICF KH) procedure ES 7, Rev. 3, Section 6.2.

Responses to the questions of Section 6.2.1.4 of procedure ES 7 are as follows:

1) Were the design inputs correctly selected?

YES This conclusion is based on the review of the following document: FDC Rev 2 Tank 241-C-106 Sluicing, Definitive Design.

2) Were all necessary conditions considered in the design?

YES

3) Are required assumptions adequately described? Are sources identified reasonable for the design?

YES

4) Was appropriate design method used?

YES

5) Where necessary, are the assumptions reverified when the design is complete?

YES

KEH 0008.00 (12/94) KEF065

6) Were the design inputs correctly incorporated?

YES

7) Is the design output reasonable compared to the design input?

YES

8) Are necessary design input and verification requirements for interfacing organizations specified in design documents or in supporting procedures or instructions?

YES -

9) Was the applicable Hanford Plant Standards (HPS) followed? If not, is documented approval included from DOE-RL?

YES SDC 4.1, Rev. 12 was followed.

DESIGN VERIFICATION RECORD

Project/Document Number STRUCTURAL ANALYSIS OF SYSTEM PAD/WIND MISSILE EVALUATION ~ CALC # W320-24-026

Prepared By G.L. HOPKINS ; ____ ; ____
(Print) (Print) (Print)

Verifier Name G.L. HOPKINS Initial GLH Date 7-27-95
(Print)

Verifier Name ____ Initial ____ Date ____
(Print)

Verifier Name ____ Initial ____ Date ____
(Print)

Formal Design Verification is determined to be necessary per the Design Verification Screening Criteria and was performed by the following method(s).

1. Alternate Calculation Method YES NO (Circle One)
   Calculation Number ____ Revision ____
2. Testing Method YES NO (Circle One)
   Test Number ____ Revision ____
   Test Title ____
3. Identical Method YES NO (Circle One)
   Document Number ____ Revision ____
   Title ____ Date ____
4. Design Review Method YES NO (Circle One)
   Design Review Chairman ____
   Finding or Attached Memo Report Number SEE ATTACHED IOM OF 2-8-95 FROM G.L. HOPKINS TO C.B. ORGAN
   Date 7-27-95

Formal design verification is complete and acceptable:

Design Verification Officer CB Organ Date 7/27/95

ATTACH ALL DOCUMENTATION RELATED TO THE DESIGN VERIFICATION CONDUCTED.

KEH-1980.00 (06/91)

KAISER ENGINEERS HANFORD

DESIGN ANALYSIS

Calc. No. W320-24-026
Revision 0

Client: Westinghouse Hanford Company	WO/Job No. ER4319/W-320	
Subject Structural Concrete Pad	Date 6/24/94	By JR Booth JRB
	Checked 10/27/94	By J.D. Rupert
Location: 200E	Revised	By

DESIGN CONCRETE PAD

Determine Design Loads:

1. Snow (REF. ASCE 7-88, pg. 23-27)

$C_e := 0.9$

$C_t := 1.1$

$I := 1.2$

$p_g := 15 \cdot \frac{lb}{ft^2}$ Ref. SDC 4.1

$p_f := 0.7 \cdot C_e \cdot C_t \cdot I \cdot p_g$

$p_f = 12.474 \cdot \frac{lb}{ft^2}$ Use $p_f := 20 \cdot \frac{lb}{ft^2}$ (Minimum Snow Load per SDC 4.1)

2. Wind: (Ref. SDC 4.1 and ASCE 7-88, section 6)
Dimensions: 6'-6" X 4'-0" X 6' high (See Attachment 2)
Exposure Class=C (SDC 4.1, pg.9)
Wind Speed=90 mph (SDC 4.1, pg.9)
Importance Factor=1.0 (SDC 4.1, pg.9)

$I := 1.0$

$V := 90$

$K_z := 0.80$ (Table 6 of ASCE 7-88)

$q_z := 0.00256 \cdot K_z \cdot (I \cdot V)^2 \cdot \frac{lb}{ft^2}$

$q_z = 16.589 \cdot \frac{lb}{ft^2}$ (Velocity pressure, Eq.3 of ASCE 7-88)

$G_h := 1.32$ (Gust response factor, Table 8 of ASCE 7-88)

$C_f := 1.2$ (Force Coeff. for Solid Signs, Table 13)

$A_f := 6.5 \cdot ft \cdot 6 \cdot ft$ (Projected area normal to wind in sq. ft)

$W_w := q_z \cdot G_h \cdot C_f \cdot A_f$ (Design Wind Force from Table 4, ASCE 7-88)

$W_w = 1.025 \cdot 10^3 \cdot lbs$

Determine wind force on least dimension side (4'-0" x 6'-0")

$A_{f2} := 4 \cdot ft \cdot 6 \cdot ft$

$W_{w2} := q_z \cdot G_h \cdot C_f \cdot A_{f2}$

$W_{w2} = 630.64 \cdot lb$

Note: Wind loading controls horizontal loading.

3. Ashfall Roof Loading

$A := 24 \cdot \frac{lb}{ft^2}$ (Per SDC 4.1, pg. 12)

4. Live Floor Load

$L := 0 \cdot lb$ — Live assumed zero, panels to be front accessable and enclosures are not designed for occupancy or any other equipment.

5. Seismic: Ref. SDC 4.1, UCRL 15910, UBC-91 and NUREG-0800.

An Equivalent Static Analysis will be used to determine base shear. Base shear will be applied 100% in two horizontal directions and 2/3 vertically.

Critical Damping = 7% for welded steel per UCRL 15910 Table 4-6.

Peak Acceleration = 0.38 g, this value will be multiplied by 1.5 for the static equivalent analysis.

a. Determine weight of components and metal enclosure.

$w_{s12} := 4.375 \cdot \frac{lb}{ft^2}$ (Weight of 12 gage steel, Ryerson pg. 453)

$SF := 2 \cdot (4 \cdot ft \cdot 6 \cdot ft) + 2 \cdot (6.5 \cdot ft \cdot 6 \cdot ft) + (4 \cdot ft \cdot 6.5 \cdot ft)$ (Square footage of enclosure sides)

$W_{se} := w_{s12} \cdot SF$ (Weight of enclosure)

$W_{se} = 665 \cdot lb$

$We := 15 \cdot lb + 150 \cdot lb$ (Weight of electrical equipment, 15 lb for seismic switch and 150 lb for electrical panel enclosure, see Attach 3)

$Wt := W_{se} + We$ (Total weight of enclosure and equipment)

$Wt = 830 \cdot lb$

$Wt := 900 \cdot lb$ Round up for miscellaneous loads.

Design Base Shear

$a := 0.38$

$E_{ssh} := a \cdot Wt \cdot 1.5$ (1.5 is the multiplier for static equivalent analysis)

$E_{ssh} = 513 \cdot lb$ (Base shear applied in both horizontal directions 100%)

Verticle force from seismic

$E_{ssv} := \frac{2}{3} \cdot E_{ssh}$

$E_{ssv} = 342 \cdot lb$

6. Dead Loads: Slab dimensions 15'-6" X 5'-6" X 0'-8"

$Wc := 150 \cdot \frac{lb}{ft^3} \cdot \left(15.5 \cdot ft \cdot 5.5 \cdot ft \cdot \frac{8}{12} \cdot ft\right)$ (Weight of concrete slab)

$Wc = 8.525 \cdot 10^3 \cdot lb$ $\quad Wt = 900 \cdot lb$

$D := Wc + 2 \cdot Wt$

$D = 1.033 \cdot 10^4 \cdot lb$

KAISER ENGINEERS HANFORD

DESIGN ANALYSIS

Calc. No. W320-24-026
Revision 0

Client: Westinghouse Hanford Company	WO/Job No. ER4319/W-320	
Subject Structural Concrete Pad	Date 6/24/94	By JR Booth JRB
	Checked	By RWD
Location: 200E	Revised	By

7. Load Combinations
   a. Determine worst case load case. (Ref. ACI 349, sec 9.2).

$D_l := 0 \cdot lb$ (Meaningless adder to make MathCAD work)

$L_f := (p_f + A) \cdot 15.5 \cdot ft \cdot 5.5 \cdot ft$ Snow Load and Ashfall

$L_f = 3.751 \cdot 10^3 \cdot lbs$ Conservatively including snow load as a live load.

$L_l := 0 \cdot lb$ (Meaningless adder to make MathCAD work)

$F := 0 \cdot lb$ Fluid Load

$H := 0 \cdot lb$ Soil Loads

$R_o := 0 \cdot lb$ $Y_r := 0 \cdot lb$ High-energy pipe break

$R_a := 0 \cdot lb$ $Y_j := 0 \cdot lb$

$P_a := 0 \cdot lb$ $Y_m := 0 \cdot lb$

$T_a := 0 \cdot lb$ $T_o := 0 \cdot lb$

$E_o := 0 \cdot lb$ OBE

$W_t := 0 \cdot lb$ Extreme wind condition

1. $W_v := 1.4 \cdot D + 1.4 \cdot F + 1.7 \cdot L_f + 1.7 \cdot H + 1.7 \cdot R_o$
   $W_v = 2.083 \cdot 10^4 \cdot lb$ Controls

2. $U := 1.4 \cdot D + 1.4 \cdot F + 1.7 \cdot L_f + 1.7 \cdot H + 1.7 \cdot E_o + 1.7 \cdot R_o$
   $U = 2.083 \cdot 10^4 \cdot lb$

3. $U := 1.4 \cdot D_l + 1.7 \cdot L_l + 1.7 \cdot H + 1.7 \cdot (2 \cdot W_w) + 1.7 \cdot R_o$
   $U = 3.484 \cdot 10^3 \cdot lb$

4. $U := D_l + F + L_l + H + T_o + R_o + E_{ssh}$
   $U = 513 \cdot lb$
   $U := D + F + L_f + H + T_o + R_o + E_{ssv}$
   $U = 1.442 \cdot 10^4 \cdot lb$

5. $U := D_l + F + L_l + H + T_o + R_o + W_t$
   $U = 0 \cdot lb$

6. $U := D + F + L_f + H + T_a + R_a + 1.25 \cdot P_a$
   $U = 1.408 \cdot 10^4 \cdot lb$

7. $U := D + F + L_f + H + T_a + R_a + 1.15 \cdot P_a + 1 \cdot (Y_r + Y_j + Y_m) + 1.15 \cdot E_o$
   $U = 1.408 \cdot 10^4 \cdot lb$

8. $U := D + F + L_f + H + T_a + R_a + 1.0 \cdot P_a + 1.0 \cdot (Y_r + Y_j + Y_m) + 1.0 \cdot E_{ssv}$

$U = 1.442 \cdot 10^4 \cdot lb$

$U := D_1 + F + L_1 + H + T_a + R_a + 1.0 \cdot P_a + 1.0 \cdot (Y_r + Y_j + Y_m) + 1.0 \cdot E_{ssh}$

$U = 513 \cdot lb$

9. $U := 1.05 \cdot D + 1.05 \cdot F + 1.3 \cdot L_f + 1.3 \cdot H + 1.05 \cdot T_o + 1.3 \cdot R_o$

$U = 1.572 \cdot 10^4 \cdot lb$

10. $U := 1.05 \cdot D + 1.05 \cdot F + 1.3 \cdot L_f + 1.3 \cdot H + 1.3 \cdot E_o + 1.05 \cdot T_o + 1.3 \cdot R_o$

$U = 1.572 \cdot 10^4 \cdot lb$

11. $U := 1.05 \cdot D_1 + 1.05 \cdot F + 1.3 \cdot L_1 + 1.3 \cdot H + 1.3 \cdot (2 \cdot W_w) + 1.05 \cdot T_o + 1.3 \cdot R_o$

$U = 2.664 \cdot 10^3 \cdot lb$

b. UCRL 15910, pg. 5-10 recommended load combinations.

$W_h := D_1 + 1.3 \cdot (2 \cdot W_w)$

$W_h = 2.664 \cdot 10^3 \cdot lb$ Controls

$W_{h2} := D_1 + 1.3 \cdot W_{w2}$

$W_{h2} = 819.832 \cdot lb$

$U := 1.1 \cdot D_1 + 0.5 \cdot L_1 + 1.2 \cdot (2 \cdot W_w)$

$U = 2.459 \cdot 10^3 \cdot lb$

c. Controlling loading conditions:

$W_v = 2.083 \cdot 10^4 \cdot lb$ Controls vertical loading

$W_h = 2.664 \cdot 10^3 \cdot lb$ Controls horizontal loading in two directions.

8. Check Soil Bearing Properties

a. Check Qmax against Qapplied.

$Q_{max} := 4000 \cdot \frac{lb}{ft^2}$ (Shannon an Wilson Report pg. 10, para. 2)

$Q_{applied} := \frac{W_v}{15.5 \cdot ft \cdot 5.5 \cdot ft}$ $Q_{applied} = 244.36 \cdot \frac{lb}{ft^2}$

Foundation Bearing pressure OK.

b. Check longitudinal sliding.

$F_f := 0.35 \cdot D$ (Lateral Sliding coefficient given in UBC, pg. 590)

$F_f = 3.614 \cdot 10^3 \cdot lb$ Resistance to sliding by friction is sufficient in both directions.

9. Concrete Slab Design. Using the design proceedures of ACI SP-17(91).

$kip := 1000 \cdot lb$ $f_c := 4000$ psi $f_y := 60000$ psi

$w_u := \left(\frac{Q_{applied} \cdot 1 \cdot ft^2}{1000 \cdot lb} \right) \cdot 1.6$ (Bearing pressure as determined above and service factor)

$w_u = 0.391 \ \frac{kip}{ft}$

$l := 2.25$ Length of slab in ft. Assumes cantilever length from edge of enclosure to end of slab is half the slab width (conservative).

$M_u := \frac{w_u \cdot l^2}{2}$

$M_u = 0.99 \ ft \cdot kip$

$h := 8$ (Slab thicknes in inches)

$d := h - 3 - 0.625$ $d = 4.375$ (Effective depth of slab with 3" min. cover for rebar)

$b := 12$

$\rho_{max} := 0.0214$ SP17, Flexure 2.2

$F := \frac{d^2}{1000}$ $F = 0.019$

$K_n := \frac{M_u}{F}$

$K_n = 51.705$

$K_n := 175$

$a_n := 4.37$ SP17, Flexure 2.2 For grade 60 steel

$A_s := \frac{M_u}{d \cdot a_n}$ Area of steel required per 12" strip of concrete, sq. in

$A_s = 0.052 \ \frac{in^2}{ft}$

$\rho_{min} := 0.0018$ For slabs per ACI 318, sec 7.12.2.1.

$A_{smin} := \rho_{min} \cdot b \cdot h$ Controls

$A_{smin} = 0.173 \ in^2$

9. Continued:

Check shear

$V_u := \frac{w_u \cdot l}{2}$

$V_u = 0.44$ kips

$b_w := 12$ in $\quad \phi := 0.85 \quad d := 9$ in

$V_c := \phi \cdot \left(2 \cdot \sqrt{f_c}\right) \cdot b_w \cdot d$

$V_c = 1.161 \cdot 10^4$ lb Ok

Use #5 bars spaced 12" O.C. As=0.31 sq. in. See H-2-818456 for sketch of reinforcing.

10. Check overturning moment

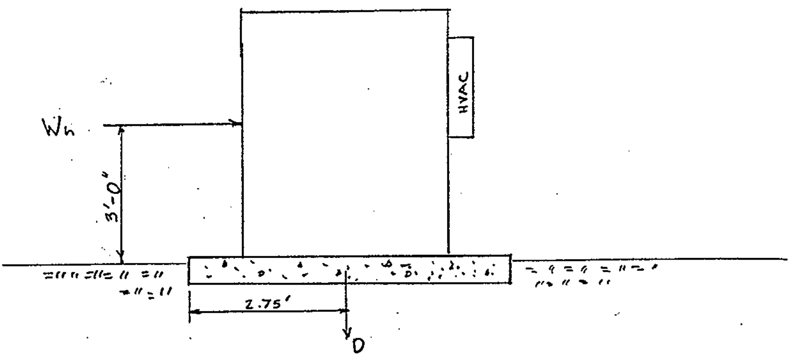


Figure 1

$M_{ot} := W_h \cdot 3 \cdot ft$ Overturning moment applied at the estimated mid-height of the enclosure.

$M_{ot} = 7.993 \cdot 10^3 \cdot lbs \cdot ft$

$M_r := D \cdot 2.75 \cdot ft$ Resisting moment to overturning

$M_r = 2.839 \cdot 10^4 \cdot lbs \cdot ft$

$\frac{M_{ot}}{M_r} = 0.282$ OK, since less than 2/3.

11. Design embedded plates

Assume each embedded plate will see half the horizontal force and half the tension force created by the overturning moment. Design guide: Nelson Construction - Design Data. Try (2) 1/2 X 4 1/8 studs mounted to a 12" X 6" X 0'-0 1/2" embedded steel plate.

$S_1 := \frac{W_h}{2} \cdot 2$ Shear force in large surface direction times S.F. of 2.

$S_1 = 2.664 \cdot 10^3 \cdot lb$

$S_2 := \frac{W_{h2}}{2} \cdot 2$ Shear force in small surface direction times S.F. of 2.

$S_2 = 819.832 \cdot lb$

$S_b := \sqrt{S_1^{\,2} + S_2^{\,2}}$

$S_b = 2.788 \cdot 10^3 \cdot lb$

$T_b := \left(\frac{M_{ot}}{4.33 \cdot ft}\right) \cdot \frac{1}{2} \cdot 2$ Tension force acting on plate times S.F. of 2

$T_b = 1.846 \cdot 10^3 \cdot lb$

$S_u := \frac{S_b}{2}$

$S_u = 1.394 \cdot kip$ Shear force per stud

$T_u := \frac{T_b}{2}$

$T_u = 0.923 \cdot kip$ Tension force per stud

$D_e := 3 \cdot in$ Minimum required distance from free edge to center of stud w/o reduction.

$P_{uc} := 10.6 \cdot kip$ Table No. 10, no reduction

$S_{uc} := 10.33 \cdot kip$ Table No. 18, no reduction

$\left(\frac{T_u}{P_{uc}}\right)^{\frac{5}{3}} + \left(\frac{S_u}{S_{uc}}\right)^{\frac{5}{3}} = 0.053$ $0.049 \le 1.0$ OK

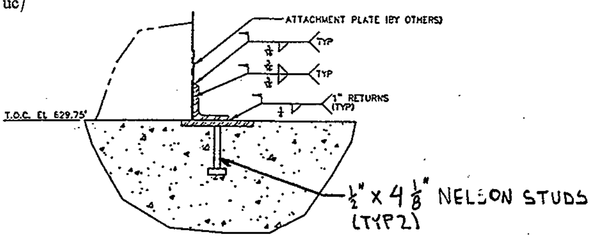


Figure 2

KAISER ENGINEERS HANFORD

DESIGN ANALYSIS

Calc. No. W320-24-026
Revision 0
Page No. 10 of 13

Client: Westinghouse Hanford Company	WO/Job No. ER4319/W-320
Subject Wind Missile Evaluation	Date 6/24/94 By JR Booth JRB
	Checked 10/27/94 By J.P. Rupert
Location: 200E	Revised By

MATERIAL THICKNESS FOR PROTECTION FROM MISSILE IMPACT

1. Assumptions:
   a. The worst case horizontal missile is given in SDC 4.1 as a 2 X 4 timber plank traveling at 50 mi/h weighing 15 lbs. Vertical missile velocity is 2/3 of horizontal.
   b. The missile has normal (direct) impact with wall resulting in the most conservative estimate.
   c. Only direct missile force with no other loads taken simultaneously are considered for structural response.
   d. Elasto-Plastic target response with no concurrent loading.
   e. One dimensional approximation.
   f. Plastic Impact (Coefficient of Restitution e=0)
   g. See Attachment 2 for target.

2. Calculate the Perforation Thicknes:

T=Steel plate thickness
M=Mass of Missile

$W := 15 \cdot lb$ (Weight of Missile)

$g := 32.2 \cdot \frac{ft}{sec^2}$ (Acceleration due gravity)

$M_m := \frac{W}{g}$

$M_m = 0.466 \cdot lbs \cdot ft^{-1} \cdot sec^2$

$V_s := 73.5 \cdot \frac{ft}{sec} \cdot 12 \cdot \frac{in}{ft}$ (Striking velocity of missile)

$A := 5.25 \cdot in^2$

$D := \sqrt{\frac{A}{\left(\frac{\pi}{4}\right)}}$

$D = 2.585 \cdot in$ (Equivalent diameter of missile)

$$T := \frac{\left(\frac{\frac{M_m}{1 \cdot lb \cdot 1 \cdot ft} \cdot V_s^{\,2}}{2}\right)^{\frac{2}{3}}}{672 \cdot D} \cdot 1 \cdot in^2$$ (BRL Formula for Steel Plates, Bechtel Report eq. 2-7)

$T = 0.067 \cdot in$

$t_s := 1.25 \cdot T$

$t_s = 0.084 \cdot in$ (Increase thickness by 25% to prevent perforation, Bechtel Report eq. 2-8)

3. Determine Structural Response by Energy Balance Method.
   a. Determine Effective Mass of Target During Impact.

$D_x := 0.125 \cdot ft$ (Lateral missile contact dimension)

$D_y := 0.292 \cdot ft$ (Vertical to ground)

$\gamma_s := 492 \cdot \frac{lb}{ft^3}$ (Weight per unit volume of steel)

$t := 0.0087 \cdot ft$ (Cold rolled 12 gage steel thickness = 0.1046")

3. Continued:

$M_e := D_x \cdot D_y \cdot \left(\gamma_s \cdot \frac{t}{g}\right)$ (Average effective mass of target during impact, eq. 3-18)

$M_e = 0.005 \cdot lbs \cdot ft^{-1} \cdot sec^2$

b. Determine required target strain energy.

$E_s := \frac{M_m^{\ 2} \cdot V_s^{\ 2}}{2 \cdot (M_m + M_e)} \cdot 12 \cdot \frac{in}{ft}$ (EQ.3-8) Multiplied by 12 in/ft to get units to work out.

$E_s = 1.494 \cdot 10^4 \cdot lbs \cdot in$

c. Determine the required ductility ratio.

$b := 1 \cdot in$ Use 1 inch wide strip to determine Mu, per Table 4-3.

$d := 0.1046 \cdot in$

$S := \frac{\left(\frac{1}{12}\right) \cdot b \cdot d^3}{\left(\frac{d}{2}\right)}$ (Section Modulus)

$S = 0.002 \cdot in^3$

$f_y := 50000 \cdot \frac{lb}{in^2}$ (Yield Strength, A607(50))

$M_u := S \cdot f_y \cdot 1.2$ (Dynamic increase factor of 1.2 per table 4-1)

$M_u = 109.412 \cdot lbs \cdot in$ (Ultimate moment)

$R_m := 2 \cdot \pi \cdot M_u$ (Resistance, Table 4-3 of Bechtel Report)

$R_m = 687.453 \cdot lbs \cdot in$

$\alpha := 0.1518$ (Height to Width ratio, where a=6 ft and b=6.5 ft per attachment 2)

$E := 30 \cdot 10^6 \cdot \frac{lb}{in^2}$ (Modulus of elasticity)

$I := \frac{b \cdot d^3}{12}$

$I = 9.537 \cdot 10^{-5} \cdot in^4$ (Moment of inertia)

$\nu := 0.3$ (Poisson's ratio)

$x_e := \left(\frac{\alpha \cdot R_m^{\ 2}}{12 \cdot E \cdot I \cdot 1 \cdot lb}\right) \cdot \left(1 - \nu^2\right) \cdot in$

$x_e = 1.901 \cdot in$ (Displacement, Table 4-3)

KAISER ENGINEERS HANFORD

DESIGN ANALYSIS

Client: Westinghouse Hanford Company	WO/Job No. ER4319/W-320
Subject Wind Missile Evaluation	Date 6/24/94 By JR Booth JRB
	Checked 10/27/94 By J. A. Rupert
Location: 200E	Revised By

$\mu_r := \left(\frac{E_s}{x_e \cdot R_m} + 0.5 \cdot \frac{1}{in}\right) \cdot in$ (Ductility ratio for steel needs to be less than 20 for the plate to survive a missile impact, see Table 4-4)

$\mu_r = 11.932$ OK

Note: 12 gage, grade 50 steel will survive a wind missile impact. The equipment inside the enclosure are at a minimum of 6 inches away from the enclosure wall and will not be affected by the wall deflection.

KAISER ENGINEERS
HANFORD

DESIGN ANALYSIS

Calc. No. W320-24-026
Revision 0
Page No. 13 of 13

Client: Westinghouse Hanford Company	WO/Job No. ER4319/W-320	
Subject: Weld Calculation	Date 6/24/94	By JR Booth JRB
	Checked	By
Location: 200E	Revised	By

DESIGN EQUIPMENT ANCHORING WELD

Attach enclosure to embedded plates with 4 - 9" long L 3 x 3 x 3/8 angles at base of enclosure. See Attachments 1 & 2.

$a := 0.133 \cdot in$ Try 3/16" SMAW weld

$R_{total} := \sqrt{S_b^2 + T_b^2}$ SSRS of load acting on weld

$R_{total} = 3.344 \cdot kip$

$F_{EXX} := 70 \cdot \frac{kip}{in^2}$ E70XX weld electrodes

$\phi R_{nw} := 0.75 \cdot 0.6 \cdot F_{EXX} \cdot a$ Weld strength /in

$\phi R_{nw} = 4.189 \cdot \frac{kip}{in}$

$F_u := 58 \cdot \frac{kip}{in^2}$ Tensile strength of material

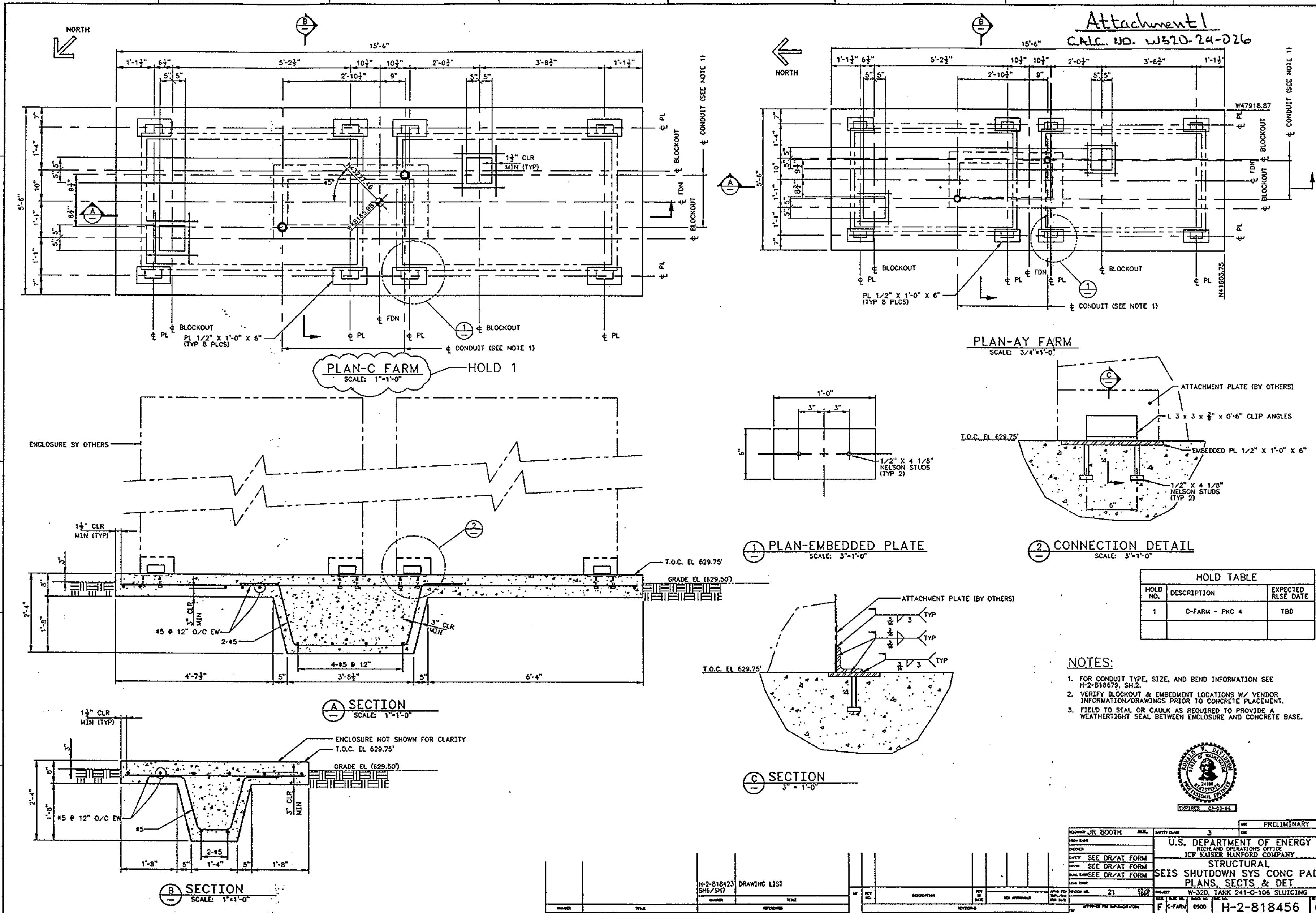
$t := \frac{3}{8} \cdot in$

$\phi R_{ns} := 0.75 \cdot 0.6 \cdot F_u \cdot t$ Shear rupture strength of angle

$\phi R_{ns} = 9.787 \cdot \frac{kip}{in}$

Welds will be as shown on attachment 1.

Attachment 1
CALC. NO. W320-24-026



HOLD TABLE

HOLD NO.	DESCRIPTION	EXPECTED RLSE DATE
1	C-FARM - PKG 4	TBD

NOTES:

1. FOR CONDUIT TYPE, SIZE, AND BEND INFORMATION SEE H-2-818679, SH.2.
2. VERIFY BLOCKOUT & EMBEDMENT LOCATIONS W/ VENDOR INFORMATION/DRAWINGS PRIOR TO CONCRETE PLACEMENT.
3. FIELD TO SEAL OR CAULK AS REQUIRED TO PROVIDE A WEATHERTIGHT SEAL BETWEEN ENCLOSURE AND CONCRETE BASE.

H-2-818423 SH6/SH7 DRAWING LIST

B818456A 2B:IBM:ACD2:12.0:NN

PRELIMINARY

JR BOOTH

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
ICF KAISER HANFORD COMPANY

STRUCTURAL
SEIS SHUTDOWN SYS CONC PADS
PLANS, SECTS & DET
W-320, TANK 241-C-106 SLUICING

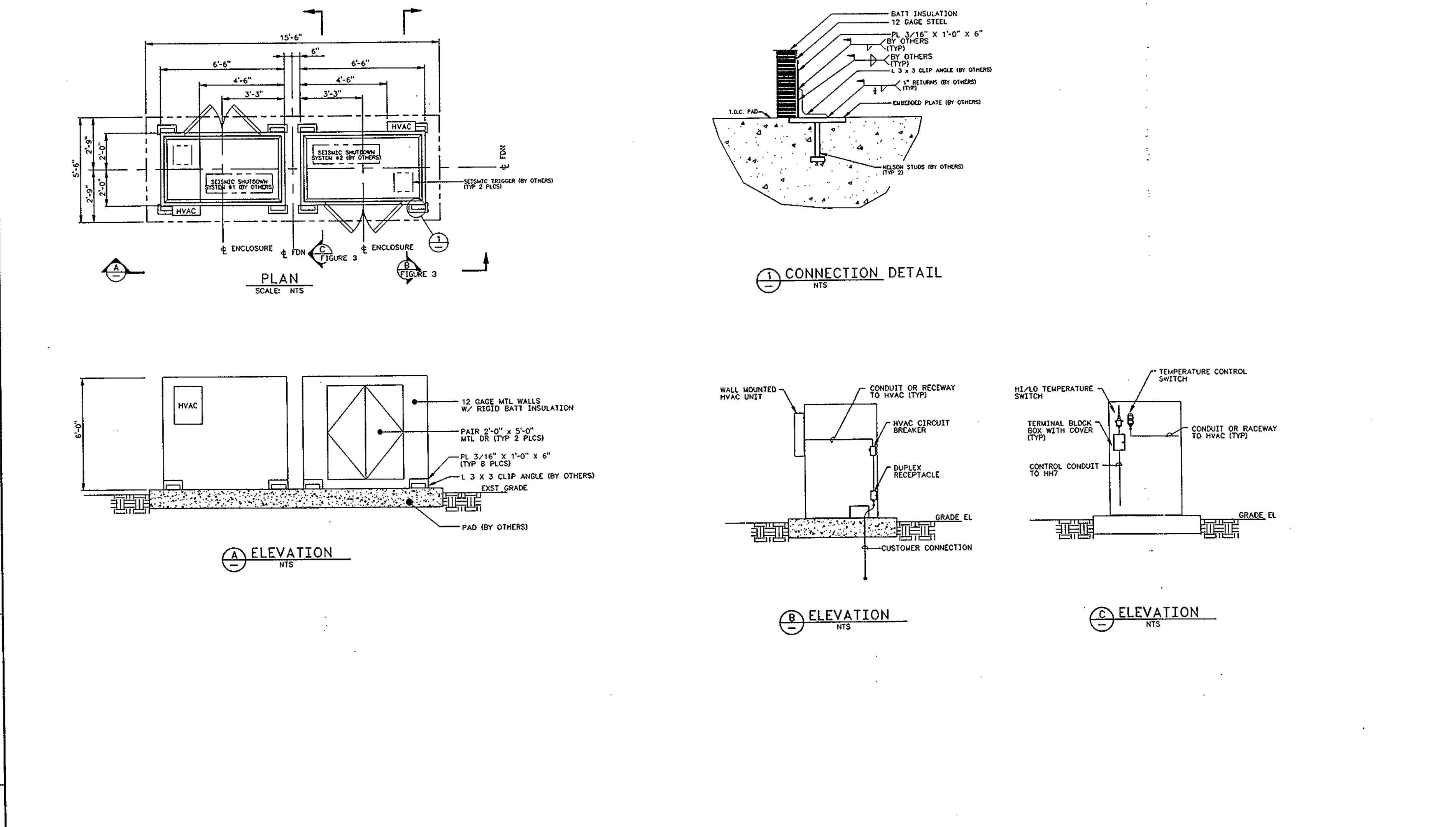
SEE DR/AT FORM
SEE DR/AT FORM
SEE DR/AT FORM

F C-FARM 0900 H-2-818456 0

SHOWN ER4319 SHEET 1 OF 1

PLOT SCALE: 1=24 KENCAD

Attachment 2
Calc. No. W320-24-026



DESIGNER	JR BOOTH
SAFETY	SEE DR/AT FORM
DWSR	SEE DR/AT FORM
QUAL ENGR	SEE DR/AT FORM
REVIEW NO.	4
BY	WHC

PRELIMINARY

SAFETY CLASS 3

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
ICF KAISER HANFORD COMPANY

STRUCTURAL
SEIS SHUTDOWN SYS ENCL
PLAN & SECTIONS

W-320 TANK 241-C-106 SLUICING

F | C-FARM | 0901 | ESPSPEC | 0

SCALE SHOWN | ER4319 | SHEET 1 of 1

CAD FILE ESPSPEC | CAD CODE 2B:IBM:ACD2:12.0:NN

2 PLOT SCALE: 1=24 | KEHCAD

Attachment 3 pg 1 of 2
W320-24-026

DON'T SAY IT --- *Write It!*

DATE: 6/28/94

TO: Jim Booth

FROM: Moe Khorsandian

Telephone: 373-2331

cc: Tim Kasnick
Juanito Del Rosario

SUBJECT: Seismic Switch Assembly Structure

1. Size of enclosure box for contactor assembly is 36" x 36" x 12". The box is typically designed for wall mounting application, but it can be modified for floor standing (option). This box will house the contactor, Seismic Switch Power Supply, Aux Relays and Misc Control Relays (up to 4) & instruments (see attached copy for more info for the enclosure box).

2. Weight of contactor itself is approximately 45 lb. Add 5 lb for SS Power Supply, ≈ 50 lb for enclosure box and misc loads. Total weight not to exceed ≈150 lb.

3. Clearance required for cable and conduit entrances: Preliminary design is to bring conduit from bottom straight through (underground conduit). Panels should have a clearance of at least 3 ft from the floor. Connection between two panels is straight line, no bending/clearance is required for panels interconnections.

Question: Have you considered the possibility of having a heavy metal enclosure cabinet, walk-in type, possibly with HVAC unit, light, etc. to be anchored on the concrete pad to serve as a missile barrier for seismic switch assembly instead of concrete building or pit ?

Attachment 3 pg 2 of 2
W320-24-026

GENERAL DESCRIPTION

The TS-3/TS-3A consists of orthogonal acceleration transducers which are individually adjustable and are mounted in a rugged, watertight housing. As a triaxial seismic trigger for centrally-located accelerographs (SMA-3, DSA-3 or CRA-1), external starter (for the SMA-1, DSA-1 or SMA-2) or for low-level alarms, the set point of the TS-3/TS-3A is adjustable from 0.005g to 0.05g. As a seismic switch for remote alarms (for nuclear plant annunciation), the TS-3/TS-3A set point is adjustable from 0.025g to 0.25g. The detectors for the unit are small moving coils of 4 Hz natural frequency, and the seismic trigger version includes a filter which limits the flat response to the 1 Hz-10 Hz band. Energy outside this band is attenuated to preclude trigger response to non-earthquake events such as rotating equipment, blasts, vehicles, and industrial vibrations.

When seismic energy exceeds the set point on any axis, a relay in the TS-3/TS-3A housing closes, remains closed from 6 to 20 seconds (adjustable) after the acceleration falls below the threshold, and then resets automatically. On the TS-3, an MS connector on the housing links a remote 12 Vdc power supply and the user's remote accelerograph or alarm on the TS-3. On the TS-3A, the power supply consists of two internal, rechargeable 6V batteries in series. The components of the TS-3 can withstand up to 1 x 10^7 rads radiation. The set points in either unit may be tested or adjusted in the field with the FC-1 Field Calibrator (see Accessories).

TECHNICAL SPECIFICATIONS

Natural Frequency
4 Hz

Actuating Acceleration
0.005 g to 0.05 g, field adjustable with FC-1; optional range 0.025 g to 0.25 g

Damping
1.5 critical, provides flat response between 1 Hz and 10 Hz (optional damping 3.5 critical used for 0.025 g to 0.25 g range to provide flat response between 0.5 Hz and 15 Hz)

Output
Switch closure SPST: contact rating 10 watts for dc, or 12 VA for ac, 0.5 amp maximum

Closure Timing
On actuation the relay contacts close and stay closed for 6 to 20 seconds (adjustable) after motion falls below preset displacement threshold

Current Drain
0.45 mA standby, 60 mA operating from 12 Vdc

PHYSICAL CHARACTERISTICS

Dimensions
20.3 cm x 20.3 cm x 20.3 cm (8" x 8" x 8")

Weight
6.3 kg (14 lbs)

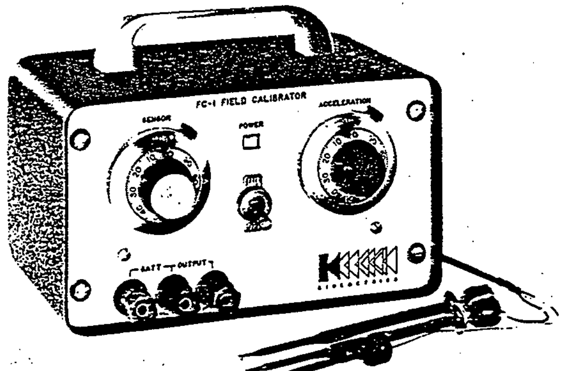
Operating Temperature
-20°C to +55°C (0°F to 130°F)

RECOMMENDED ACCESSORIES

1. FC-1 Field Calibrator, designed to adjust electromagnetic triggers to the desired actuation acceleration; powered by internal batteries.
2. SP-1 Seismic Switch Power Supply for use with TS-3 (SP-1 data sheet available).

ORDERING INFORMATION

1. Specify set point of actuating acceleration.



FC-1 Field Calibrator

Fluor Daniel Northwest	CALCULATION IDENTIFICATION AND INDEX	Page i of iv Date January 7, 1998

This sheet shows the status and description of the attached Design Analysis sheets.

Discipline Structural   WO/Job No. ER4319/W-320   Calculation No. W320-24-027

Project No. & Name Project W-320, Tank 241-C-106 Sluicing

Calculation Item Structural Analysis for Safety Related Equipment Attachments

These calculations apply to:

Dwg. No. H-2-818498   Rev. No. 0

Dwg. No. H-2-818499, sh 1 & 2   Rev. No. 0

Other (Study, CDR) ECN W-320-691   Rev. No. N/A

The status of these calculations is:

[] Preliminary Calculations

[X] Final Calculations

[] Check Calculations (On Calculation Dated)

[] Void Calculation (Reason Voided)

Incorporated in Final Drawings? [X] Yes [] No

This calculation verified by independent "check" calculations? [] Yes [X] No

Original and Revised Calculation Approvals:

	Rev. ~~2~~ 3 Signature/Date	Rev. ~~1~~ 4 Signature/Date	Rev. ~~2~~ 5 Signature/Date
Originator	Ann S. Langevin 1/7/98 Ann S Langevin		
Checked by	Michael R Custer 1/7/98		
Approved by	Ann S Langevin 1/7/98		
Checked Against Approved Vendor Data	Ann S Langevin 1/7/98		

INDEX

Design Analysis Page No.	Description
	INDEX see page ii
Revision 3	Added new cover sheet. Revised index pages ii & iii, and page 1 of calc. Added pages 21 through 27 for addition of air breather filter support analysis.

A-6002-143 (01/97) GEF410

W320-24-027

Structural Analysis for Safety Related Equipment Attachments

KAISER ENGINEERS HANFORD	CALCULATION IDENTIFICATION AND INDEX	Page ~~i~~ of ~~iii~~ Date 2/2/95

This sheet shows the status and description of the attached Design Analysis sheets.

Discipline STRUCTURAL WO/Job No. ER4319/W-320 Calculation No. W320-24-027

Project No. & Name PROJECT W-320, TANK 241-C-106 SLUICING

Calculation Item STRUCTURAL ANALYSIS FOR SAFETY RELATED EQUIPMENT ATTACHMENTS

These calculations apply to:

Dwg. No. H-2-818498 Rev. No. 0

Dwg. No. H-2-818499, SH. 1 & 2 Rev. No. 0

Other (Study, CDR) N/A Rev. No. N/A

The status of these calculations is:

[] Preliminary Calculations

[X] Final Calculations

[] Check Calculations (On Calculation Dated)

[] Void Calculation (Reason Voided)

Incorporated in Final Drawings? [X] Yes [] No

This calculation verified by independent "check" calculations? [] Yes [X] No

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	James R. Booth James R Booth 2/2/95	Michael R Custer 1/2/96	Michael B. Lasota 2/1/97
Checked by	R.W. Dorsiofer 7/27/95	R.W. Dorsiofer 1/24/96	R.W. Dorsiofer 2/12/97
Approved by	R.W. Dorsiofer 7/28/95	R.W. Dorsiofer 2/13/96 1/24/96	R.W. Dorsiofer 2/12/97
Checked Against Approved Vendor Data			R.W. Dorsiofer 3/31/97

REVISION 1 : ADDED PAGES 11 AND 12. ADDED ATTACH. 3, REVISED PAGE NUMBERING ON PAGES 1 THRU 10.

: ADDED PAGES 13, 14 AND ATTACH. 4, REVISED PAGE NUMBERING RWD 1/24/96

INDEX

Design Analysis Page No.	Description
1	OBJECTIVE, CRITERIA, DATA, ASSUMPTIONS, METHOD, REFERENCES, AND CONCLUSIONS
2-6	EVALUATION OF SUPPORT FRAME & ATTACHMENT REQUIREMENTS OF THE COOLING COIL TO BE MOUNTED ON THE WALL OF SLUICE PIT 241-AY-02E
6-7	TYPICAL ELECTRICAL PANEL OVERTURNING/EXPANSION ANCHOR CHECK
8	SEISMIC BOLT SHEAR CALC OF BOLTS ATTACHING THE SLUICE DRIVE TO SLUICE RING
8-9	EXPANSION ANCHOR BOLT CALC OF SEISMIC RESTRAINT FOR PUMP IN PIT AY-02E
9-~~10~~ 14	EXPANSION ANCHOR BOLT CALC FOR SEISMIC SHUTDOWN CONTACTOR BOX ATTACHMENT
ATTACH. 1	PIT COOLING COIL FAN ASSEMBLY
ATTACH. 2	PIT COOLING COIL FAN SUPPORT FRAME
ATTACH. 3	EQUIPMENT VENDOR CALC. (NUTHERM INTERNATIONAL INC., CALC. NO. 7455-03, REV. 0), 9 PAGES
ATTACH. 4	VENDOR DWG W25255BA (AIR MONITOR CORP, SPEC. W-320-P41) / ECN W-320-365, SHT. 3
15-20	EVALUATION OF CONNECTION BETWEEN CAMERA ASSEMBLY AND MODIFIED FLANGE (R-7, 06A PIT)

RWD 2/12/97 2

KEH 0378.00 (06/92) KEF072

RWD 1/24/96

Revision 2: Added pages 15 thru 20. Revised page numbering of pages 1 thru 14.

CALCULATION CROSS INDEX (Typical)

Subject Calculation No. W320-24-027

Subject Calculation Revision No.	Superceded by Calculation No.	These interfacing calculation/documents provide input to the subject calculation, and if revised may require revision of the subject calculation.		Results and conclusions of the subject calculation are used in these interfacing calculations and/or documents.		Does the output interface calculation/ documents require revision?		Has the output interface calculation/ documents been revised?		Discipline manager's signature and date indicating evaluation complete.
		Calculation/Document No.	Revision No.	Calculation/Document No.	Revision No.	Yes	No	Yes	No	
Ø	N/A	N/A	—	H-2-818489	Ø		✓		✓	[signature] 7/28/95
Ø	N/A	N/A	—	H-2-818490, sh. 1 & 2	Ø		✓		✓	
Ø	N/A	N/A	—	H-2-818702, sh. 1 & 2	Ø		✓		✓	
Ø	N/A	N/A	—	H-2-818704, sh. 1-4	Ø		✓		✓	
Ø	N/A	N/A	—	H-2-818462	Ø		✓		✓	
Ø	N/A	N/A	—	H-2-818543, sh-2	Ø		✓		✓	
Ø	N/A	N/A	—	H-2-818696, sh-3	Ø		✓		✓	
Ø	N/A	N/A	—	H-2-818679, sh-2	Ø		✓		✓	
3	N/A	N/A	—	H-2-818519, sh 1	Ø		✓		✓	Ann Slangerm 1/6/98

KEH 1975.00 (12/88)

DESIGN VERIFICATION SCREENING CRITERIA

Project/Document No. W-320/W320-24-027

When the design or design change affects hardware, formal design verification must be performed if one or more of the following questions must be answered affirmatively (YES).

YES	NO		
____	X	1.	Does the design or design change involved meet the established criteria to be considered Safety Class 1 ~~or 2~~ (Design involves anchorage/ attachment to SC-1 designated seismic strength qualified structures). RWD 7/28/95
____	X	2.	Does this design or design change cause or permit changes to Safety Class 1 or 2 instrument or alarm setpoints outside of previously approved operational limits?
____	X	3.	Does this design or design change significantly affect the nuclear safety consequences of a malfunction or failure of the structure, system, or component?
____	X	4.	Does this design or design change involve or change design that has previously undergone formal design verification?

R W Donaldson ____ 7/28/95
Assigned Lead Engineer — Date

R W Donaldson ____ 7/28/95
Responsible Discipline Manager — Date

Original Design Package Distribution:

Project Engineer

Chief Design Engineer

Engineering Document Control

Design Change Distribution:

Attach to Engineering Change Notice

KEH-1981.00 (02/90)

KAISER ENGINEERS HANFORD

DESIGN ANALYSIS

Calc. No. W320-24-027
Revision ~~0~~ ~~1~~ ~~2~~ 3
Page No. 1 of ~~10~~ ~~14~~ 20

Client: Westinghouse Hanford Company	WO/Job No. ER4319/W-320	
Subject: Structural Analysis for Safety Related Equipment Attachments	Date 2/2/95	By JR Booth ARB
	Checked 7/27/95	By
Location: AY-Farm & C-Farm	Revised 1/2/96	By M.R. CUSTER MRC
	Revised 1/5/98	

OBJECTIVE: The analysis of safety related equipment supports and anchorages to designated SC-1 seismic strength qualified structures.

CRITERIA:
1. SDC 4.1, Rev. 11. & Rev 12
2. SDC 4.2, Rev. 0.
3. UCRL 15910, June 1990.

DATA: See body of calc.

ASSUMPTIONS: See body of Calc.

METHOD: MathCAD 4.0

REFERENCES:
1. Standard ARCH-Civil Design Criteria, SDC-4.2. Design and Installation of Expansion Anchors. Rev. 0.
2. American Institute of Steel Construction. Load & Resistance Factor Design (LRFD). First Edition. 1986.
3. U.S. Nuclear Regulatory Commision, Standard Review Plan, Office of Reactor Regulation. Section 3.7.2, Seismic System Analysis. Rev. 1, July 1981. (NUREG-0800).
4. Standard ARCH-Civil Design Criteria, SDC-4.1. Design Loads for Facilities. Rev. 11.
5. H-2-818498, REV.O.
6. H-2-818499, SH. 1 & 2, REV. 0.
7. Uniform Building Code, (UBC-91).
8. American Society of Civil Engineers (ASCE). Minimum Design Loads for Buildings and Other Structures.
9. International Conference of Building Officials (ICBO). Report No. 4627. March 1989/FEB. 1992
10. HNF-1559, Rev. 2 Preliminary Engineering Analysis for Safety Class and Safety Significant WRSS Equipment (page A23 App. A)
11. HNF-SD-WM-~~SEL~~-040, Rev 0 TWRS Facility Safety Equipment List (Table A-3.6) page A-73)
12. HNF-SD-W320-FDC-001 Rev 0 - Functional Design Criteria for Tank 241-C-106 Waste Retrieval
13. Stand Arch-Civil Design Criteria SDC-4.1, Design Loads for Facilities Rev. 12.

CONCLUSIONS: See body of calc.

14. Operating Specification for Single-Shell Tanks OSD-T-151-00013, Rev D-1

54-4300-037 KEH-0037.00 (06/92)

KAISER ENGINEERS
HANFORD

DESIGN ANALYSIS

Calc. No. W320-24-027
Revision ~~0~~ ~~1~~ 2
Page No. 2 of ~~10~~ ~~14~~ 20

Client: Westinghouse Hanford Company	WO/Job No. ER4319/W-320		
Subject: Structural Analysis for Safety Related Equipment Attachments	Date 2/2/95	By JR Booth	
	Checked 7/20/95	By	
Location: AY-Farm & C-Farm	Revised 1/12/96	By M.R CUSTER MRC	

1. Evaluate the support frame and attachment requirements of the Cooling Coil to be mounted on the wall of the Sluice Pit (241-AY-02E).

a. Determine dead load.

$$D_1 := \left(5.4 \cdot \frac{lb}{ft}\right) \cdot ((4 \cdot 1.67 \cdot ft) + (2 \cdot 1.65 \cdot ft) + (4 \cdot ft) + (2 \cdot 4.67 \cdot ft) + (0.33 \cdot ft))$$

$D_1 = 127.71 \cdot lb$ (C4 X 5.4 Channels, see pg. A-2)

$D_2 := 300 \cdot lb$ (Approx. weight of Pit Cooling Fan Coil and misc. piping. Ref. 6, sh. 1.

$D := D_1 + D_2$

$D = 427.71 \cdot lb$

b. Seismic loading. Use a Equivilant Static Analysis as mentioned in Ref. 3 and analyze at safety class 1 seismic accelerations due to attachment of SC-3 support frame to existing SC-1 designated seismic strength qualified structures.

$a := 0.42$ (Peak acceleration from figure 3 of Ref. 4 at 5% critical damping)

$f := 1.5$ (Equivalent Static Factor from Ref. 3)

$E_h := 1.5 \cdot a \cdot D$

$E_h = 269.457 \cdot lb$ (Horizontal earthquake load)

$E_v := E_h \cdot \frac{2}{3}$

$E_v = 179.638 \cdot lb$ (Vertical earthquake load)

c. Evaluate the following load conditions from Ref. 2, Sec. A4.1.

$L := 0 \cdot lb$ (No live load)

Vertical

$L_{v1} := 1.4 \cdot D$

$L_{v1} = 598.794 \cdot lb$

$L_{v2} := 1.2 \cdot D + 1.5 \cdot E_v + 0.5 \cdot L$

$L_{v2} = 782.709 \cdot lb$ Controls vertical loading

$L_{v3} := 0.9 \cdot D - 1.5 \cdot E_v$

$L_{v3} = 115.482 \cdot lb$

$D_h := 0 \cdot lb$ (Horizontal dead load)

Horizontal

$L_{h1} := 1.2 \cdot D_h + 1.5 \cdot E_h + 0.5 \cdot L$

$L_{h1} = 404.186 \cdot lb$ Controls horizontal loading

$L_{h2} := 0.9 \cdot D_h - 1.5 \cdot E_h$

$L_{h2} = -404.186 \cdot lb$

d. Determine the ultimate moment in member A-C and ultimate axial force in member B-D. See page A-2, Detail 2.

$kip := 1000 \cdot lb$

$x := 2 \cdot lb$ guess

$R_a := root\left[\left(\frac{14}{12}\right) \cdot ft \cdot x - \left(\frac{4}{12}\right) \cdot ft \cdot L_{v2}, x\right]$ (Sum of the moments about point B)

$R_a = 0.224 \cdot kip$ (Reaction at point A)

$z := 2 \cdot lb$ guess

$R_b := root\left(R_a - L_{v2} + z \cdot \sin(45 \cdot deg), z\right)$

$R_b = 0.791 \cdot kip$ Axial force acting in member B-D

$x1 := \left(\frac{4}{12}\right) \cdot ft$ Short leg

$x2 := \left(\frac{10}{12}\right) \cdot ft$ Long leg

$l := 1.17 \cdot ft$ Beam length

$M_u := \frac{L_{v2} \cdot x1 \cdot x2}{l}$

$M_u = 0.186 \cdot kip \cdot ft$ Ultimate Moment

KAISER ENGINEERS HANFORD

DESIGN ANALYSIS

Calc. No. W320-24-027
Revision ~~0~~ ~~1~~ 2
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Client: Westinghouse Hanford Company	WO/Job No. ER4319/W-320
Subject: Structural Analysis for Safety Related Equipment Attachments	Date 2/2/95 By JR Booth JRB
	Checked 7/27/95 By [illegible]
Location: AY-Farm & C-Farm	Revised 1/2/96 By M.R. CUSTER MRC 1/24/9[illegible]

e. Check C 4 x 5.4 channels for required bending and axial strength.

Bending, Ref. 2 Beam Design Section

$\mathrm{ksi} := \dfrac{1000 \cdot \mathrm{lb}}{\mathrm{in}^2}$

$\phi_b := 0.9$ (Strength reduction factor)

$F_y := 36 \cdot \mathrm{ksi}$ (Yield Stress)

$Z_y := 0.569 \cdot \mathrm{in}^3$

$\phi M_n := \dfrac{\phi_b \cdot Z_y \cdot F_y}{12 \cdot \dfrac{\mathrm{in}}{\mathrm{ft}}}$

$\phi M_n = 1.536 \cdot \mathrm{kip} \cdot \mathrm{ft}$ OK, since nominal bending moment greater than ultimate.

Axial, Ref. 2 chapter E pg. 6-39

$K := 1$ (Effective length factor, assuming pinned ends)

$l := \left(\dfrac{1.65 \cdot \mathrm{ft}}{1 \cdot \mathrm{ft}}\right) \cdot 12 \cdot \mathrm{in}$

$l = 19.8 \cdot \mathrm{in}$ (length of member)

$r_y := 0.449 \cdot \mathrm{in}$

$\dfrac{K \cdot l}{r_y} = 44.098$

$\phi F_{cr} := 27.63 \cdot \mathrm{ksi}$ (Design stress, Ref. 2 Table 3-36, pg. 6-124)

$A_g := 1.59 \cdot \mathrm{in}^2$

$\phi P_n := \phi F_{cr} \cdot A_g$

$\phi P_n = 43.932 \cdot \mathrm{kip}$ OK, design exceeds ultimate.

Shear, Ref. 2 Eq. F2.1, pg. 6-45

$l := 1.17 \cdot \mathrm{ft}$

$V_u := \dfrac{L_{v2} \cdot x2}{l}$

$V_u = 0.557 \cdot \mathrm{kip}$

$\phi_v := 0.9$

Client: Westinghouse Hanford Company	WO/Job No. ER4319/W-320
Subject: Structural Analysis for Safety Related Equipment Attachments	Date 2/2/95 By JR Booth
	Checked 1/27/95 By
Location: AY-Farm & C-Farm	Revised 1/2/96 By M.R. CUSTER MRC

$A_w := (2.625 \cdot in) \cdot \left(\frac{3}{16} \cdot in\right)$

$\phi V_n := \phi_v \cdot 0.6 \cdot F_y \cdot A_w$

$\phi V_n = 9.568 \cdot kip$ — OK, design shear strength is greater than the ultimate

f. Determine strength of 3/16" weld per inch. (Ref. 2, Sec. J2.2)

$\phi := 0.75$ — (Strength reduction factor)

$t_e := 0.707 \cdot \frac{3}{16} \cdot in$

$F_{exx} := 70 \cdot ksi$

$\phi R_n := \phi \cdot t_e \cdot (0.6 \cdot F_{exx})$

$\phi R_n = 4.176 \cdot \frac{kip}{in}$ — It can be seen that a 3/16" weld will easily carry any loads

g. Expansion Anchor Design. Per Ref. 1. Five Hilti-KWIK II bolts will be used to attach the frame to the wall.

$V_{applied} := \frac{\sqrt{L_{h1}^2 + L_{v2}^2}}{4}$ — Shear force per bolt. Divide shear force among four of the five bolts.

$V_{applied} = 220.227 \cdot lb$

$T_{ot} := \frac{L_{v2} \cdot \left(\frac{10}{12} \cdot ft\right)}{2 \cdot 1.5 \cdot ft}$ — Tension caused from overturning. Tension divided into 2 bolts.

$T_{ot} = 217.419 \cdot lb$

$T_p := \frac{L_{h1}}{4}$

$T_p = 101.046 \cdot lb$

$T_{applied} := T_{ot} + T_p$

Try 3/8" DIA. KB II w/ 1 5/8" Min. Embed. (Ref. 1, Table 11). Assumed concrete strength (f'c) is 3000psi.

$V := 780 \cdot lb$ (Allowable)
$T := 610 \cdot lb$ (Allowable)

$\frac{V_{applied}}{V} + \frac{T_{applied}}{T} \le 1.0$

$\frac{V_{applied}}{V} + \frac{T_{applied}}{T} = 0.804$ ok

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HANFORD

DESIGN ANALYSIS

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Client: Westinghouse Hanford Company	WO/Job No. ER4319/W-320		
Subject: Structural Analysis for Safety Related Equipment Attachments	Date 2/2/95	By JR Booth JRB	
	Checked 7/27/95	By	
Location: AY-Farm & C-Farm	Revised 1/2/96	By M.R. CUSTER MRC	

CONCLUSION: Cooling coil support frame shall be made of C 4 x 5.4 channels and welded together with 3/16" fillet welds. Anchorage to the pit wall shall be made with 3/8" DIA. Hilti KWIK II bolts. See drawings H-2-818498, sh. 1 and H-2-818499, sh.1 for details.

===

TYPICAL ELECTRICAL PANEL OVERTURNING/EXPANSION ANCHOR CHECK, SAFETY CLASS 3

1. Determine controlling lateral force.

$D_1 := 100 \cdot lb$ — Weight of worst case Hoffman box

$D_2 := 50 \cdot lb$ — Additional weight of breakers and cable

$W_p := D_1 + D_2$

$W_p = 150 \cdot lb$

a. Seismic

$Z := 0.2$ — Seismic Acceleration, Ref. 7.

$I := 1.25$ — Importance Factor, Ref. 4.

$C_p := 2 \cdot (0.75)$ — Horizontal force factor per Ref. 7, Table 23-P. Factor multiplied by 2 per UBC sec. 2336(b).

$F_p := Z \cdot I \cdot C_p \cdot W_p$ — Lateral seismic force per UBC sec. 2336(b)

$F_p = 56.25 \cdot lb$

$F_{p2} := 0.3 \cdot F_p$

$E := \sqrt{F_p^2 + F_{p2}^2}$ — SSRS of two orthogonal directions

$E = 58.727 \cdot lb$

b. Wind

$I := 1.07$ — Importance factor, Ref. 4, pg. 8

$V := 70$ — Wind speed in mph, Ref. 4, pg.8

$K_z := 0.8$ — Table 6 of Ref. 8

$q_z := 0.00256 \cdot K_z \cdot (I \cdot V)^2 \cdot \frac{lb}{ft^2}$ — Velocity pressure, EQ.3 of Ref.8

$G_h := 1.32$ — Gust response factor, Table 8 of Ref. 8

$C_f := 1.2$ — Force Coeff. for Solid signs, Table 13 of Ref. 8

$A_f := 9 \cdot ft^2$ Conservative, assuming 3 ft x 3 ft panel

$W := q_z \cdot G_h \cdot C_f A_f$

$W = 163.791 \cdot lb$

WIND FORCE CONTROLS!!!!

2. Check overturning moment. See H-2-818704, SH2 section A for case.

$M_{ot} := W \cdot (5 \cdot ft)$

$M_{ot} = 818.957 \cdot lb \cdot ft$

$W_s := (3 \cdot ft \cdot 3 \cdot ft \cdot 0.67 \cdot ft) \cdot 150 \cdot \frac{lb}{ft^3}$ Weight of 3'-0" x 3'-0" x 0'-8" pad

$W_s = 904.5 \cdot lb$

$M_r := W_s \cdot 1.5 \cdot ft$

$M_r = 1.357 \cdot 10^3 \cdot lb \cdot ft$

$\frac{M_{ot}}{M_r} = 0.604$ OK!!

3. Determine expansion anchor requirements

Try 5/8" DIA. expansion anchors with 2 3/4" min embed

$T_a := 2000 \cdot lb$ Allowables given are for HKB II bolt installed with special inspection. Ref. 9

$V_a := 2625 \cdot lb$

$T_{applied} := \frac{M_{ot}}{2 \cdot 0.5 \cdot ft}$ $T_{applied} = 818.957 \cdot lb$

$V_{applied} := \frac{W}{2}$ $V_{applied} = 81.896 \cdot lb$

$\frac{V_{applied}}{V_a} + \frac{T_{applied}}{T_a} \le 1.0$

$\frac{V_{applied}}{V_a} + \frac{T_{applied}}{T_a} = 0.441$ OK!!

RO 1/24/97 $\triangle$1

Conclusion: A 3 ft square by 8" deep pad will be sufficient for proposed electrical panels around C106 and 5/8" DIA expansion anchors are suffient for unistrut base plates. unless otherwise stated. See Calc W320-24-029 for detailed structural analysis of safety related electrical equipment supports & anchorage/fdn req'mnts.

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Revision ~~0~~ ~~1~~ 2
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Client: Westinghouse Hanford Company	WO/Job No. ER4319/W-320	
Subject: Structural Analysis for Safety Related Equipment Attachments	Date 3/27/95	By JR Booth JRB
	Checked 7/20/95	By
Location: AY-Farm & C-Farm	Revised 1/2/96	By M.R. CUSTER MRC

SEISMIC BOLT SHEAR CALC OF BOLTS ATTACHING THE SLUICER DRIVE ASSEMBLY TO THE SLUICE RING, SAFETY CLASS 3

$W_p := 1600 \cdot lb$ — Ref. H-2-818550, sh-5

Note: Because of the relatively low profile of the Sluice Drive versus weight, seismic will control horizontal loading

1. Combined loadin from Sluice Drive and calc W320-27-034.

$Z := 0.2$ — Seismic Acceleration, Ref. 7.

$I := 1.25$ — Importance factor, Ref.4.

$C_p := 2 \cdot (0.75)$ — Horizontal force factor per Ref.7, Table 23-P. Factor multiplied by 2 per UBC sec. 2336(b).

$F_p := Z \cdot I \cdot C_p \cdot W_p$ — Lateral seismic force per UBC sec. 2336(b).

$F_p = 600 \cdot lb$

$F_{p2} := 0.3 \cdot F_p$

$E := \sqrt{F_p^{\,2} + F_{p2}^{\,2}}$ — SSRS of two orthogonal directions

$E = 626.418 \cdot lb$

$V := 1.27 \cdot kip$ — Combined seismic and operating loads from W320-27-034.

$S := 1.5 \cdot E + V$ — 1.5 is for equivalent staic analysis

2. Check 3/4" Dia. bolts ASTM A307, Grade B. Ref. H-2-818462, sh-1.

$U := 1.5 \cdot S$ — LRFD load factor design.

$U = 3.314 \cdot 10^3 \cdot lb$ — Factored seismic load acted as shear force on the bolts

$\phi R_n := 7.16 \cdot kip$ — Ultimate design load of 3/4" Dia. bolts with threads included in the shear plain. Ref. 2, page 5-5.

$\phi F_p := 78.3 \cdot kip$ — Ultimate desgn bearing strength of 1" thick A36 steel plate. Ref. 2, pg. 5-7.

Since the ultimate design loads of the bolt and connected parts are greater than the factored load, the bolt pattern for connecting the Sluice Drive Assembly adequately designed to resist seismic forces.

EXPANSION ANCHOR BOLT CALC OF SEISMIC RESTRAINT FOR PUMP IN PIT AY-02E

$D_p := 3180 \cdot lb$ — Boosterpump jumper weight. Ref. DWG H-2-818503, sh-1.

1. Determine seismic forces acting on expansion anchors. Use a Equivilant Static Analysis as mentioned in Ref. 3 and analyze at Safety Class 1 seismic accelerations.

$a := 0.42$ — (Peak acceleration from figure 3 of Ref. 4 at 5% critical damping)

$f := 1.5$ — (Equivalent Static Factor from Ref. 3)

$E_h := 1.5 \cdot a \cdot D_p$

$E_h = 2.003 \cdot 10^3 \cdot lb$ — (Horizontal earthquake load)

$E_v := E_h \cdot \frac{2}{3}$

$E_v = 1.336 \cdot 10^3 \cdot lb$ (Vertical earthquake load)

2. Expansion Anchor Check. (4) Hilti Kwik-Bolt II 1/2" Dia. w/ 2 1/4" min embed will be used to restrain the pump to the pit wall (H-2-818543, sh-2). Assumed concrete strength (f'c) is 3000psi. The seismic restraint that attaches the pump to the wall will not transfer a moment on to the plate shown on H-2-818543, sh-2 since there is no rigid connection to the wall plate.

$V_{applied} := \frac{\sqrt{E_h^2 + E_v^2}}{4}$ Shear force per bolt. Divide shear force among two bolts.

$V_{applied} = 601.947 \cdot lb$

$T_{applied} := \frac{E_h}{4}$

$T_{applied} = 500.85 \cdot lb$

$V := 1390 \cdot lb$ (Allowable)
$T := 1000 \cdot lb$ (Allowable) Ref. 1, Table 11

$\frac{V_{applied}}{V} + \frac{T_{applied}}{T} = 0.934$

$\frac{V_{applied}}{V} + \frac{T_{applied}}{T} \le 1.0$ ok

EXPANSION ANCHOR BOLT CALC. FOR SEISMIC SHUTDOWN SWITCH CONTACTOR BOX ATTACHMENT

The contactor box will be inside a missile shield enclosure; therefore, seismic loads will be evaluated. The contactor box is safety class 1.

1. Determine an estimated weight.

$D_1 := 200 \cdot lb$ Weight of worst case Hoffman box

$D_2 := 100 \cdot lb$ Additional weight of breakers and cable

$W_t := D_1 + D_2$

$W_t = 300 \cdot lb$ Total weight

1. Determine seismic forces acting on expansion anchors. Use a Equivilant Static Analysis as mentioned in Ref. 3 and analyze at Safety Class 1 seismic accelerations due to elevated SC-1 seismic strength qualification of foundation pad.

$a := 0.42$ (Peak acceleration from figure 3 of Ref. 4 at 5% critical damping)

$f := 1.5$ (Equivalent Static Factor from Ref. 3)

$E_h := 1.5 \cdot a \cdot W_t$

$E_h = 189 \cdot lb$ (Horizontal earthquake load)

$E_v := E_h \cdot \frac{2}{3}$

$E_v = 126 \cdot lb$ (Vertical earthquake load)

2. Determine overturning moment.

$M_{ot} := E_h \cdot (3 \cdot ft)$

$M_{ot} = 567 \cdot lb \cdot ft$

3. Expansion Anchor Check. (4) Hilti Kwik-Bolt II 3/8" Dia. w/ 1 5/8" min embed will be used to attach the contactor box to the Seismic Shutdown Pad (H-2-818456). Concrete strength (f'c) is 4000psi.

$T_a := 710 \cdot lb$ Allowables given are for HKB II bolt installed with special inspection. Ref. 9

$V_a := 875 \cdot lb$

$T_1 := \frac{M_{ot}}{2 \cdot 1 \cdot ft}$ $T_1 = 283.5 \cdot lb$

$T_{applied} := T_1 + \frac{E_v}{4}$ $T_{applied} = 315 \cdot lb$

$V_{applied} := \frac{E_h}{2}$ $V_{applied} = 94.5 \cdot lb$

$$\frac{V_{applied}}{V_a} + \frac{T_{applied}}{T_a} \le 1.0$$

$$\frac{V_{applied}}{V_a} + \frac{T_{applied}}{T_a} = 0.552$$ OK!!

NOTE:

REFER TO PAGES 11 AND 12 FOR REVISED ANCHOR CHECK, BASED ON THE VENDOR'S SUBMITTAL OF EQUIPMENT FOUNDATION LOADS PER ATTACH. 3.

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DESIGN ANALYSIS

Calc. No. W320-24-027
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Client WESTINGHOUSE HANFORD COMPANY	WO/Job No. ER4319/W-320		
Subject STRUCTURAL ANALYSIS FOR SAFETY RELATED EQUIPMENT ATTACHMENTS	Date 12/22/95	By M.R. CUSTER MRC	
	Checked 1/26/96	By	
Location AY-FARM & C-FARM	Revised	By	

RE-EVALUATE THE EXPANSION ANCHORS ATTACHING THE SEISMIC SHUTDOWN SYSTEM CABINETS (AY-SSS-1A AY-SSS-1B, C-SSS-1A AND C-SSS-1B) TO THE SEISMIC SHUTDOWN PAD.

REFER TO VENDOR CALCULATION NO. 7455-03, REV. 0 (NUTHERM INTERNATIONAL, INC.) AND PAGE 9 OF THIS CALCULATION.

THE ENVELOPING FORCES AND MOMENTS PER THE VENDOR ARE AS FOLLOWS:

DEAD LOADS:	DYNAMIC LOADS
$F_x = 0$	$F_x = 475.4$ lbs
$F_y = 546.5$ lbs	$F_y = 316.4$ lbs
$F_z = 0$	$F_z = 475.4$ lbs
$M_x = 699$ IN-lbs	$M_x = 15606$ IN-lbs
$M_y = 0$	$M_y = 3713$ IN-lbs
$M_z = 3634$ IN-lbs	$M_z = 17346$ IN-lbs

DETERMINE TENSION (T) AND SHEAR (V) LOADS:

$T_1 = 316.4/6 = 52.7$ lb

$T_2 = M_x/d(2) = (699 + 15606)/12''(2) = 679.4$ lb

$T_3 = M_z/d(3) = (3634 + 17346)/24.25(3) = 288.4$ lb

$V_1 = 475.4/6 = 79.2$ lb

$V_2 = 475.4/6 = 79.2$ lb

$V_3 = 3713/24.25(3) + 3713/12(2) = 205.8$ lb

$T_A = 52.7 + 679.4 + 288.4 = 1020.5$ lb

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DESIGN ANALYSIS

Calc. No. W320-24-077
Revision ~~1~~ 2
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Client WESTINGHOUSE HANFORD COMPANY	WO/Job No. ER4319/W-320		
Subject STRUCTURAL ANALYSIS FOR SAFETY RELATED EQUIPMENT ATTACHMENTS	Date 12/22/95	By M.R. CUSTER MRC	
	Checked 1/24/96	By KW	
Location AY-FARM & C-FARM	Revised	By	

$$V_A = (79.2^2 + 79.2^2 + 205.8^2)^{1/2} = 234 \text{ lbs}$$

CHECK UNITY:

$$\frac{V_A \text{ (APPLIED)}}{V_a \text{ (ALLOWABLE)}} + \frac{T_A \text{ (APPLIED)}}{T_a \text{ (ALLOWABLE)}} \leq 1.0$$

REFERENCE: ICBO REPORT No. 4627, FEB. 1992 AND ICF KAISER PROCEDURE GC-ANCR-01, REV. 0

CHECK 1/2"Ø ANCHOR:
- MINIMUM EMBEDMENT = 2 1/4"
- f'_c = 4000 PSI
- SPECIAL INSPECTION PROVIDED
- ANCHOR (CARBON STEEL HILTI KWIK-BOLT II)

ALLOWABLES:	GC-ANCR-01	ICBO 4627
V_a	1470 LBS	1840 LBS
T_a	1360 LBS	1365 LBS

$$\frac{234}{1470} + \frac{1020}{1360} = 0.91 < 1.0 \ldots\ldots \text{O.K}$$

USE 1/2"Ø EXPANSION ANCHOR W/ 2 1/4" MIN. EMBEDMENT W/ SPECIAL INSPECTION.

Final: Use 1/2" dia. Hilti Kwik-bolt II's, w/2-1/4" min emb for all SC 1 electrical equipment attachments to Seismic Shutdown Sys pads. Use a minimum of (4) exp. bolts to anchor contactor boxes and a minimum of (6) exp. bolts to anchor cabinets.

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DESIGN ANALYSIS

Client WHC

WO/Job No. ER-6159/W- 320

Subject Structural Analysis for Safety Related Equipment Attachments

Date 06/20/96 By M.R Custer MRC

Checked 6/26/96 By

Location AY- Farm & C-Farm

Revised By

EVALUATION FOR CHANGES PER ECN W-320-365:

The following provides design evaluation of modifications to the equipment anchorage for the Instrumentation and Control Cabinet (reference vendor drawing W25255BA by "Air Monitor Corporation) per specification W-230-P41. The cabinet is mounted on the Exhaust Skid provided per specification W-320-P1 and is Safety Class 3.

The modifications involve providing (6)- 3 x 3 x 1/4" angles, 4" long. (3) angles positioned each side, along the short dimension of the cabinet.

DESIGN LOADS:

Dead Load, weight of the cabinet = 1100 lb (Ref. Attachment 4)

Seismic Loads:

En-s = .375 Wp = .375 (1100) = 413 lb, use 420 lb

Ee-w = 1/3 (.375) Wp = 138 lb , use 140 lb

Ev = 0

Wind Load: (Use 20 psf x maximum projected area of cabinet)

Maximum projected area, Amax = 82"/12 x 35.3"/ 12 = 20.1 sq ft

Maximum wind load, Pw = 20 lb/sq ft x 20.1 sq ft = 402 lb

Determine the governing load combination:

The governing load combination will be determined based on the magnitude of the reactions at the base of the cabinet, resulting from the overturning moment(s).

Maximum Reaction due to Wind loading:

Max. uplift force at the support = [(82"/2 x 402 lb) + (1100 lb x 13.03")]/ 22.03" - 1100 lb(.85) = 463 lb

Reaction/ connection = 463 lb/ 2 = 232 lb/ connection

Maximum Reaction due to Earthquake loading:

Max. uplift force at the support, E n-s = [(420 lb x 8") + (1100 x 13.03")]/ 22.03" - 1100 lb(.85) = - 132 lb

Reaction = no uplift

Max. uplift force at the support, E e-w = ([(140 lb x 8") + (1100 lb x 14")]/ 35.3" - 1100 lb(.85) = - 467 lb

Reaction = no uplift

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Client WHC	WO/Job No. ER-6159/W- 320
Subject Structural Analysis for Safety Related Equipment Attachments	Date 06/20/96 By M.R Custer MRC
	Checked 6/24/96 By [signature]
Location AY- Farm & C-Farm	Revised By

Maximum reaction due to wind loading, R = 232 lb, Load Combination D + W governs uplift.

W shear = 402/ 6 = 67 lb/ connection

W uplift = 232 lb/ connection

SUMMARY OF FORCES AND MOMENTS: (Per connection)

Fx = 232 lb, Fy = 0, Fz = 67 lb $Fr = [(232)^2 + (67)^2]^{1/2}$ = 241 lb

Mx = 0, My = 232 lb (1.5") = 348 in-lb, Mz = 0

fw = Fx/Aw + My/ Swy + Fz/Aw, Aw = 6, Swy = d3/ 6 = 3

fw = 232/ 6 + 348/ 3 + 67/6 = 166 lb/in , w = fw/ 15800 = 0.010", min. weld = 3/16" , OK

Check 1/2" bolt : Ab = .196 in2 (Based on the nominal bolt dia.)

fb = .241 k/ .196 in2 = 1.2 ksi < 10 ksi .... OK

FLUOR DANIEL NORTHWEST INC.

DESIGN ANALYSIS

Calc. No.: W320-24-027
Revision: 2
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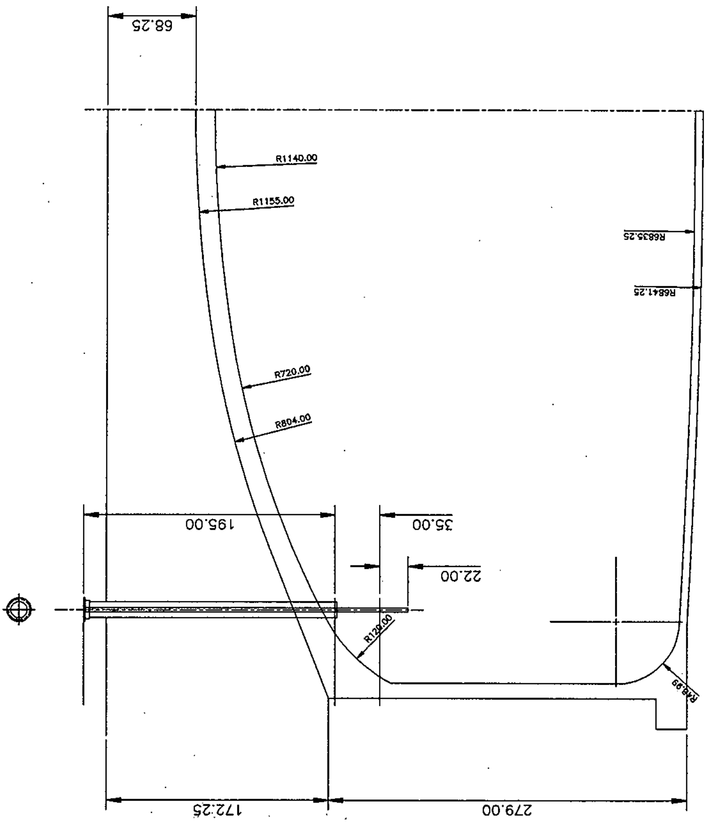
Client: NHC
Subject: Structural Analysis of Safety Related Equipment Attachments
Location: AY-Farm & C-Farm

WO/Job No.: ER4319/W 320
Date: 2/06/97 By: ~~MB Lasota~~
Checked: 2/12/97 By:
Revised: By:



TANK C-106,
RISER 7 & VIDEO SYSTEM

ACADFIL: 2427F1G1

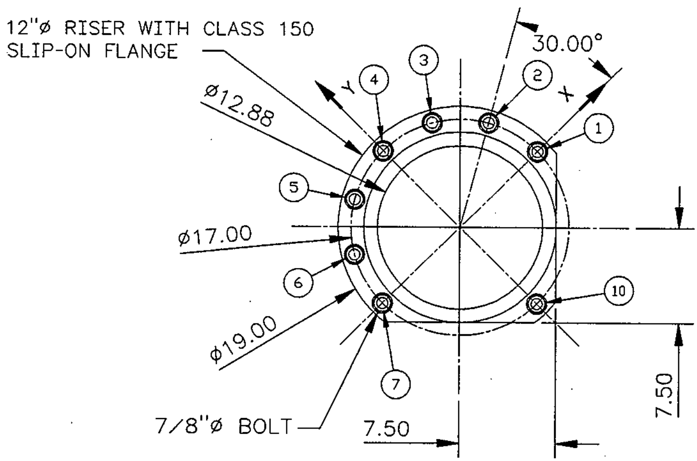
FLUOR DANIEL NORTHWEST INC.

DESIGN ANALYSIS

Calc. No.: W320-24-027
Revision: 2
Page No.: 16 of 20

Client: NHC
Subject: Structural Analysis of Safety Related Equipment Attachments
Location: AY-Farm & C-Farm

WO/Job No.: ER4319/W 320
Date: 2/06/97 By: MB Lasota
Checked: 2/12/97 By:
Revised: By:



MODIFIED FLANGE
FOR VIDEO SYSTEM

ACADFIL: 2427FIG2

FLUOR DANIEL NORTHWEST INC.

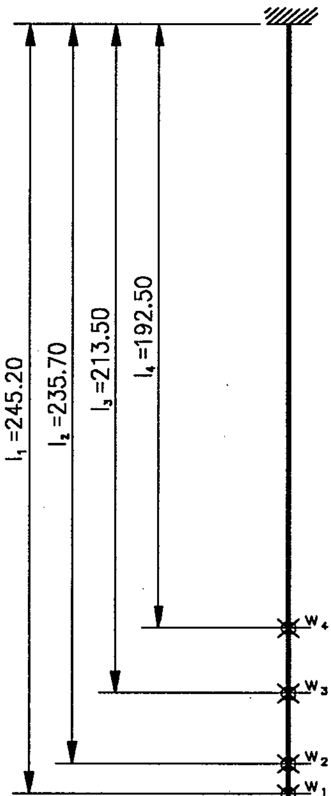
DESIGN ANALYSIS

Client: NHC
Subject: Structural Analysis of Safety Related Equipment Attachments.
Location: AY- Farm & C- Farm

WO/Job No.: ER4319/W320
Date: 2/10/1997 By: MB Lasota
Checked: 2/12/97 By:
Revised: By:

Evaluation of the connection between the Camera Assembly and modified flange of 12" Riser.

For an evaluation of the bolted flange of the Riser, reactions at the fixed end of Camera Assembly is required. The following is a determination of the magnitude of the reaction.



MATH MODEL OF THE MAST COLOR VIDEO SYSTEM

From the vendor calculations, the following are parameters used for evaluation of the mast:

$g_h := 0.63 \qquad i := 1..4$

$w_1 := 33.4 \cdot lbf$

$w_2 := 46.0 \cdot lbf$

$w_3 := 128.3 \cdot lbf$

$w_4 := 20.6 \cdot lbf$

$\gamma_{st} := 490 \cdot pcf \qquad \gamma_w := 62.4 \cdot pcf$

Mast consist of the steel tubing 3.5" OD and 2.9" ID, the weight of the mast is:

$d_o := 3.5 \cdot in \qquad d_i := 2.9 \cdot in$

$w_{mst} := \frac{\pi}{4} \cdot \left(d_o^2 - d_i^2\right) \cdot \gamma_{st} \qquad w_{mst} = 10.26 \cdot plf$

Attached to the mast are 1/2" tube filled with water and cables which estimated weight is 20 lbf.

$d_{ot} := 0.5 \cdot in \qquad d_{it} := (0.5 - 2 \cdot 0.035) \cdot in$

$w_t := \frac{\pi}{4} \cdot \left(d_{ot}^2 - d_{it}^2\right) \cdot \gamma_{st} + \frac{\pi}{4} \cdot d_{it}^2 \cdot \gamma_w \qquad w_t = 0.24 \cdot plf$

$w_c := 20 \cdot lbf$

The combined weight of the shielding plate, upper junction box and flange is:

$w_{upp} := 110 \cdot lbf + 90.9 \cdot lbf \qquad w_{upp} = 200.9 \cdot lbf$

The combined shear and moment at the fixed end of the mast are:

$l_1 := 245.2 \cdot in \qquad l_2 := 235.7 \cdot in \qquad l_3 := 213.5 \cdot in \qquad l_4 := 192.5 \cdot in$

$V_{upp} := w_{upp} \cdot g_h \qquad V_l := \left[\left(w_{mst} + w_t + \frac{w_c}{l_1}\right) \cdot l_1 + \sum_i w_i\right] \cdot g_h$

$V := V_{upp} + V_l \qquad V = 418.2 \cdot lbf$

FLUOR DANIEL NORTHWEST INC. **DESIGN ANALYSIS**

Client: NHC
Subject: Structural Analysis of Safety Related Equipment Attachments.
Location: AY- Farm & C- Farm

WO/Job No.: ER4319/W320
Date: 2/10/1997 By: MB Lasota
Checked: 2/12/97 By:
Revised: By:

$$M := \left[\sum_i w_i \cdot l_i + \left(w_{mst} + w_t + \frac{w_c}{l_1}\right)\cdot\frac{(l_1)^2}{2}\right]\cdot g_h \qquad M = 49.86\cdot in\cdot kips$$

$$M_4 := \left[\sum_i w_i\cdot(l_i - l_4) + \left(w_{mst} + w_t + \frac{w_c}{l_1}\right)\cdot\frac{(l_1 - l_4)^2}{2}\right]\cdot g_h \qquad M_4 = 4.9\cdot in\cdot kips$$

$$V_4 := \left[\sum_i w_i + \left(w_{mst} + w_t + \frac{w_c}{l_1}\right)\cdot(l_1 - l_4)\right]\cdot g_h \qquad V_4 = 175.6\cdot lbf$$

Check deflection of the mast at the lower junction box.

Actual bending moment as a function of a variable in vertical direction (y) is:

$$M_\alpha(y) := M_4 + V_4\cdot y + \left(w_{mst} + w_t + \frac{w_c}{l_1}\right)\cdot\frac{y^2}{2} \qquad M_\alpha(0\cdot ft) = 4.9\cdot in\cdot kips \qquad M_\alpha(l_4) = 56.42\cdot in\cdot kips$$

and virtual moment as a function of y is:

$$m_\alpha(y) := y$$

Sectional properties of the mast are:

$$I := \frac{\pi}{64}\cdot\left(d_o^{\,4} - d_i^{\,4}\right) \qquad I = 3.89\cdot in^4 \qquad E_s := 29000\cdot ksi$$

Deflection at the lower junction box is: $l_4 = 192.5\cdot in$

$$\delta_{ljb} := \frac{g_h}{E_s\cdot I}\cdot\int_{0\cdot in}^{192.5\cdot in} M_\alpha(y)\cdot m_\alpha(y)\,dy \qquad \delta_{ljb} = 3.75\cdot in$$

Above found deflection is in excess of the gap provided at the lower junction box. As a consequence the junction box will travel to close provided gap and will impose a reaction at the Riser. Let the reaction be x.

The gap provided is:

$$\Delta_{min} := 0.64\cdot in \qquad \Delta_{max} := 1.096\cdot in$$

$$Q := \frac{g_h}{E_s\cdot I}\cdot\int_{0\cdot in}^{192.5\cdot in} m_\alpha(y)^2\,dy \qquad Q = 0.0133\cdot\frac{in}{lbf}$$

$\delta_{ljb}(x) = Q\cdot x - \left(\delta_{ljb} + \Delta_{min}\right)$ let $\delta_{ljb}(x) = 0\cdot in$ thus

$$x_1 := \frac{\delta_{ljb} - \Delta_{min}}{Q} \qquad x_1 = 234.5\cdot lbf$$

, Similarily, for max gap:

$$x_2 := \frac{\delta_{ljb} - \Delta_{max}}{Q} \qquad x_2 = 200.2\cdot lbf$$

Adjusted reaction at the flange when the minimum gap is closed is:

$V_1 := (V_{upp} + V_l) - x_1$ $\qquad V_1 = 183.6 \cdot lbf$

$M_1 := \left[\sum_i w_i \cdot l_i + \left(w_{mst} + w_t + \frac{w_c}{l_1}\right) \cdot \frac{(l_1)^2}{2}\right] \cdot g_h - x_1 \cdot l_4$ $\qquad M_1 = 4.71 \cdot in \cdot kips$

Adjusted reaction at the flange when the maximum gap is closed is:

$V_2 := (V_{upp} + V_l) - x_2$ $\qquad V_2 = 218 \cdot lbf$

$M_2 := \left[\sum_i w_i \cdot l_i + \left(w_{mst} + w_t + \frac{w_c}{l_1}\right) \cdot \frac{(l_1)^2}{2}\right] \cdot g_h - x_2 \cdot l_4$ $\qquad M_2 = 11.33 \cdot in \cdot kips$

Since the Web Protrusions, when subjected to the load other than radial will exhibit relatively low stiffness due to plate bending, the reactions at the upper flange will be taken as the envelope of all boundary conditions considered.

$V = 418 \cdot lbf$ $\qquad V_1 = 184 \cdot lbf$ $\qquad V_2 = 218 \cdot lbf$

$M = 50 \cdot in \cdot kips$ $\qquad M_1 = 5 \cdot in \cdot kips$ $\qquad M_2 = 11 \cdot in \cdot kips$

Properties of the bolted flange connection.
Assume the critical axia to be rotated 45 degrees from E-W direction. Sectional properties of the bolt group is calculated as follows:

$\kappa := 1, 2 .. 12$

$\phi_o := 30 \cdot deg$

$\phi_\kappa := (\kappa - 1) \cdot \phi_o$

$A_b := 0.462 \cdot in^2$

Determine location of the center of gravity of the bolt group:

$r_b := 8.5 \cdot in$

$x_\kappa := r_b \cdot \cos(\phi_\kappa)$ $\qquad y_\kappa := r_b \cdot \sin(\phi_\kappa)$

$Q_x := \sum_\kappa A_b \cdot y_\kappa - A_b \cdot (y_8 + y_9 + y_{11} + y_{12})$ $\qquad Q_x = 10.73 \cdot in^3$

$Q_y := \sum_\kappa A_b \cdot x_\kappa - A_b \cdot (x_8 + x_9 + x_{11} + x_{12})$ $\qquad Q_y = 0 \cdot in^3$

$A_z := 8 \cdot A_b$ $\qquad A_z = 3.7 \cdot in^2$

$$x_o := \frac{Q_y}{A_z} \qquad x_o = 0 \cdot in$$

$$y_o := \frac{Q_x}{A_z} \qquad y_o = 2.9 \cdot in$$

$$I_x := \sum_{\kappa} A_b \cdot (y_\kappa - y_o)^2 - A_b \cdot \left[(y_8 - y_o)^2 + (y_9 - y_o)^2 + (y_{11} - y_o)^2 + (y_{12} - y_o)^2\right] \qquad I_x = 102.37 \cdot in^4$$

$$I_y := \sum_{\kappa} A_b \cdot (x_\kappa - x_o)^2 - A_b \cdot \left[(x_8 - x_o)^2 + (x_9 - x_o)^2 + (x_{11} - x_o)^2 + (x_{12} - x_o)^2\right] \qquad I_y = 133.52 \cdot in^4$$

Conservatively, ignoring the gravity loads the forces in critical bolt (10) are:

$$T_b := \frac{M \cdot (|y_{10}| + y_o)}{I_x} \cdot A_b \qquad T_b = 2566 \cdot lbf$$

$$V_b := \frac{V}{A_z} \cdot A_b \qquad V_b = 52 \cdot lbf$$

Check tension in the anchor (1), when earthquake direction is in North-East direction:

$$T_b := \frac{M \cdot |x_1 + x_o|}{I_y} \cdot A_b \qquad T_b = 1466 \cdot lbf$$

As shown, the assumption that the bolt 10 is critical holds true.

The magnitude of the maximum forces in 7/8 inch diameter bolt is a fraction of its capacity (ASTM A-307 Gr B bolt T_{all}=12 kips, and V_{all}=6 kips), it is therefore safe to conclude, that the connection will perform satisfactory during postulated earthquake.

Fluor Daniel Northwest

Calc. No. W-320-24-027
Revision 3
Page No. 21 of -

DESIGN ANALYSIS

Client Numatec
Subject Structural Analysis for Safety Related Equipment Attachments
Location AY-Farm & C-Farm

WO/Job No. W-320
Date 12/29/97 By A.S. Langevin ASL
Checked 1/7/98 By Michael R Curtis
Revised By

C-105 Air Breather Filter

Analyze the C-105 Air breather filter support.

This equipment is added by ECN W-320-691

Equipment is Safety Class per HNF-1559 Rev 2 and HNF-SD-WM-SEL-040 Rev 0 (references 10 & 11).

A description of the SC class components is provided in the TWRS SEL (reference 11) which shows the supports to be GS. Design the supports for SC load criteria but otherwise as GS. (conservative)

Use load criteria from SDC 4.1 Rev 12 (reference 13) in accordance with the latest revision of the FDC, Rev 4 (reference 12).

Client Numatec		WO/Job No. W-320	
Subject Structural Analysis for Safety Related Equip. Attach.		Date 1/5/98	By Ann Langevin
		Checked 1/7/98	By Michael R. Critten
Location AY-Farm & C-Farm		Revised	By

Evaluate air-breather filter support

Dead load

Housing (includes filter and valve) = 150 lb per D. Evan

Frame:

2" pipe $[(2\times2')+(4\times5')+(4\times0.5')]\ 3.65\ lb/ft = 95\ lb$

3/8" bar $[(2\times2.75')+(2\times2')]\ 2.55\ lb/ft = 25\ lb$

TOTAL = 270 lb

TOTAL FRAME = 120 lb

Seismic: Use equivalent static as per Ref 3

Use Seismic for Non-Reactor SC II per figure. 3 of Ref 13.

Peak accel at 5% damping = 0.42 H

$2/3(0.42) = 0.28\ V$

Housing $E_{h1} = 1.5(0.42)(150\ lb) = 95\ lb$

Frame $E_{h2} = 1.5(0.42)(120\ lb) = 76\ lb$

Housing & Frame $E_V = 1.5(0.28)(270) = 113\ lb.$

FLUOR DANIEL NORTHWEST, INC.

Calc. No. W320-24-027
Revision 3
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DESIGN ANALYSIS

Client Numatec
WO/Job No. W-320
Subject Structural Analysis for Safety Related Equipment Attach.
Date 1/5/98 By [signature]
Checked 1/7/98 By Michael R Custer
Location AY-farm & C-farm
Revised By

Wind: - use ref 8. ASCE-7 - use latest edition (1995) and Table in paragraph 3.2.1 of Ref 13.

$$q_z = 0.00256\, K_z\, K_{zt}\, V^2 I \qquad (\text{Eq. } 6\text{-}1)$$

$$= 0.00256\underbrace{(0.85)}_{\text{Table 6-3}}(1.0)(80)^2(1.0)$$

$$= 14 \text{ psf}$$

$$F = q_z\, G\, C_f\, A_f$$

$$= 14\underbrace{(0.85)}_{6.6.1}\underbrace{(1.2)}_{\text{Table 6-8 for solid signs}}(2' \times 2') = 57 \text{ lb}$$

Housing Wind = 57 lb

∴ Seismic Controls.

Seismic loads are very small and the frame is very stiff and heavy.
Frame OK by inspection

Look at anchorage.

BD-6002-142 (12/96)

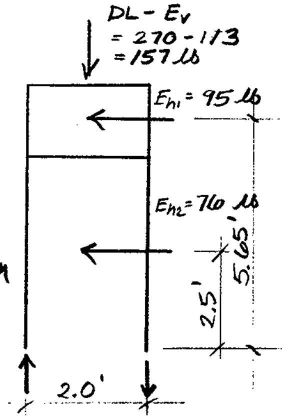
FLUOR DANIEL NORTHWEST, INC.

DESIGN ANALYSIS

Calc. No. W320-24-027
Revision 3
Page No. 24 of —

Client Numatec		WO/Job No. W-320	
Subject Structural Analysis for Safety Related Equipment Attach.		Date 1/5/98	By Ann Shangewin
		Checked 1/7/98	By Michael R Custer
Location AY-Farm & C-Farm		Revised	By

Anchorage



$$T_1 = \frac{(95\ lb)(5.65') + (76\ lb)(2.5')}{(2.0')(2\ legs)}$$

$$= 182\ lb/leg.$$

T_2 due to seismic in orthagonal direction

$$T_2 = 182\left(\frac{2.0}{2.75}\right) = 132\ lb/leg$$

$$T_{resultant} = \sqrt{(182)^2 + (132)^2} - \frac{157\ lb}{4\ leg}$$

$$T_{resultant} = 186\ lb/leg = 46\ lb/bolt$$

$$V_{resultant} = \sqrt{2}\left(\frac{95 + 76}{4\ legs}\right) = 42\ lb/leg = 11\ lb/bolt$$

Per Ref. 1, Table 23, for Hilti KB II 3/8" w/ 1 5/8" emb:

$$\left.\begin{array}{l} T_a = 690\ lb >> 46\ lb \\ V_a = 1240\ lb >> 11\ lb \end{array}\right\} \therefore \text{Hiltis OK}$$

Slab

$$(3.5')(4')(6/12)(150\ lb/ft^3) = 1050\ lb$$

Slab is much heavier than equipment itself and loads on equipment legs are small
Check overturning - see page 27
Punching OK

Use reinforcement per the standard detail
WWF 6x6 - W2.9 x W2.9

Plus add (4) #4 bars x 3'-0" long around riser

FLUOR DANIEL NORTHWEST, INC.

DESIGN ANALYSIS

Calc. No. W320-24-027
Revision 3
Page No. 25 of —

Client Numatec
WO/Job No. W-320
Subject Structural Analysis for Safety Related Equipment Attach.
Date 1/5/98 By [signature]
Checked 1/7/98 By Michael R Custer
Location AY-Farm & AZ Farm
Revised By

Existing Riser: frame will take most lateral load however, the exist riser may take some of the seismic load - Look at potential additional stresses by conservatively assuming all lateral loads are taken by riser.

Moment at base due to Housing & Frame

$M = (95\ lb)(5.65) + (76\ lb)(2.5') = 727\ ft\text{-}lb$
Say 800 ft-lb

Riser is 12" ϕ sch 40 pipe to 14" above grade. with 12" ϕ 14 ga sheet metal above that.

- 12" ϕ Sch 40: $f_b = \frac{M}{S} = \frac{800\ ft\text{-}lb(12)}{43.8} = 219\ psi$

$\frac{f_b}{F_b} = \frac{0.219}{0.60(35 ksi)} = 0.010$ — approx 1% increase in stress.

- At 1.2' above base (14 ga sheet metal)

$M = (95\ lb)(4.45) + (76\ lb)(1.3') = 521\ ft\text{-}lb.$

$S_{14 ga.} = \pi R^2 t = \pi (6")^2 (0.0785") = 8.88\ in^3$

$f_b = \frac{521(12)}{8.88} = 704\ psi$

$\frac{f_b}{F_b} = \frac{0.704}{0.60(38 ksi)} = 0.03$ — 3% stress increase
∴ negligible impact on riser.

BD-6002-142 (12/96)

FLUOR DANIEL NORTHWEST, INC.

Calc. No. W-320-24-02
Revision 3
Page No. 26 of —

DESIGN ANALYSIS

Client Numatec
WO/Job No. W-320
Subject Structural Analysis for Safety Related Equipment Attachments
Date 1/5/98 By [signature]
Checked 1/7/98 By [signature]
Location
Revised By

DOME LOAD

Look at additional weight added by air breather filter support and pad.
(A dome load report was not prepared by this project for tank 241-C-105)

Housing	=	150 lbs
Frame	=	120
Concrete	=	1050
Concrete Void at riser $\pi(0.5')^2(6/12)(150)$	=	-59

TOTAL ADDED WEIGHT = 1261 lb.

Per OSD (Reference #14) the allowable live load limit is 200,000 lb — The weight of this equipment is negligible in comparison

FLUOR DANIEL NORTHWEST, INC.

Calc. No. W320-24-027
Revision 3
Page No. 27 of –

DESIGN ANALYSIS

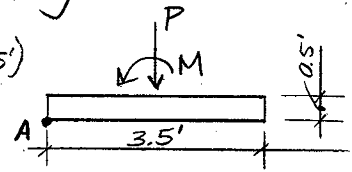
Client Numatec	WO/Job No. W320		
Subject Structural Analysis for Safety Related Equipment Attach	Date 1/6/98	By	
	Checked 1/7/98	By	
Location AY-Farm & C-Farm	Revised	By	

Slab - Check for overturning

$M = 95\,lb\,(5.65' + 0.5') + 76\,lb\,(2.5' + 0.5')$

$M = 812\ lb\text{-}ft$

$P = 157 + 1050 = 1207\ lb$

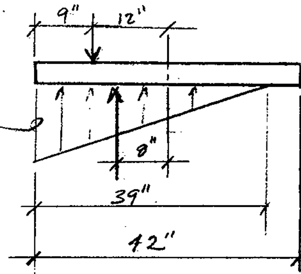


Overturning about pt. A: $SF = \dfrac{(0.85P)\left(\frac{3.5'}{2}\right)}{M} = \dfrac{(0.85)(1207)\left(\frac{3.5'}{2}\right)}{812\ lb\text{-}ft}$

$SF = 2.2 > 1.5$
OK

$e = \dfrac{M}{P} = \dfrac{812}{1207} = 0.67' = 8''$ $\quad (0.67)(6) = 4'$

resultant is slightly outside of middle third of slab. - OK



Check slab bending

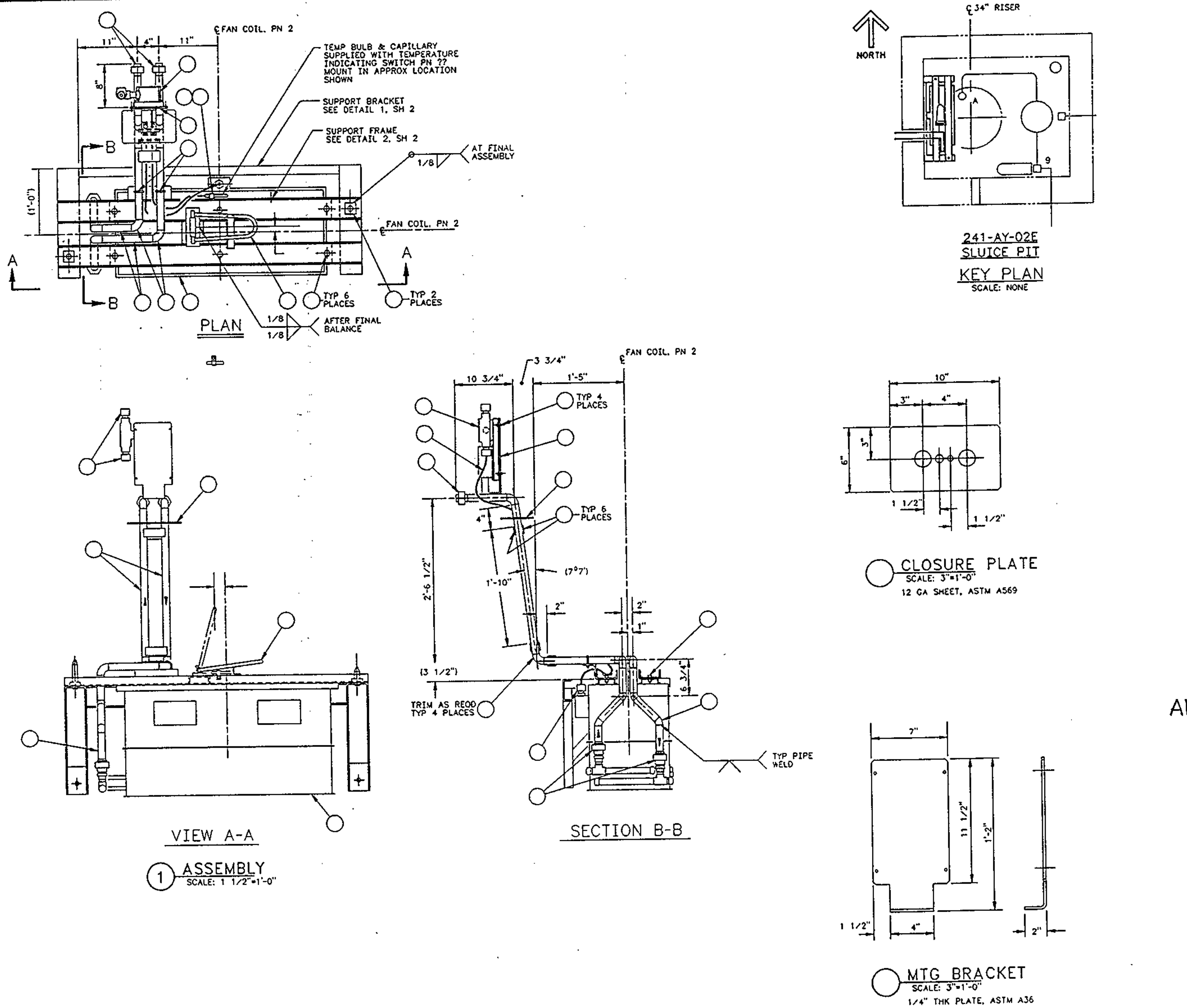
p_{max}

$p_{max} = \dfrac{2(P)}{(39/12)(4')} = 186\ psf$
soil pressure small

Apply p_{max} to slab span between support legs

$M = \dfrac{wl^2}{8} = \dfrac{186\ lb/ft\,(2')^2}{8} = 93\ ft\text{-}lb$ very small moment
WWF reinf OK

BD-6002-142 (12/96)



PARTS/MATERIAL LIST

QTY REQD	PART/DASH NUMBER	NOMENCLATURE/DESCRIPTION	MATERIAL/REFERENCE	SHEET	ITEM NO.
X	-010	ASSEMBLY			1
					2
					3
					4
					5
					6
					7
					8
					9

ALL Channels shown are C 4 X 5.4

W320-24-027
REV. 0
Pg. A-1

PRELIMINARY

DESIGNED D. PECK
SAFETY SEE DR/AT FORM
ENVIR SEE DR/AT FORM
QUAL ENG SEE DR/AT FORM
SAFETY CLASS 3

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
ICF KAISER HANFORD COMPANY

PIPING
PIT COOLING
FAN COIL ASSEMBLY

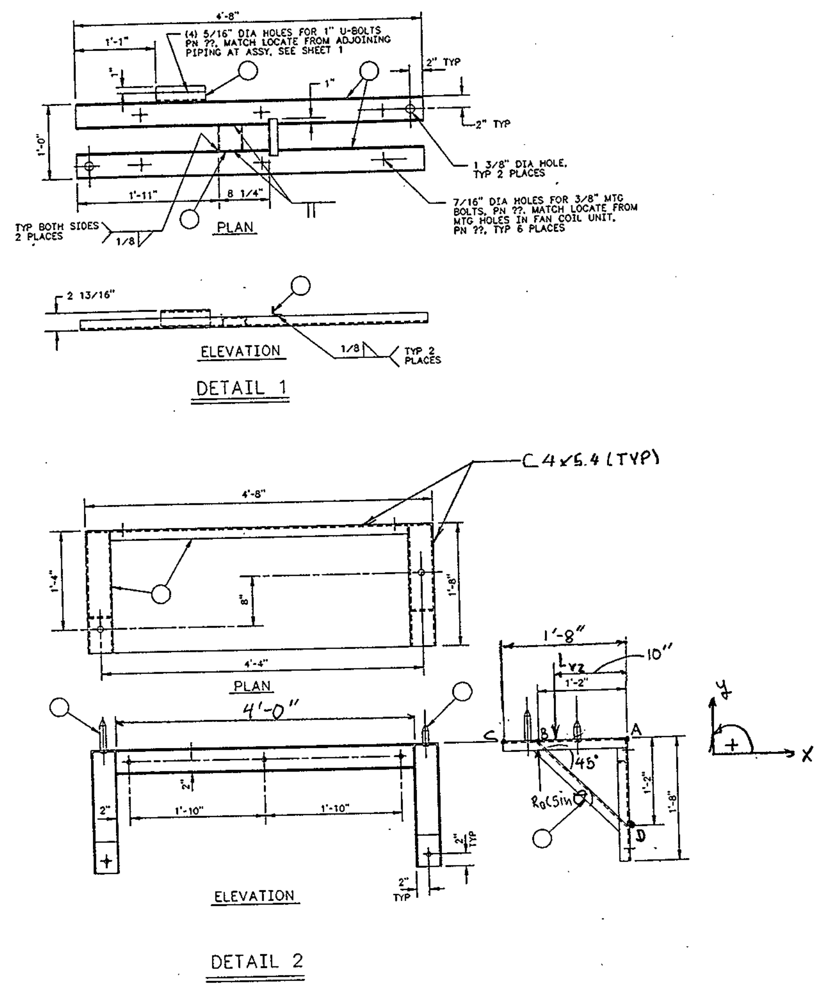
W320 TANK 241-C-106 SLUICING

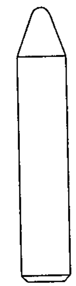
F | H-2-818499 | 0

SCALE: SHOWN | ER4319 | SHEET 1 OF 2

8818499A | 2J:IBM-ACD2-12.0:NN

W32D-24-027
REV: 0
Pg. A-2





• 1/4" Fillet Welds
• C 4 x 5.4 Channels
• 3/8" Ø HKB II

PRELIMINARY

U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
ICF KAISER HANFORD COMPANY

SEE DR/AT FORM
SEE DR/AT FORM
SEE DR/AT FORM

F | ? | 0
SHOWN | SHEET 1 OF 1
WHC
8818499B | 2J:IBM-ACD2:12.0:NN
PLOT SCALE: 1=8 | KEMCAD

Nutherm INTERNATIONAL, INC. Mt Vernon, IL 62864 (618) 244-6000	HNF-2468, Rev.0 **Calculation Cover Sheet** Page 1 of 8

Calculation No. 7455-03 Group Eng.

Subject: Determination of Foundations Loads of Seismic Shutdown Systems.

_____ Computer Output Listing(s) on file X No Computer Output Listing

Revision No.	Description	Originator/Date	Checker/Date	Approved/Date
0	Initial Issue	12/4/95	N/A	12/4/95

Abstract:

Objective: This calculation was performed to determine the foundation loads of the Seismic Shutdown Systems identified in reference no.1.

References:
1. Westinghouse Hanford Company Specification No. W-320-P35, Rev. 0.
2. IEEE Standard 344-1987.
3. Nutherm Calculation Nos. 7455-01CG & 7455-02CG, "Center of Gravity of the Seismic Shutdown System Cabinets"

FL 239 56591-13-1

Calculation Details

Procedure: In accordance with Reference 1 the foundation loads shall be calculated for the Seismic Shutdown Systems. The calculations are performed individually for shutdown systems AY-SSS-1A & AY-SSS-1B. System C-SSS-1A & C-SSS-1B are identical to the above analyzed systems. The configuration, dimensions, and symbols of the shutdown system are shown on page 4 of this calculation.

The dimensions and weights of the equipment are presented on page 5 of this calculation. The center of gravity locations are extracted from Reference 3.

The operability loads and nozzle loads are not applicable to the equipment analyzed.

The foundation loads are determined for two load conditions:

1. Dead weight loads (which would include normal operating conditions);
2. Dynamic loads, SSE conditions.

The foundation loads for the SSE condition was determined by implementation of static coefficient analysis, as described in paragraph 6.3 of reference 2.

The peak acceleration levels of the RRS' are presented on page 6 of this calculation. They were derived from a composite of the RRS provided in Appendix "A" of specification W-320-P35. The RRS' for the following damping value was used:

SSE condition - 5%

A static coefficient of 1.5 is used to take into account the effects of both multifrequency excitation and multi-mode response.

The orientation of the shutdown systems in the nuclear power plant is unknown. Therefore, the highest horizontal acceleration level is used in the calculation for both horizontal directions.

Calculation Details

The base of the shutdown system is bolted to the foundations with symmetrically spaced bolts. That is why the centroid of the foundation bolts is located in the center of the base. The foundation loads were calculated using the following equations:

Dead Weight Loads

$$F_x = 0;\ F_y = W;\ F_z = 0$$

Dead Weight Moments

$$M_x = F_y\left|\frac{B}{2} - b\right|;\ M_y = 0;\ M_z = F_y\left|\frac{L}{2} - \ell\right|$$

$$= W\left|\frac{B}{2} - b\right|;\ M_y = 0;\ M_z = W\left|\frac{L}{2} - \ell\right|$$

Dynamic Loads

$$F_{xd} = 1.5\ H_a \times W;\ F_{yd} = 1.5V_a \times W;\ F_{zd} = 1.5H_a \times W;$$

Dynamic Moments

$$M_x = F_{zd} \times h + F_{yd}\left|\frac{B}{2} - b\right|$$

$$= 1.5\ W\left[H_a \times h + V_a\left|\frac{B}{2} - b\right|\right]$$

$$M_y = F_{xd}\left|\frac{B}{2} - b\right| + F_{zd}\left|\frac{L}{2} - \ell\right|$$

$$= 1.5\ W\ H_a\left[\left|\frac{B}{2} - b\right| + \left|\frac{L}{2} - \ell\right|\right]$$

$$M_z = F_{xd} \times h + F_{yd}\left|\frac{L}{2} - \ell\right|$$

$$= 1.5\ W\left[H_a \times h + V_a\left|\frac{L}{2} - \ell\right|\right]$$

where:

W = weight, see page 5;
H_a = horizontal acceleration, see page 6;
V = vertical acceleration, see page 6;
L, B, H = seismic shutdown system dimensions, see pages 4 & 5;
ℓ, b, h = center of gravity location, see pages 4 & 5;
1.5 = static coefficient, ref. 2

The results of foundation load calculation are presented on pages 7 & 8.

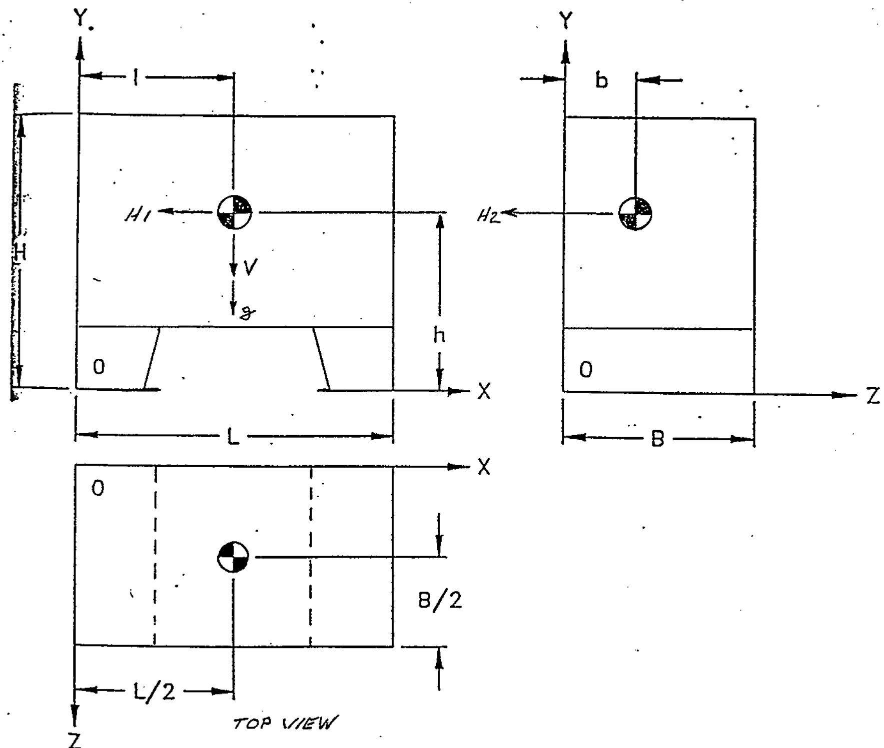
Nutherm INTERNATIONAL, INC.
Vernon, IL 62864 (618) 244-6000

Calculation Continuation Sheet

Calculation No. 7455-03

Rev. No.	0															

Calculation Details



SYMBOLS:

- CENTER OF GRAVITY
- CENTROID OF THE FOUNDATION BOLTS

H1 & H2 – HORIZONTAL DYNAMIC ACCELERATIONS

V – VERTICAL DYNAMIC ACCELERATION

g – GRAVITY ACCELERATION

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Vernon, IL 62864 (618) 244-6000

Calculation Continuation Sheet

Calculation No. 7455-03

Rev. No.	0															

Calculation Details

SEISMIC SHUTDOWN SYSTEM
DIMENSIONS, CENTER OF GRAVITY LOCATIONS,
AND WEIGHTS

Equipment Tag No.	Dimensions In.			Center of Gravity Location, In			Weight W, lbs.
	L	B	H	ℓ	b	h	
SSS1A	36	16	60	11.35	6.84	32.06	546.50
SSS1B	36	16	60	17.47	6.31	30.79	413.50

Calculation No. 7455-03

Rev. No.	0															

Calculation Details

PEAK ACCELERATION LEVELS

SSE	
Vertical, g's	Horizontal, g's
V	H_a
0.386	0.58

Note: H_a - acceleration used in calculation for both horizontal directions and includes 10% margin of composite RRS from Appendix A of specification W-320-P35.

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Calculation Continuation Sheet

Calculation No. 7455-03

Rev. No. 0

Calculation Details

FOUNDATION LOAD SUMMARY

Equipment Title: Seismic Shutdown System

Equipment Number: AY-SSS-1A

FOUNDATION LOADS		FORCES (LBS)			MOMENTS (IN-LBS)		
TYPE OF LOADS		F_x	F_y	F_z	M_x	M_y	M_z
DEADWEIGHT LOAD		0	546.5	0	634	0	3634
DYNAMIC LOADS	SSE Conditions	475.4	316.4	475.4	15,606	3,713	17,346

Nutherm INTERNATIONAL, INC. Mt Vernon, IL 62864 (618) 244-6000	HNF-2468, Rev.0 **Calculation Continuation Sheet** Page 8 of 8

Calculation No. 7455-03

Rev. No.	0															

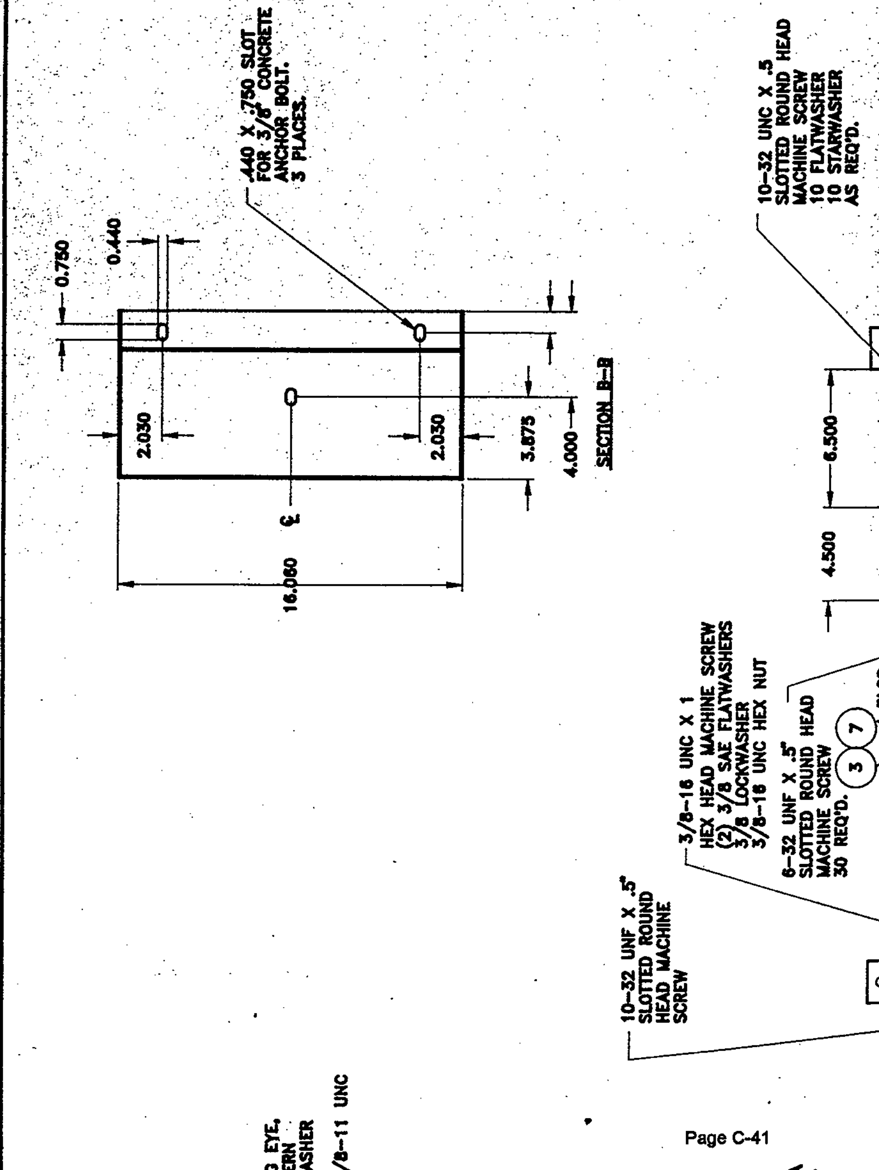
Calculation Details

FOUNDATION LOAD SUMMARY

Equipment Title: Seismic Shutdown System

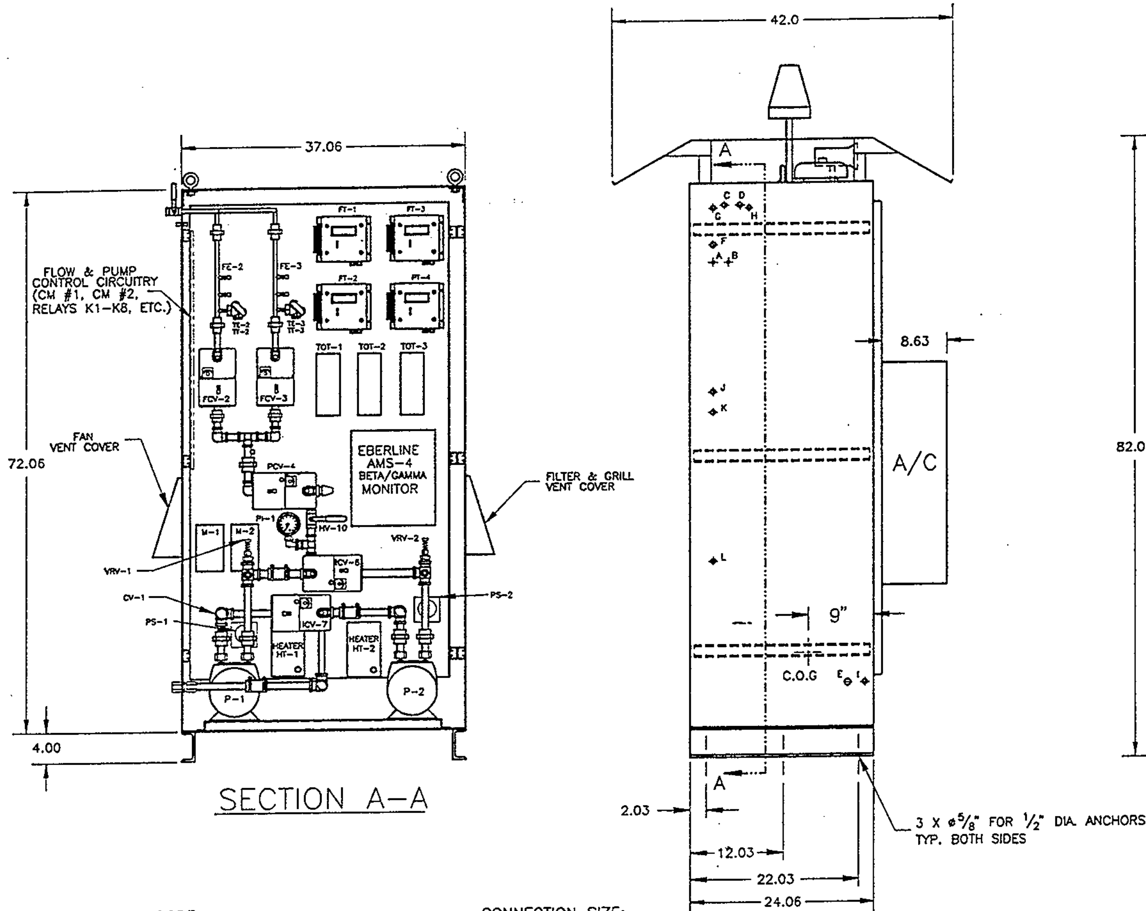
Equipment Number: AY-SSS-1B

FOUNDATION LOADS		FORCES (LBS)			MOMENTS (IN-LBS)		
TYPE OF LOADS		F_x	F_y	F_z	M_x	M_y	M_z
DEADWEIGHT LOAD		0	413.5	0	699	0	219
DYNAMIC LOADS	SSE Conditions	360	239	360	11,482	799	11,202


.440 X .750 SLOT FOR 3/8" CONCRETE ANCHOR BOLT. 3 PLACES.
0.750
0.440
2.030
2.030
3.875
4.000
16.060
SECTION B–B
6.500
4.500
10–32 UNC X .5 SLOTTED ROUND HEAD MACHINE SCREW 10 FLATWASHER 10 STARWASHER AS REQ'D.
3/8–16 UNC X 1 HEX HEAD MACHINE SCREW (2) 3/8 SAE FLATWASHERS 3/8 LOCKWASHER 3/8–16 UNC HEX NUT
6–32 UNF X .5" SLOTTED ROUND HEAD MACHINE SCREW 30 REQ'D.
3
7
10–32 UNF X .5" SLOTTED ROUND HEAD MACHINE SCREW

REV		DESCRIPTION	DATE	DWN	APV
1		SEE DCR # 1214	11/9/95	SFM	
2		SEE DCR # 1233	4/1/96	SFM	

NOTES:
ENCLOSURE IS HOFFMAN A-72H3724FS
TOTAL ENCLOSURE WEIGHT IS APPROXIMATELY 1100 POUNDS



DS-1 = STACK LOW FLOW ALARM
DS-2 = RECORD SAMPLE NON-ISO FLOW ALARM
DS-3 = BETA/GAMMA SAMPLE NON-ISO FLOW ALARM
DS-4 = PUMP #1 FAILURE ALARM
DS-5 = PUMP #2 FAILURE ALARM
DS-6 = CABINET POWER
DS-7 = PUMP #1 ON
DS-8 = PUMP #2 ON
DS-9 = RADIATION DETECTOR FAILURE ALARM

SW-5 = PUMP #1 LEAD/LAG

PB-1 = PUMP START/STOP
PB-2 = PUMP FAILURE ALARM RESET
PB-3 = FAILURE ALARM ACKNOWLEDGE
PB-4 = HIGH RADIATION ALARM ACKNOWLEDGE
PB-5 = RAD. MON. CALIBRATION IN PROGRESS

FRONT OF CABINET

ATTACHMENT 4
CALC. W-320-027, REV. 1
PAGE 1 OF 2

CONNECTION CODE:	CONNECTION SIZE:
A. STACK STATIC PRESSURE LINE	1/4" COMPRESSION
B. STACK TOTAL PRESSURE LINE	1/4" COMPRESSION
C. STACK RECORD SAMPLE LINE	1/2" FPT
D. STACK BETA/GAMMA MONITOR SAMPLE LINE	1/2" FPT
E. STACK RETURN EXHAUST LINE	1" COMPRESSION
F. STACK RTD & BETA/GAMMA MONITOR SIGNAL	1-1/4" CONDUIT
G. RECORD SAMPLE HEAT TRACE	3/4" CONDUIT
H. BETA/GAMMA SAMPLE HEAT TRACE	3/4" CONDUIT
I. SAMPLE RETURN LINE HEAT TRACE	3/4" CONDUIT
J. POWER TO RECORD SAMPLE CABINET	1/2" CONDUIT
K. POWER TO BETA/GAMMA CABINET	1/2" CONDUIT
L. INCOMING POWER FROM CUSTOMER	3/4" CONDUIT

PROJECT:
PROJECT W-320-P41
WESTINGHOUSE HANFORD CO.
RICHLAND, WA
AMC W.O. 25255
P.O. 80166

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES, TOLERANCES ARE:
PER Q.A. PROCEDURE # 26

DRAWN BY:	S. MINAKER	DATE: 8/21/95
DESIGN BY:	S. Minaker	DATE: 9/6/95
DESIGN VERIF:	P. Dave	DATE: 9/6/95
QA REVIEW BY:	D. Sitzle	DATE: 9/6/95
APPROVED BY:	D. DeBaun	DATE: 9/7/95

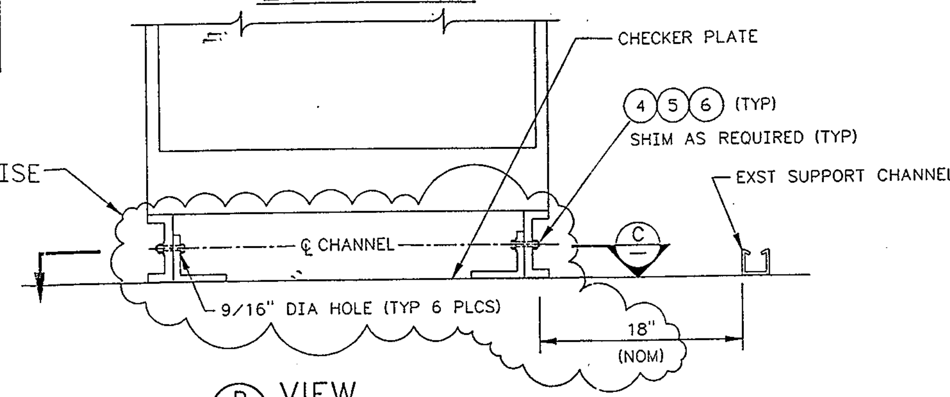
AIR MONITOR CORPORATION
P.O. BOX 6358 SANTA ROSA CA 95406
TELEPHONE (707) 544-2706

INSTRUMENT & CONTROL CABINET GENERAL ARRANGEMENT

CAD PLOT 04/02/96 10:05:26 | FORMAT B | DWG NO. W25255BA | REV 2
SCALE FACTOR: 17.00 | SCALE: 1:17.00 | DO NOT SCALE DRAWING

ICF KAISER HANFORD			ENGINEERING CHANGE NOTICE SKETCH			
Ref Dwg	Sh	Rev	Prepared By	Checked By	ECN No	Page
H-2-818585	1	0	SM DUNHAM	[signature]	W-320-365	3

ZONE B-7/8



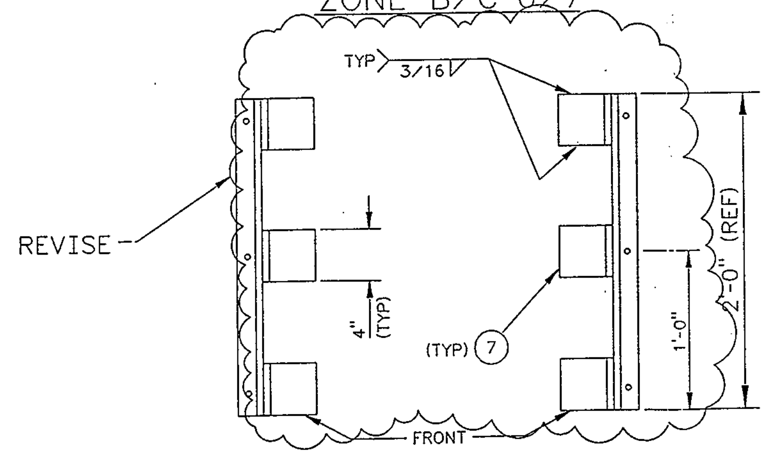
B VIEW

ZONE F-1/2

		MATERIAL LIST	
QTY.	P/N	DESCRIPTION	MATERIAL/REF
AR	1	TUBING, 1/4" ODT X 0.035" WALL, SST	SPECIFICATION W-320-C5 SEC 13440
AR	2	TUBING, 1/2" ODT X 0.049" WALL, SST	SPECIFICATION W-320-C5 SEC 13440
AR	3	TUBING, 1" ODT X 0.065" WALL, SST	SPECIFICATION W-320-C5 SEC 13440
6	4	HEX HEAD CAP SCREW, 1/2"-13UNC-2A X 1-1/2" L	ASTM A307-92A
6	5	NUT, 1/2"-13 UNC-2B	ASTM A194 GR 2
6	6	WASHER, 1/2"	ASTM F-463 TYPE 3
6	7	ANGLE, 3" X 3" X 1/4" X 0'-4"	ASTM A36

REVISE
REVISE

ZONE B/C-6/7



C VIEW

ATTACMENT 4
CALC. W-320-027, REV. 1
PAGE 2 OF 2

CAD FILE:

PLOT SCALE: 1=1

W320-24-028

Engineering Evaluation of
Commercial Grade Items

KAISER ENGINEERS HANFORD	CALCULATION IDENTIFICATION AND INDEX	Page i of i Date 8-1-95

This sheet shows the status and description of the attached Design Analysis sheets.

Discipline Civil/Structural WO/Job No. ER4319 Calculation No. W320-24-028

Project No. & Name W-320, Tank 241-C-106 Sluicing

Calculation Item Engineering Evaluation of Commercial Grade Items

These calculations apply to:

Dwg. No. NA Rev. No. NA

Dwg. No. Rev. No.

Other (Study, CDR) Rev. No.

The status of these calculations is:

[] Preliminary Calculations

[X] Final Calculations

[] Check Calculations (On Calculation Dated)

[] Void Calculation (Reason Voided)

Incorporated in Final Drawings? [X] Yes [] No

This calculation verified by independent "check" calculations? [] Yes [X] No

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	RW Davidson 8/1/95	ALangevin 4/7/98	
Checked by	NA	NA	
Approved by	[signature] 8/8/95	ALangevin 4/7/98	
Checked Against Approved Vendor Data		NA	

INDEX

Design Analysis Page No.	Description
1-2	ACME Pre-Approved Mix Design No. 6452
3	Deformed Steel Bars for Concrete Reinforcement, ASTM A 615
4	Rolled Steel Shapes, Plates, Bars, ASTM A 36
5	Steel Pipe, ASTM A 53
6-7	Nelson Weld Stud Anchors, Type H4L
8-9	Nonshrink Epoxy Grout, ASTM C 827
1	Revised p. 9

KEH 0378.00 (06/92) KEF072

KAISER ENGINEERS HANFORD	Calc. No. W320-24-028
	Revision 0
DESIGN ANALYSIS	Page No. 1 of
Client WHC	WO/Job No. ER4319/W320
Subject Engineering Evaluation of Commercial Grade Items	Date 8-1-95 By RW Davidson
	Checked By NA
Location 200E, Tank 241-C-106 Sluicing	Revised By

Commercial Grade Item: ACME Pre-Approved Mix Design No. 6452

1. What is the function that the concrete must perform to enable the safety class 1 system to perform its safety or critical function.

   a. The concrete forming the cover blocks must provide an impervious barrier to mitigate the release of a spray leak to the outside environment during Sluicing activities only. Note: Enviromental/seismic qualification must satisfy only a safety class 3 over 1 function to insure structural integrity of concrete cover blocks and pits is maintained when Sluicing activities are not taking place.

2. What characteristics of the concrete are critical to the performance of its critical function.

   a. Tension, compression and/or shear failure due to self weight and applied normal operating loads during Sluicing.

   b. Propagation of shrinkage cracks due to low water/cement (W/C) ratio.

   c. Void spaces or segregation within a concrete pour due to viscosity of concrete mix.

3. What characteristics does the item have which are critical to the predictability of its performance? (Critical characteristics are identifiable and/or measurable attributes of a part/item which provides assurance that the part/item will perform as predicted.)

   a. Tension, compression and shear strengths are all a function of the compressive strength of the concrete at 28 days after batching.

   b. Compressive strength, W/C ratio and the concrete mix viscosity are all a function of the reliability of the mix proportion data.

4. What type of acceptance testing, when required, (load tests, Brinell hardness tests, nondestructive examination (NDE) tests, destructive physical tests, etc.) is required to be performed by KEH to provide confidence that the part/item has the necessary critical characteristics?

   a. Perform an evaluation of the concrete mix proportions in accordance with ACI 349, Sections 4.2 and 4.3 for the specified class of concrete.

   b. Perform an evaluation of the concrete mix ingredients to insure compliance with specifications and applicable codes and standards. The following is a list of concrete mix ingredients to be evaluated:

      - ~~Cement in accordance with ASTM C 150, Type II~~

KAISER ENGINEERS
HANFORD

DESIGN ANALYSIS

Calc. No. W320-24-028
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Subject Engineering Evaluation of Commercial Grade Items	Date 8-1-95	By RW Davidson
	Checked	By NA
Location 200E, Tank 241-C-106 Sluicing	Revised	By

Commercial Grade Item: ACME Pre-Approved Mix Design No. 6452.... Cont'd

- Fly Ash in accordance with ASTM C 618, Class F. Amount of fly ash shall be 25% ± 1% by weight of cement.
- Aggregates in accordance with ASTM C 33 , maximum size of course aggregate 3/4".
- Air Entraining Admixture in accordance with ASTM C 260, no chloride added during manufacture.
- Water Reducing Admixture in accordance with ASTM C 494, Type D, no chloride added during manufacture.

c. Perform an evaluation of the concrete mix properties to insure compliance with specifications and applicable codes and standards. The following is a list of concrete mix properties to be evaluated:

- Slump 4" ± 1"
- Air Content 5% ± 1%

d. Perform the following test procedures on the concrete mix at the time of placement in the field. Each test procedure shall be performed a minimum of one time for each pour or one time for each 100 yards delivered for a pour, whichever is greater.

- Slump test in accordance with ASTM C 143, 4" ± 1".
- Air Content test in accordance with ASTM C 173 5% ± 1%.
- Obtain concrete test cylinders in accordance with ASTM C 31for determination of concrete compressive strength in accordance with ASTM C 39, $f'_c \geq 4000$ psi.

5. What manufacturing controls are required, if any, in addition to receipt inspection and/or acceptance testing (such as KEH witnessing test, KEH shop inspection, etc.)?

a. The Concrete Testing Agency(s) performing tests during development and field placement of the concrete mix shall be evaluated in accordance with ASTM E 329.

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Client WHC	WO/Job No. ER4319/W320	
Subject Engineering Evaluation of Commercial Grade Items	Date 8-1-95	By RW Davidson
	Checked	By NA
Location 200E, Tank 241-C-106 Sluicing	Revised	By

COMMERCIAL GRADE ITEM (CGI): Deformed Steel Bars for Concrete Reinforcement (ASTM A 615, Grade 60)

1. What is the function that the rebar must perform to enable the safety class 1 system to perform its critical function.

   a. Provide tensile and shear strength to concrete to resist live, dead loadings during Sluicing activities.

   b. Minimize temperature and shrinkage cracking in concrete at right angles to principal reinforcement.

2. What characteristics does the item have which are critical to the predictability of its performance? (critical characteristics are identifiable and/or measurable attributes of an item which provide assurance that the item will perform as predicted.)

   A. Tension and shear strength of the material is by yield strength of the material.

   B. Physical shape, such as deformation size and spacing.

   C. Weight of the material.

3. What type of acceptance testing, when required, (load tests, Brinnell hardness tests, NDE tests, destructive physical tests, etc.) is required to be performed by KEH to provide confidence that the part/item has the necessary critical characteristics?

   Submit certified test reports (mill test reports) verifying yield strength and chemical composition of rebars in accordance with ASTM A 615, grade 60. The test reports must verify that the material meets the weight, spacing and height of deformations requirements in accordance with ASTM A 615, grade 60.

4. What manufacturing controls are required, if any, in addition to receipt inspection and/or acceptance testing (such as KEH witnessing test, KEH shop inspection, etc.)?

   None

5. Is part/item identifiable to a manufacturer's published product description which meet the critical characteristics?

   A. Product description for deformed steel bars for concrete reinforcing is ASTM A 615, Grade 60. Each bundle of reinforcing rebar with certified test report (at placement) shall be traceable with a permanently marked tag identifying manufacturer and heat numbers from which the product was made.

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Subject Engineering Evaluation of Commercial Grade Items	Date 8-1-95	By RW Davidson
	Checked	By NA
Location 200E, Tank 241-C-106 Sluicing	Revised	By

Commercial Grade Item: Rolled Steel Shapes, Plates, Bars (ASTM A 36)

1. What would cause the part/item to fail (what are the credible failure modes)?

   a. Tension, compression, shear and/or buckling failure due to applied loads.
   b. Tension or shear failure near a weld due to applied loads.
   c. Insufficient material to resist the applied loads.
   d. Incorrect chemical composition.

2. What characteristics does the item have which are critical to the predictability of its performance? (Critical characteristics are identifiable and/or measurable attributes of a part/item which provides assurance that the part/item will perform as predicted.)

   a. Tension, compression, shear and buckling strength of the material is based on the yield strength of the material.
   b. Chemical composition.
   c. The physical dimensions of the shapes or plates.

3. What type of acceptance testing, when required, (load tests, Brinell hardness tests, nondestructive examination (NDE) tests, destructive physical tests, etc.) is required to be performed by KEH to provide confidence that the part/item has the necessary critical characteristics?

   a. Perform a tensile test in accordance with ASTM A 370 to verify the minimum yield strength of the material is greater than 36,000 psi.
   b. Perform a chemical analysis in accordance with ASTM A 751 to verify the material meets the chemical requirements of ASTM A 36 Table 2.
   c. Perform a check of the dimensions to verify the plates or shapes are within permissible variations of ASTM A 6.

4. What manufacturing controls are required, if any, in addition to receipt inspection and/or acceptance testing (such as KEH witnessing test, KEH shop inspection, etc.)?

   None

5. Is part/item identifiable to a manufacturer's published product description which meet the critical characteristics?

   Product description for rolled steel shapes and plates is ASTM A 36.

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HANFORD

DESIGN ANALYSIS

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Subject Engineering Evaluation of Commercial Grade Items	Date 8-1-95	By RW Davidson
	Checked	By NA
Location 200E, Tank 241-C-106 Sluicing	Revised	By

Commercial Grade Item: Steel pipe (ASTM A 53)

1. What would cause the part/item to fail (what are the credible failure modes)?

   a. Insufficient material integrity.
   b. Incorrect chemical composition.

2. What characteristics does the item have which are critical to the predictability of its performance? (Critical characteristics are identifiable and/or measurable attributes of a part/item which provides assurance that the part/item will perform as predicted.)

   a. Material integrity is a function of the yield strength of the material.
   b. Chemical composition.

3. What type of acceptance testing, when required, (load tests, Brinell hardness tests, nondestructive examination (NDE) tests, destructive physical tests, etc.) is required to be performed by KEH to provide confidence that the part/item has the necessary critical characteristics?

   a. Perform a tensile test in accordance with ASTM A 370 to verify the minimum yield strength of the material is greater than 35,000 psi.
   b. Perform a chemical analysis in accordance with ASTM A 751 to verify the material meets the chemical requirements of ASTM A 53 Table 1 and 2 for Type S, Grade B.

4. What manufacturing controls are required, if any, in addition to receipt inspection and/or acceptance testing (such as KEH witnessing test, KEH shop inspection, etc.)?

   None

5. Is part/item identifiable to a manufacturer's published product description which meet the critical characteristics?

   Product description for steel pipes is ASTM A53, Type S, Grade B.

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Subject Engineering Evaluation of Commercial Grade Items	Date 8-1-95	By RW Davidson
	Checked	By NA
Location 200E, Tank 241-C-106 Sluicing	Revised	By

Commercial Grade Item: Nelson Stud Welded Concrete Anchor type H4L, manufactured by TRW Nelson Stud Welding Division

1. What would cause the part/item to fail, (what are the credible failure modes)?

   a. Tension or shear
   b. Compressive strength of concrete
   c. Stud size, spacing and edge distance
   d. Welding of studs

2. What characteristics does the part/item have which are critical to the predictibility of its performance? (Critical characteristics are identifiable and/or measurable attributes of an item which provide assurance that the item will perform as predicted.)

   a. Tensile or shear strength is based on studs installed in accordance with the manufacturer's instructions.
   b. Ultimate compressive stress of the concrete.
   c. Stud size, spacing and edge distance
   d. Welding of studs

3. What type of acceptance testing, when required, (load tests, Brinell hardness tests, nondestructive examination (NDE) tests, destructive physical tests, etc.) is required to be performed by KEH to provide confidence that the part/item has the necessary critical characteristics?

   Extensive testing on Nelson Weld Studs were performed by the Engineering Division of The Nelson Stud Welding Company and was witnessed by an independent agency, Herron Testing Laboratories of Cleveland, Ohio. The tensile and compressive results from these tests became the basis of the Concrete Cone Failure Concept, published in Prestressed Concrete Institute Design Handbook in 1971, (Ref. d). Another comprehensive test program at Lehigh University, Pennsylvania resulted in the following publication, "

   "Headed Steel Anchors Under Combined Loading", AISC Engineering Journal, Second Quarter 1973, pages 43-52 (Ref. e). The failure mechanism of stud anchors is controlled by yielding of steel rather than shear cone failure. ACI 349-85 discusses this concept in pages 18-26. (Ref. b)

   The shear and tensile ultimate values developed by testing and used by TRW Nelson Stud Welding Division were compared with analytical values based on the shear cone concept. The ultimate loads computed by analytical method were lower than loads acheived by actual testing.

   Based on the above mentioned history, the track record of the studs for the last thirty years, and the fact that they are almost a sole source in industry use, their tensile and shear ultimate values as given by the manufacturer are acceptable provided the following conditions are met:

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Client WHC	WO/Job No. ER4319/W-320
Subject Engineering Evaluation of Commercial Grade Items	Date 8-1-95 By RW Davidson
	Checked By NA
Location 200E, Tank 241-C-106 Sluicing	Revised By

a. Perform a tensile test to verify that the minimum tensile strength of the studs is 60,000 psi. Tensile test will be performed in accordance with ASTM A370 and samples selected in accordance with ASTM A29.

b. Perform a bending, torquing or tensioning test in accordance with AWS D1.1, Article 7.6.6 to ensure that the weld attaching the weld stud to the base material will not fail.

c. Perform a check of the stud dimensions to ensure permissible variations in dimensions are in accordance with ASTM A29.

d. Perform visual inspection of stud spacings and edge distances to verify that no stud is placed with less then the minimum requirement, as specified by the manufacturer, and more then the maximum requirement, as specified by design.

e. Certificate of conformance will be required from the manufacturer to ensure that the studs meet the requirements of ASTM A108.

f. Concrete with required compressive strength shall be furnished by a qualified supplier who meets specified NQA-1 requirements or be furnished by a manufacturer where their product has been independently tested and qualified as a Commercial Grade Item.

4. What manufacturing controls are required, if any, in addition receipt inspection and/or acceptance testing (such as KEH witnessing test, KEH shop inspection, etc.)?

   None

5. Is part/item identifiable to a manufacturer's published product description which meet the critical characteristics?

   Product is the Nelson Stud Welded Concrete Anchor type H4L manufactured by TRW Nelson Stud Welding Division.

References:

a. Design Data, Nelson Concrete Anchor, studs for securing steel to concrete, Published in 5/76 by TRW Nelson Division.

b. ACI349-85, Commentary on Code Requirements for Nuclear Safety Related Concrete Structures.

c. ANSI/AWS D1.1-88, Structural Welding Code.

d. Prestressed concrete Institute Design Handbook.

e. "Headed Steel Anchors Under combined Loading", AISC Engineering Journal Second Quarter, 1973.

KAISER ENGINEERS HANFORD

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DESIGN ANALYSIS

Client WHC
WO/Job No. ER4319/W320
Subject Engineering Evaluation of Commercial Grade Items
Date 8/1/95 By RW Davidson
Checked By NA
Location 200E, Tank 241-C-106 Sluicing
Revised By

Commercial Grade Item (CGI): Nonshrink Epoxy Grout (ASTM C 827)

1. What would cause the part/item to fail (what are the credible failure modes)?

   a. Volume change as a result of shrinkage or excessive expansion.
   b. Compressive failure due to applied loads.
   c. Thermal expansion as a result of excessive heat.
   d. Creep as a result of excessive loading over time.

2. What characteristics does the item have which are critical to the predictability of its performance? (Critical characteristics are identifiable and/or measurable attributes of a part/item which provides assurance that the part/item will perform as predicted.)

   a. Volume change.
   b. Compressive strength.
   c. Thermal expansion.
   d. Creep Resistance.

3. What type of acceptance testing, when required, (load tests, Brinell hardness tests, nondestructive examination (NDE) tests, destructive physical tests, etc.) is required to be performed by ICF KH to provide confidence that the part/item has the necessary critical characteristics?

   a. Grout shall show no shrinkage (0.0%) and a maximum 2.0% expansion from time of placement when tested according to ASTM C 827, modified to use a ball with a specific gravity between 0.9 and 1.1.

   b. Grout shall show a minimum 7-day compressive strength of 16,000 psi when tested according to ASTM C 579.

   c. Grout shall show a maximum coefficient of thermal expansion of 30 x 10^{-6} in/in/°F when tested according to ASTM C 531.

KAISER ENGINEERS **HANFORD**		Calc. No. W320-24-028
		Revision ~~0~~ 1
DESIGN ANALYSIS		Page No. 9 of
Client WHC	WO/Job No. ER4319/W320	
Subject Engineering Evaluation of Commercial Grade Items	Date 8/1/95	By RW Davidson
	Checked	By NA
Location 200E, Tank 241-C-106 Sluicing	Revised 4/7/98	By aHangeri

d. Grout shall show creep equal to or less than 5.0×10^{-3} in/in at 180°F for one year with a load of 400 psi when tested according to CPR Creep Test.

4. What manufacturing controls are required, if any, in addition to receipt inspection and/or acceptance testing (such as ICF KH witnessing test, ICF KH shop inspection, etc.)?

None

5. Is part/item identifiable to a manufacturer's published product description which meet the critical characteristics?

Product description is Nonshrink Epoxy Grout (ASTM C 827): U.S. Grout Corporation "Five Star Epoxy Grout" or approved substitute. Properties of Headed Studs, TRW Nelson Division, 1977.

NOTE

Safety Classification of Grout was changed to 3/1 (see ECN W-320-290) making CGI no longer a requirement 1

KEH 0037.00 (06/92) KEF055

W320-24-029

Structural Analysis of Safety Related Electrical Equipment Supports

ICF KAISER HANFORD COMPANY	CALCULATION IDENTIFICATION AND INDEX	Page *i* of *iv* Date *7/29/1995*

This sheet shows the status and description of the attached Design Analysis sheets.

Discipline *Structural* WO/Job No. *ER 4319/W320* Calculation No. *W320-24-029*

Project No. & Name *W320, Tank 241-C-106 Sluicing.*

Calculation item *Structural analysis of Safety Related Electrical Equipment Supports.*

These calculations apply to:

Dwg. No.: *H-2-818678 shts 1 and 5, H-2-818690 sht 1, H-2-818702 shts 1 and 2* Rev. No.: *0/0/0/0/0*

Dwg. No.:*H-2-818695 shts 1,2,4 and 5, H-2-818704 sh 1,3 and 4, H-2-820752 sh 3* Rev. No.: *0/0/0/0/0/0/0/0*

Other (Study, CDR): *ECN W-320-251* Rev. No. *N/A*

The status of these calculations is:

[] Preliminary Calculations

[X] Final Calculations

[] Check Calculations (On Calculation Dated)

[] Void Calculation (Reason Voided)

Incorporated in Final Drawings? [X] Yes [] No

This calculation verified by independent "check" calculations? [] Yes [X] No

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	*Michael B. Lasota* *12/11/95*	*Michael B. Lasota* *05/08/1997* MBL	Ann Slangevin 1/14/98
Checked by	*Ronald W. Davidson* *12/19/95*	*Ronald W. Davidson* *5/08/1997* RD *M.R. Custer* *5/08/1997* MRC	H.B. LASOTA HBL 1/20/98
Approved by	R.W. Davidson 12/19/95	R.W. Davidson 5/12/97	Ann Slangevin 1/20/98
Checked Against Approved Vendor Data			A Slangevin 4/7/98

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1	*Criteria and assumptions*
1	*Structural Analysis - description*
1	*References*
1	*Index*
2 to 30	*Calculations*
31 through 49	*Figures 1 through 17*
50	*Conclusions*

ICF KAISER HANFORD COMPANY	CALCULATION IDENTIFICATION AND INDEX Continuation Sheet	Page ii of iv Date 7/29/1995

Discipline *Structural* WO/Job No. *ER 4319/W320* Calculation No. *W320-24-029*

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	*Michael B. Lasota* 12/11/95	*Michael B. Lasota* 05/08/97	ALangevin 1/14/98
Checked by	*Ronald W. Davidson* 12/19/95	*Ronald W. Davidson* 5/08/97 / *M.R. Custer* 5/08/97 MRC	M.B. LASOTA 1/20/98

INDEX

Design Analysis Page No.	Description

REVISION

Revision No.	Description
0	*Initial issue*
1	*Revised Page number for figures 1, 3 thru 9, 12, 13; replaced figures 2, 10; added figures 11 and*
	14 thru 17. Replaced sheet 1; Revised sheets 10, 11, 12, 13; added new sheets 13a, 13b, 14, 15, 16,
	17a thru 17g, 18 thru 23, 24 thru 30 and 50.
2	Revised page 10 and added p. 27a per changes
	from ECN W320-709 (deleted anchor bolt) and
	ECN W-320-682 (added equipment pad).
	Correct page #s on pages ii and iii

KEH 0378.01 (06/92) KEF072

C029.COV

2

CALCULATION CROSS INDEX (Typical)

Subject Calculation No. W320-24-029

Page ~~ix~~ of ~~xii~~

Subject Calculation Revision No.	Superceded by Calculation No.	These interfacing calculation/documents provide input to the subject calculation, and if revised may require revision of the subject calculation.		Results and conclusions of the subject calculation are used in these interfacing calculations and/or documents.		Does the output interface calculation/ documents require revision?		Has the output interface calculation/ documents been revised?		Discipline manager's signature and date indicating evaluation complete.
		Calculation/Document No.	Revision No.	Calculation/Document No.	Revision No.	Yes	No	Yes	No	
0	N/A	H-2-818678 sh 1	0	H-2-818678 sh1	1	X		X		[illegible] 12/14/95
		H-2-818678 sh 5	0	H-2-818678 sh5	1					
		H-2-818690 sh1	0	H-2-818690 sh1	1					
		H-2-818702 sh1	0	H-2-818702 sh1	1					
		H-2-818702 sh 2	0	H-2-818702 sh2	1					
		H-2-818695 sh1	0	H-2-818695 sh1	1					
		H-2-818695 sh 2	0	H-2-818695 sh 2	1					
		H-2-818695 sh 4	0	H-2-818695 sh 4	1					
		H-2-818695 sh 5	0	H-2-818695 sh5	1					
		H-2-818704 sh1	0	H-2-818704 sh1	1					
		H-2-818704 sh3	0	H-2-818704 sh3	1					
		H-2818704sh4	0	H-2-818704 sh4	1					
2	N/A	H-2-818674 sh5	0	H-2-818674 sh5	0	X		per ECN-682		ASLangevin 1/14/98
2	N/A	H-2-818695 sh6	0	H-2-818695 sh6	0	X		per ECN-709		ASLangevin 1/14/98

KEH 1975.00 (12/88)

DESIGN VERIFICATION SCREENING CRITERIA

HNF-2468, Rev.0

Project/Document No. W-320/W320-24-029

When the design or design change affects hardware, formal design verification must be performed if one or more of the following questions must be answered affirmatively (YES).

YES	NO	
	✓	1. Does the design or design change involved meet the established criteria to be considered Safety Class 1?
	✓	2. Does this design or design change cause or permit changes to Safety Class 1 instrument or alarm setpoints outside of previously approved operational limits?
	✓	3. Does this design or design change significantly affect the nuclear or environmental safety consequences of a malfunction or failure of the structure, system, or component?
	✓	4. Does this design or design change involve or change design that has previously undergone formal design verification?

[signature] 12/19/95
Assigned Lead Engineer Date

[signature] 12/19/95
Responsible Discipline Manager Date

Original Design Package Distribution:

- Project Manager
- Design Verification Officer
- Engineering Document Control

Design Change Distribution:

Attach to Engineering Change Notice

KEH-1981.00 (09/92)

ICF KAISER HANFORD COMPANY

DESIGN ANALYSIS

Calc. No.: W320-24-029
Revision: 1
Page No.: 1 of

Client: WHC
Subject: Structural analysis of Safety Related Electrical Equipment Supports.
Location: 241-C-106 & 241-AY-102

WO/Job No.: ER4319/W 320
Date: 05/06/1997 By: M. B. Lasota
Checked: 5/8/97 By: R. W. Davidson
Revised N/A By N/A

1. OBJECTIVES

The purpose of this calculations is to demonstrate that the design of the Electrical Equipment Supports is adequate to survive postulated Earthquake and Wind loads when installed at either Tank Farm during sluicing process without adversely effecting sluicing operation.

2. CRITERIA AND ASSUMPTIONS

DESIGN CRITERIA

The criteria for design of the Safety Class 3 structures is outlined in the SDC 4.1 rev. 11. According to LOI 9360642 rev. 2, the functional classification of the Electrical Equipment is SC 3.

In addition to SDC 4.1 rev 11 the Criteria is supplemented by "Specification for the Design of Cold-Formed Steel Structural Members" whenever cold formed sheet metal members, such as Unistrut channel etc., are used. Also, capacities for connections in Unistrut were extracted from manufacturers tests and design reports.
The design of expansion anchors was based on ref 5.

3. STRUCTURAL ANALYSIS.

The Electrical Equipment Supports consist of small, simple structures, that is why the manual Structural Analysis was chosen.

4. REFERENCES

1. "Manual of Steel Construction - Allowable Stress Design" Ninth Edition, AISC 1989.
2. "Cold-Formed Steel Design Manual" August 19, 1986, Edition, AISI.
3. SDC 4.1 Rev. 11.
4. "Code requirements for Nuclear Safety Related Structures" ACI 349-85.
5. A/E Standard GC-ANCR-01 Rev. 0.
6. UBC 1991.

5. INDEX.

ICF KAISER HANFORD COMPANY

DESIGN ANALYSIS

Client: WHC
Subject: Structural analysis of Safety Related Electrical Equipment Supports.
Location: 241-C-106 & 241-AY-102

WO/Job No.: ER 4319/W 320
Date: 10/17/95 By: M.B. Lasota
Checked 12/19/95 By
Revised By

241-CR-106 - Rack for In Tank Imaging System CCTV - Figure 8 p. 38, (ref dwg. H-2- 818704 sh 1 & H-2-818690).

Wind pressure ref. ASCE 7-93 " Minimum Design Loads for Buildings and Other Structures".

From SDC 4.2 rev. 11 the following are parameters used in wind pressure calculation for Safety Class 3 structures:

Basic wind speed: $V := 70 \cdot mph$
Importance Factor: $I := 1.07$
Exposure Category: C

$K_z := 0.8$

$q_z := 0.00256 \cdot K_z \cdot \left(\frac{I \cdot V}{mph}\right)^2 \cdot psf$ $q_z = 11.49 \cdot psf$

use $q_z := 11.5 \cdot psf$

From Table 4. for other structures: $G_h := 1.32$

and from Table 13. $C_f := 1.6$ $p_w := q_z \cdot G_h \cdot C_f$ $p_w = 24.29 \cdot psf$ $F_w = p_w \cdot A$

Seismic load per UBC (36-1)

$F_p = Z \cdot I \cdot C_p \cdot W_p$

From SDC 4.1 rev 11 : $Z := 0.12$ $I := 1.25$ $C_p := 2.12$ $a_h := Z \cdot I \cdot C_p$ $a_h = 0.32$

Box 01:	$h_1 := 36 \cdot in$	$w_1 := 24 \cdot in$	$A_1 := h_1 \cdot w_1$	$y_1 := 48 \cdot in$	$A_1 = 6.00 \cdot ft^2$	$Q_1 := A_1 \cdot y_1$
Box 02:	$h_2 := 24 \cdot in$	$w_2 := 24 \cdot in$	$A_2 := h_2 \cdot w_2$	$y_2 := 54 \cdot in$	$A_2 = 4.00 \cdot ft^2$	$Q_2 := A_2 \cdot y_2$
Box 03:	$h_3 := 6 \cdot in$	$w_3 := 6 \cdot in$	$A_3 := h_3 \cdot w_3$	$y_3 := 33 \cdot in$	$A_3 = 0.25 \cdot ft^2$	$Q_3 := A_3 \cdot y_3$
Uni 04:	$h_4 := 1.625 \cdot in$	$w_4 := 57 \cdot in$	$A_4 := h_4 \cdot w_4$	$y_4 := 52.13 \cdot in$	$A_4 = 0.64 \cdot ft^2$	$Q_4 := A_4 \cdot y_4$
Uni 05:	$h_5 := 1.625 \cdot in$	$w_5 := 57 \cdot in$	$A_5 := h_5 \cdot w_5$	$y_5 := 56.25 \cdot in$	$A_5 = 0.64 \cdot ft^2$	$Q_5 := A_5 \cdot y_5$
Uni 06:	$h_6 := 1.625 \cdot in$	$w_6 := 57 \cdot in$	$A_6 := h_6 \cdot w_6$	$y_6 := 22 \cdot in$	$A_6 = 0.64 \cdot ft^2$	$Q_6 := A_6 \cdot y_6$
TS 07:	$h_7 := 66 \cdot in$	$w_7 := 3.0 \cdot in$	$A_7 := h_7 \cdot w_7$	$y_7 := 78 \cdot in$	$A_7 = 1.37 \cdot ft^2$	$Q_7 := A_7 \cdot y_7$
TS 08:	$h_8 := 66 \cdot in$	$w_8 := 3.0 \cdot in$	$A_8 := h_8 \cdot w_8$	$y_8 := 23 \cdot in$	$A_8 = 1.37 \cdot ft^2$	$Q_8 := A_8 \cdot y_8$

$i := 1..8$ $A := \sum_i A_i$ $A = 14.93 \cdot ft^2$ $Q := \sum_i Q_i$ $Q = 61.25 \cdot ft^3$ $y_o := \frac{Q}{A}$ $y_o = 4.10 \cdot ft$

for wind load computation increase area by 15% $A_f := 1.15 \cdot A$ $A_f = 17.17 \cdot ft^2$

Wind load therefore is:

$F_w := q_z \cdot G_h \cdot C_f \cdot A_f$ $F_w = 417 \cdot lbf$

ICF KAISER HANFORD COMPANY

DESIGN ANALYSIS

Calc. No. W320-24-029
Revision 0
Page No. 3 of

Client: WHC
Subject: Structural analysis of Safety Related Electrical Equipment Supports.
Location: 241-C-106 & 241-AY-102

WO/Job No.: ER 4319/W 320
Date: 10/17/95 By: M.B. Lasota
Checked 12/19/95 By
Revised By

Overturning moment caused by wind forces will be amplified by weight eccentricity.

Distance from the center of the column to the back of electrical boxes is a:

$a := \frac{3.25 \cdot in}{2} + 1.625 \cdot in \qquad a = 3.25 \cdot in$

$W_1 := 200 \cdot lbf \qquad d_1 := 8 \cdot in \qquad m_1 := W_1 \cdot \left(a + \frac{d_1}{2}\right) \qquad W_2 := 100 \cdot lbf \qquad d_2 := 16 \cdot in \qquad m_2 := W_2 \cdot \left(a + \frac{d_2}{2}\right)$

$W_3 := 5 \cdot lbf \qquad d_3 := 4 \cdot in \qquad m_3 := W_3 \cdot \left(a + \frac{d_3}{2}\right)$

$m_{1to3} := m_1 + m_2 + m_3 \qquad m_{1to3} = 2601.25 \cdot lbf \cdot in$

Moment due to unistrut eccentricity:

$a_u := \frac{3.22 \cdot in}{2} + 0.709 \cdot in \qquad a_u = 2.32 \cdot in$

Unit weight of the unistrut and its total length are as follows:

$w_u := 1.9 \cdot \frac{lbf}{ft} \qquad l_u := w_4 + w_5 + w_6 \qquad l_u = 14.25 \cdot ft$

$m_{4to6} := w_u \cdot l_u \cdot a_u \qquad m_{4to6} = 62.79 \cdot lbf \cdot in$

$M_e := m_{1to3} + m_{4to6} \qquad M_e = 222.00 \cdot lbf \cdot ft$

Check the foundation, 6'-6"x4'-0"x0'-8" deep pad: $a := 6.5 \cdot ft \qquad b := 4 \cdot ft \qquad d := 8 \cdot in \qquad w_t := 9.42 \cdot \frac{lbf}{ft}$

Assume density of concrete to be: $\gamma := 150 \cdot pcf$

Dead Weight: $W_e := W_1 + W_2 + W_3 + (w_4 + w_5 + w_6) \cdot w_u + (h_6 + h_7) \cdot w_t \qquad W_e = 385.16 \cdot lbf$

$W_c := a \cdot b \cdot d \cdot \gamma \qquad W_c = 2600.00 \cdot lbf$

Bearing capacity of the soil from UBC Table 29B for sandy gravel is:

$p_a := 2000 \cdot psf$

The load on the footing is:

$W := W_e + W_c \qquad W = 2985.16 \cdot lbf$

$M := F_w \cdot y_o + M_e \qquad M = 1932.76 \cdot ft \cdot lbf$

Check for negative soil pressure:

$p := \frac{W}{a \cdot b} - \frac{6 \cdot M}{a \cdot b^2} \qquad p = 3.3 \cdot psf$ uplift at the end of foundation will not occur.

Find maximum soil pressure due to eccentricity:

$p_{max} := \frac{W}{a \cdot b} + \frac{6 \cdot M}{a \cdot b^2}$ $\qquad p_{max} = 226.3 \cdot psf$

$p_{max} \le p_a$ soil pressure is acceptable.

Check footing for overturning:

$M_s := \frac{W \cdot b}{2}$ $\qquad FS_o := \frac{M_s}{M}$ $\qquad FS_o = 3.09$ $\qquad FS_o \ge 1.5$ stability of the foundation is satisfactory.

Check TS3X3X0.1875 section for stress:

Bending about major axis:

$M_x := \frac{M}{2}$ $\qquad M_x = 11596.58 \cdot lbf \cdot in$

Bending about minor axis:

$P_{wy} := (5.5 \cdot ft \cdot 3.25 \cdot in + 24 \cdot in \cdot 16 \cdot in + 12 \cdot in \cdot 8 \cdot in) \cdot p_w$ $\qquad P_{wy} = 117.1 \cdot lbf$

$P_{sy} := W_e \cdot a_h$ $\qquad P_{sy} = 122.5 \cdot lbf$

$M_y := P_{sy} \cdot y_o$ $\qquad M_y = 6029.7 \cdot lbf \cdot in$

Properties for the TS3X3X0.1875 are as follows:

$A := 2.02 \cdot in^2$ $\qquad S_x := 1.73 \cdot in^3$ $\qquad S_y := 1.73 \cdot in^3$ $\qquad r_x := 1.13 \cdot in$ $\qquad r_y := 1.13 \cdot in$

$\sigma_x := \frac{M_x}{S_x}$ $\qquad \sigma_x = 6.7 \cdot ksi$ $\qquad \sigma_y := \frac{M_y}{S_y}$ $\qquad \sigma_y = 3.49 \cdot ksi$

The stresses found above occur at different location of the member, also they are a result of two non-concurrent events, the combination is therefore not required.

Check members for axial load.

$C := \frac{W_e}{2}$ $\qquad C = 192.58 \cdot lbf$

$l_x := 5 \cdot ft$ $\qquad K_x := 2$ $\qquad Sr_x := \frac{K_x \cdot l_x}{r_x}$ $\qquad Sr_x = 106.19$ Maximum slenderness ratio.

$l_y := 5 \cdot ft$ $\qquad K_y := 2$ $\qquad Sr_y := \frac{K_y \cdot l_y}{r_y}$ $\qquad Sr_y = 106.19$

Check members for axial load - continued.

$E := 29000 \cdot ksi$ $\quad F_y := 36 \cdot ksi$ $\quad C_c := \sqrt{\dfrac{2 \cdot \pi^2 \cdot E}{F_y}}$ $\quad C_c = 126.10$ $\quad Sr_x \le C_c$

$R := \dfrac{Sr_x}{C_c}$ $\quad R = 0.84$ $\quad \Omega_c := \dfrac{5}{3} + \dfrac{3}{8} \cdot R - \dfrac{1}{8} \cdot R^3$ $\quad \Omega_c = 1.91$

$F_a := \left(1 - \dfrac{R^2}{2}\right) \cdot \dfrac{F_y}{\Omega_c}$ $\quad F_a = 12.18 \cdot ksi$

$P_a := A \cdot F_a$ $\quad P_a = 24600.29 \cdot lbf$ $\quad P_a = 24600.29 \cdot lbf$ $\quad P_a \ge C$ $\quad$ O.K..

Check Base Plate for capacity.

Check expansion anchors:

$l_1 := 2.125 \cdot in$ $\quad l_{01} := 1.5 \cdot in + 2 \cdot 0.5 \cdot in + 5 \cdot in - 1.25 \cdot in - 0.875 \cdot in$ $\quad l_{01} = 5.38 \cdot in$

$l_2 := 2.125 \cdot in$ $\quad l_{02} := 1.5 \cdot in + 2 \cdot 0.5 \cdot in + 5 \cdot in - 1.25 \cdot in - 0.875 \cdot in$ $\quad l_{02} = 5.38 \cdot in$

$M := M_x - \dfrac{W_e \cdot d_1}{2}$ $\quad M = 10.06 \cdot kips \cdot in$

$$M = T_{max} \cdot \left[l_{01} + \left(\frac{l_1}{l_2}\right)^2 \cdot l_{02} \right]$$

$T_{max} := \dfrac{M}{l_{01} + \left(\dfrac{l_1}{l_2}\right)^2 \cdot l_{02}}$ $\quad T_{max} = 935.44 \cdot lbf$ $\quad T_{min} := T_{max} \cdot \left(\dfrac{l_1}{l_2}\right)^2$ $\quad T_{min} = 935.44 \cdot lbf$

$T_b := T_{max}$ $\quad T_b = 935.44 \cdot lbf$ $\quad V_b := \dfrac{F_w}{8}$ $\quad V_b = 52.13 \cdot lbf$

For 5/8" dia HKB II with 2 3/4" min. embedment, installed in f'_c=4000psi concrete, allowable loads are:

$T_a := 2000 \cdot lbf$ $\quad V_a := 2530 \cdot lbf$ $\quad$ Ref. A/E Standard GC-ANCR-01 rev 0 table 21.

Interaction factor is:

$IF := \dfrac{T_b}{T_a} + \dfrac{V_b}{V_a}$ $\quad IF = 0.49$ $\quad IF \le 1.0$ $\quad$ O.K..

Check stress in the base plate:

$t_{pl} := 0.5 \cdot in$ $\quad f_b := \dfrac{6 \cdot T_b}{t_{pl}^2}$ $\quad f_b = 22.45 \cdot ksi$ $\quad F_b := \dfrac{4}{3} \cdot (0.75 \cdot F_y)$ $\quad F_b = 36.00 \cdot ksi$ $\quad f_b \le F_b$ $\quad$ O.K..

ICF KAISER HANFORD COMPANY

DESIGN ANALYSIS

Client: WHC
Subject: Structural analysis of Safety Related Electrical Equipment Supports.
Location: 241-C-106 & 241-AY-102

WO/Job No.: ER 4319/W 320
Date: 11/02/95 By: M.B. Lasota
Checked 12/19/95 By
Revised By

Process Building Electrical Rack #1 ER-1361 - Figure 6, page 36, (ref dwg H-2-818678 sheets 1 and 5).

The analysis of the rack and its foundation will include an influence of the environmental loads i.e.. Wind and Seismic. The loads are calculated on the basis outlined in UBC.

Wind Load.

From observation, the critical wind exposure appears on the frontal area of the rack (maximum Area of exposure). The following is the calculation of the exposure area. It will include overlaps of the unistrut that will compensate for the area of exposed conduit.

Box 01:	$h_1 := 21.5\cdot in$	$w_1 := 9\cdot in$	$A_1 := h_1\cdot w_1$	$y_1 := 54.5\cdot in$	$A_1 = 1.34\cdot ft^2$	$Q_1 := A_1\cdot y_1$
Box 02:	$h_2 := 15.5\cdot in$	$w_2 := 8\cdot in$	$A_2 := h_2\cdot w_2$	$y_2 := 57.5\cdot in$	$A_2 = 0.86\cdot ft^2$	$Q_2 := A_2\cdot y_2$
Box 03:	$h_3 := 15.5\cdot in$	$w_3 := 8\cdot in$	$A_3 := h_3\cdot w_3$	$y_3 := 57.5\cdot in$	$A_3 = 0.86\cdot ft^2$	$Q_3 := A_3\cdot y_3$
Box 04:	$h_4 := 26.25\cdot in$	$w_4 := 10\cdot in$	$A_4 := h_4\cdot w_4$	$y_4 := 52.13\cdot in$	$A_4 = 1.82\cdot ft^2$	$Q_4 := A_4\cdot y_4$
Box 05:	$h_5 := 18\cdot in$	$w_5 := 9\cdot in$	$A_5 := h_5\cdot w_5$	$y_5 := 56.25\cdot in$	$A_5 = 1.12\cdot ft^2$	$Q_5 := A_5\cdot y_5$
Box 06:	$h_6 := 14\cdot in$	$w_6 := 12\cdot in$	$A_6 := h_6\cdot w_6$	$y_6 := 22\cdot in$	$A_6 = 1.17\cdot ft^2$	$Q_6 := A_6\cdot y_6$
Box 07:	$h_7 := 12\cdot in$	$w_7 := 12\cdot in$	$A_7 := h_7\cdot w_7$	$y_7 := 78\cdot in$	$A_7 = 1.00\cdot ft^2$	$Q_7 := A_7\cdot y_7$
Box 08:	$h_8 := 12\cdot in$	$w_8 := 12\cdot in$	$A_8 := h_8\cdot w_8$	$y_8 := 23\cdot in$	$A_8 = 1.00\cdot ft^2$	$Q_8 := A_8\cdot y_8$
Box 09:	$h_9 := 7\cdot in$	$w_9 := 8\cdot in$	$A_9 := h_9\cdot w_9$	$y_9 := 38.5\cdot in$	$A_9 = 0.39\cdot ft^2$	$Q_9 := A_9\cdot y_9$
Box 10:	$h_{10} := 7\cdot in$	$w_{10} := 8\cdot in$	$A_{10} := h_{10}\cdot w_{10}$	$y_{10} := 38.5\cdot in$	$A_{10} = 0.39\cdot ft^2$	$Q_{10} := A_{10}\cdot y_{10}$
Box 11:	$h_{11} := 6\cdot in$	$w_{11} := 48\cdot in$	$A_{11} := h_{11}\cdot w_{11}$	$y_{11} := 23\cdot in$	$A_{11} = 2.00\cdot ft^2$	$Q_{11} := A_{11}\cdot y_{11}$
Box 12:	$h_{12} := 19.5\cdot in$	$w_{12} := 9.12\cdot in$	$A_{12} := h_{12}\cdot w_{12}$	$y_{12} := 55.5\cdot in$	$A_{12} = 1.23\cdot ft^2$	$Q_{12} := A_{12}\cdot y_{12}$
Uni 13:	$h_{13} := 1.625\cdot in$	$w_{13} := 85\cdot in$	$A_{13} := h_{13}\cdot w_{13}$	$y_{13} := 83\cdot in$	$A_{13} = 0.96\cdot ft^2$	$Q_{13} := A_{13}\cdot y_{13}$
Uni 14:	$h_{14} := 1.625\cdot in$	$w_{14} := 46\cdot in$	$A_{14} := h_{14}\cdot w_{14}$	$y_{14} := 73\cdot in$	$A_{14} = 0.52\cdot ft^2$	$Q_{14} := A_{14}\cdot y_{14}$
Uni 15:	$h_{15} := 1.625\cdot in$	$w_{15} := 85\cdot in$	$A_{15} := h_{15}\cdot w_{15}$	$y_{15} := 65.25\cdot in$	$A_{15} = 0.96\cdot ft^2$	$Q_{15} := A_{15}\cdot y_{15}$
Uni 16:	$h_{16} := 1.625\cdot in$	$w_{16} := 85\cdot in$	$A_{16} := h_{16}\cdot w_{16}$	$y_{16} := 51.75\cdot in$	$A_{16} = 0.96\cdot ft^2$	$Q_{16} := A_{16}\cdot y_{16}$
Uni 17:	$h_{17} := 1.625\cdot in$	$w_{17} := 46\cdot in$	$A_{17} := h_{17}\cdot w_{17}$	$y_{17} := 47.75\cdot in$	$A_{17} = 0.52\cdot ft^2$	$Q_{17} := A_{17}\cdot y_{17}$
Uni 18:	$h_{18} := 1.625\cdot in$	$w_{18} := 46\cdot in$	$A_{18} := h_{18}\cdot w_{18}$	$y_{18} := 41\cdot in$	$A_{18} = 0.52\cdot ft^2$	$Q_{18} := A_{18}\cdot y_{18}$
Uni 19:	$h_{19} := 1.625\cdot in$	$w_{19} := 46\cdot in$	$A_{19} := h_{19}\cdot w_{19}$	$y_{19} := 36\cdot in$	$A_{19} = 0.52\cdot ft^2$	$Q_{19} := A_{19}\cdot y_{19}$
Uni 20:	$h_{20} := 1.625\cdot in$	$w_{20} := 85\cdot in$	$A_{20} := h_{20}\cdot w_{20}$	$y_{20} := 28\cdot in$	$A_{20} = 0.96\cdot ft^2$	$Q_{20} := A_{20}\cdot y_{20}$
Uni 21:	$h_{21} := 1.625\cdot in$	$w_{21} := 85\cdot in$	$A_{21} := h_{21}\cdot w_{21}$	$y_{21} := 24\cdot in$	$A_{21} = 0.96\cdot ft^2$	$Q_{21} := A_{21}\cdot y_{21}$

Uni 22:	$h_{22} := 1.625 \cdot in$	$w_{22} := 85 \cdot in$	$A_{22} := h_{22} \cdot w_{22}$	$y_{22} := 18 \cdot in$	$A_{22} = 0.96 \cdot ft^2$	$Q_{22} := A_{22} \cdot y_{22}$
Col 23:	$h_{23} := 90 \cdot in$	$w_{23} := 3 \cdot in$	$A_{23} := h_{23} \cdot w_{23}$	$y_{23} := 45 \cdot in$	$A_{23} = 1.87 \cdot ft^2$	$Q_{23} := A_{23} \cdot y_{23}$
Col 24:	$h_{24} := 90 \cdot in$	$w_{24} := 3 \cdot in$	$A_{24} := h_{24} \cdot w_{24}$	$y_{24} := 45 \cdot in$	$A_{24} = 1.87 \cdot ft^2$	$Q_{24} := A_{24} \cdot y_{24}$
Col 25:	$h_{25} := 90 \cdot in$	$w_{25} := 3 \cdot in$	$A_{25} := h_{25} \cdot w_{25}$	$y_{25} := 45 \cdot in$	$A_{25} = 1.87 \cdot ft^2$	$Q_{25} := A_{25} \cdot y_{25}$

$j := 1 .. 25$

$A := \sum_j A_j \qquad A = 26.65 \cdot ft^2 \qquad\qquad Q := \sum_j Q_j \qquad Q = 101.37 \cdot ft^3$

$y_o := \frac{Q}{A} \qquad y_o = 45.65 \cdot in$ for wind load computation increase area by 25% $A_f := 1.25 \cdot A \qquad A_f = 33.31 \cdot ft^2$

Wind pressure ref. ASCE 7-93 " Minimum Design Loads for Buildings and Other Structures".

Basic wind speed: $V := 70 \cdot mph$
Importance Factor: $I := 1.07$
Exposure Category: C

$K_z := 0.8$

$q_z := 0.00256 \cdot K_z \cdot \left(\frac{I \cdot V}{mph}\right)^2 \cdot psf \qquad q_z = 11.49 \cdot psf$

use $q_z := 11.5 \cdot psf$

From Table 4. for other structures: $G_h := 1.32$

and from table 13: $C_f := 1.6$

Wind load therefore is: $F_w := q_z \cdot G_h \cdot C_f A_f \qquad F_w = 809.1 \cdot lbf$

Overturning moment caused by wind forces will be amplified by weight eccentricity.

Distance from the center of the column to the back of electrical boxes is :

$a := \frac{3 \cdot in}{2} + 1.625 \cdot in \qquad a = 3.12 \cdot in$

$W_1 := 20 \cdot lbf \qquad d_1 := 7 \cdot in \qquad m_1 := W_1 \cdot \left(a + \frac{d_1}{2}\right) \qquad W_2 := 20 \cdot lbf \qquad d_2 := 5 \cdot in \qquad m_2 := W_2 \cdot \left(a + \frac{d_2}{2}\right)$

$W_3 := 20 \cdot lbf \qquad d_3 := 5 \cdot in \qquad m_3 := W_3 \cdot \left(a + \frac{d_3}{2}\right) \qquad W_4 := 50 \cdot lbf \qquad d_4 := 8 \cdot in \qquad m_4 := W_4 \cdot \left(a + \frac{d_4}{2}\right)$

$W_5 := 20 \cdot lbf \qquad d_5 := 6 \cdot in \qquad m_5 := W_5 \cdot \left(a + \frac{d_5}{2}\right) \qquad W_6 := 10 \cdot lbf \qquad d_6 := 6 \cdot in \qquad m_6 := W_6 \cdot \left(a + \frac{d_6}{2}\right)$

$W_7 := 20 \cdot lbf \qquad d_7 := 6 \cdot in \qquad m_7 := W_7 \cdot \left(a + \frac{d_7}{2}\right) \qquad W_8 := 20 \cdot lbf \qquad d_8 := 6 \cdot in \qquad m_8 := W_8 \cdot \left(a + \frac{d_8}{2}\right)$

$W_9 := 10 \cdot lbf \qquad d_9 := 7 \cdot in \qquad m_9 := W_9 \cdot \left(a + \frac{d_9}{2}\right) \qquad W_{10} := 10 \cdot lbf \qquad d_{10} := 7 \cdot in \qquad m_{10} := W_{10} \cdot \left(a + \frac{d_{10}}{2}\right)$

$W_{11} := 25 \cdot lbf \qquad d_{11} := 6 \cdot in \qquad m_{11} := W_{11} \cdot \left(a + \frac{d_{11}}{2}\right) \qquad W_{12} := 20 \cdot lbf \qquad d_{12} := 5 \cdot in \qquad m_{12} := W_{12} \cdot \left(a + \frac{d_{12}}{2}\right)$

$m_{1to12} := m_1 + m_2 + m_3 + m_4 + m_5 + m_6 + m_7 + m_8 + m_9 + m_{10} + m_{11} + m_{12} \qquad m_{1to12} = 1540.63 \cdot lbf \cdot in$

Moment due to unistrut eccentricity:

$a_u := \frac{3 \cdot in}{2} + 0.709 \cdot in \qquad a_u = 2.21 \cdot in$

Unit weight of the unistrut and its total length are as follows:

$w_u := 1.9 \cdot \frac{lbf}{ft} \qquad l_u := \sum_{j=13}^{22} w_j \qquad l_u = 57.83 \cdot ft$

$m_{13to22} := w_u \cdot l_u \cdot a_u \qquad m_{13to22} = 242.73 \cdot lbf \cdot in$

$M_e := m_{1to12} + m_{13to22} \qquad M_e = 1783.36 \cdot lbf \cdot in$

Adjusted wind load by amount of weight eccentricity

$F := F_w + \frac{M_e}{y_o} \qquad F = 848.16 \cdot lbf$

Use $\quad F := 850 \cdot lbf$

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DESIGN ANALYSIS

Client: WHC
Subject: Structural analysis of Safety Related Electrical Equipment Supports.
Location: 241-C-106 & 241-AY-102

WO/Job No.: ER 4319/W 320
Date: 11/02/95 By: M.B. Lasota
Checked 12/19/95 By
Revised By

From Shannon & Wilson inc. "Final Report of Geotechnical Studies W 320 Waste Retrieval and Sluicing System 200 East Area, Hanford Site", April 1994, soil properties are:

$\gamma := 115 \cdot pcf \qquad \phi := 37 \cdot deg$

Rankine passive lateral earth pressure is:

$$p := \frac{1+\sin(\phi)}{1-\sin(\phi)} \cdot \gamma \qquad p = 462.62 \cdot \frac{psf}{ft}$$

From UBC 2907 6 (g) 2.

$S_1 := p$

$b := 15 \cdot in \qquad h := y_o \qquad h = 45.65 \cdot in$

$$P := \frac{F}{3}$$

$$\alpha := 3 \cdot 2.34 \cdot \frac{P}{b \cdot S_1} \qquad \alpha = 3.43 \cdot ft^2$$

Assume: $d := 34.68638 \cdot in$

$$A_o := \frac{\alpha}{d} \qquad A_o = 1.19 \cdot ft$$

$$u := \frac{A_o}{2} \cdot \left(1 + \sqrt{1 + \frac{4.36 \cdot h}{A_o}}\right) \qquad u = 34.68638 \cdot in$$

Use embedment depth : 3'-0"

Check stress in TS3X3X0.1875:

$$M := \frac{F \cdot y_o}{3} \qquad M = 12.91 \cdot kips \cdot in \qquad S_t := 1.73 \cdot in^3 \qquad f_b := \frac{M}{S_t} \qquad f_b = 7.46 \cdot ksi$$

Total weight of the rack and equipment is:

$$C := W_1 + W_2 + W_3 + W_4 + W_5 + W_6 + W_7 + W_8 + W_9 + W_{10} + W_{11} + W_{12} + w_u \cdot l_u + 3 \cdot 90 \cdot in \cdot 6.87 \cdot \frac{lbf}{ft}$$

$C = 509.46 \cdot lbf$

Compression in the column is:

$$P_a := \frac{C - 3 \cdot 90 \cdot in \cdot 6.87 \cdot \frac{lbf}{ft}}{2} + 90 \cdot in \cdot 6.87 \cdot \frac{lbf}{ft} \qquad P_a = 228.97 \cdot lbf$$

$$f_a := \frac{P_a}{2.02 \cdot in^2} \qquad f_a = 0.11 \cdot ksi$$

From individual stress levels it is apparent that the interaction equation is satisfied.

FLUOR DANIEL
NORTHWEST INC.

DESIGN ANALYSIS

Client: WHC
Subject: Structural analysis of Safety Related Electrical Equipment Supports.
Location: 241-C-106 & 241-AY-102

WO/Job No.: ER 4319/W 320
Date: 10/17/95 By: M.B. Lasota
Checked: 12/19/95 By: R.W. Davidson
Revised: 5/05/97 By: M.B. Lasota
Revised: 1/16/98 By: A. S. Langevin ASL

241-AY-102 - Racks for electrical enclosures: CTB-0621- Figure 3, (ref dwg. H-2-818695 sh 2 & 4), ITB-0621- Figure 4, (ref dwg. H-2-818695 sh 2 & 4), PTBX-0621- Figure 5, (ref dwg. H-2-818695 sh 2 & 5), NEMA 3R 600A SAFETY SWITCH- Figure 1, (ref dwg. H-2-818695 sh 1 & 4), ***NEMA 3R 60A SAFETY SWITCH (PIT COOLING) - Figure 2, (ref dwg H-2-818695 sh 2 & 4), LKD-102-32 - Figure 15, (ref dwg H-2-818695 sh 4) and LD-1363/1366 - Figure 16 (ref dwg H-2-818704 sh 1. *Δ1

241-CR-106 - Racks for electrical enclosures: TB-1- Figure 9, (ref dwg. H-2-818704 sh 2), TB-2 & TB-3- Figure 7, (ref dwg. H-2-818704 sh 3) and TB-4 and LD-1364/1368- Figure 10, (ref dwg. H-2-818702 sh 1 & 2). *Δ1

241-C - Rack for Standby Generator Disc Pad (ref dwg H-2-818674 and ECN W-320-682) *Δ2 MJL 1/16/98

Wind pressure ref. ASCE 7-93 " Minimum Design Loads for Buildings and Other Structures".
From SDC 4.2 rev. 11 the following are parameters used in wind pressure calculation for Safety Class 3 structures:

Basic wind speed: $V := 70 \cdot mph$
Importance Factor: $I := 1.07$

Exposure Category: C
$K_z := 0.8$

$q_z := 0.00256 \cdot K_z \cdot \left(\frac{I \cdot V}{mph}\right)^2 \cdot psf$ $\quad q_z = 11.49 \cdot psf$

use $q_z := 11.5 \cdot psf$

From Table 4. for other structures: $G_h := 1.32$

and from table 13. $C_f := 1.6$ $\quad p_W := q_z \cdot G_h \cdot C_f$ $\quad p_W = 24.29 \cdot psf$ $\quad F_W = p_W \cdot A$

Seismic load per UBC (36-1) $F_p = Z \cdot I \cdot C_p \cdot W_p$

From SDC 4.1 rev 11 : $Z := 0.12$ $\quad I := 1.25$ $\quad C_p := 2.12$ $\quad a_h := Z \cdot I \cdot C_p$ $\quad a_h = 0.32$ $\quad i := 1, 2 .. 10$

CTB-0621 $h_1 := 20 \cdot in$ $\quad w_1 := 16 \cdot in$ $\quad A_1 := h_1 \cdot w_1$ $\quad y_1 := 54.5 \cdot in$ $\quad A_1 = 2.22 \cdot ft^2$ $\quad W_1 := 40 \cdot lbf$

$F_{w_1} := p_w \cdot A_1$ $\quad F_{p_1} := a_h \cdot W_1$ $\quad F_{w_1} = 54 \cdot lbf$ $\quad F_{p_1} = 13 \cdot lbf$

ITB-0621 $h_2 := 24 \cdot in$ $\quad w_2 := 30 \cdot in$ $\quad A_2 := h_2 \cdot w_2$ $\quad y_2 := 57.5 \cdot in$ $\quad A_2 = 5.00 \cdot ft^2$ $\quad W_2 := 75 \cdot lbf$

$F_{w_2} := p_w \cdot A_2$ $\quad F_{p_2} := a_h \cdot W_2$ $\quad F_{w_2} = 121 \cdot lbf$ $\quad F_{p_2} = 24 \cdot lbf$

NEMA 3R 600A S.S. $h_3 := 60.75 \cdot in$ $\quad w_3 := 25 \cdot in$ $A_3 := h_3 \cdot w_3$ $\quad y_3 := 47.63 \cdot in$ $\quad A_3 = 10.55 \cdot ft^2$ $\quad W_3 := 109 \cdot lbf$

$F_{w_3} := p_w \cdot A_3$ $\quad F_{p_3} := a_h \cdot W_3$ $\quad F_{w_3} = 256 \cdot lbf$ $\quad F_{p_3} = 35 \cdot lbf$

Standby Generator Disc - dimensions are similar to NEMA 3R 600A S. S. - Use the same analysis *Δ2 MJL 1/16/98

NEMA 3R 60A S.S. $h_4 := 20 \cdot in$ $\quad w_4 := 8.5 \cdot in$ $\quad A_4 := h_4 \cdot w_4$ $\quad y_4 := 52.13 \cdot in$ $\quad A_4 = 1.18 \cdot ft^2$ $\quad W_4 := 20 \cdot lbf$

$F_{w_4} := p_w \cdot A_4$ $\quad F_{p_4} := a_h \cdot W_4$ $\quad F_{w_4} = 29 \cdot lbf$ $\quad F_{p_4} = 6 \cdot lbf$

***The above NEMA 3R 60A S.S. rack had been modified to include a Pneumatic Valve Actuator Control Station. Analysis of modified rack can be found on page 28 of these calculations. *Δ1

PTBX-0621 $h_5 := 30\cdot in$ $w_5 := 24\cdot in$ $A_5 := h_5 \cdot w_5$ $y_5 := 56.25\cdot in$ $A_5 = 5.00\cdot ft^2$ $W_5 := 75\cdot lbf$

$F_{w_5} := p_w \cdot A_5$ $F_{p_5} := a_h \cdot W_5$ $F_{w_5} = 121\cdot lbf$ $F_{p_5} = 24\cdot lbf$

TB-1 $h_6 := 24\cdot in$ $w_6 := 24\cdot in$ $A_6 := h_6 \cdot w_6$ $y_6 := 30\cdot in$ $A_6 = 4.00\cdot ft^2$ $W_6 := 50\cdot lbf$

$F_{w_6} := p_w \cdot A_6$ $F_{p_6} := a_h \cdot W_6$ $F_{w_6} = 97\cdot lbf$ $F_{p_6} = 16\cdot lbf$

TB-2&TB-3 $h_7 := 30\cdot in$ $w_7 := 30\cdot in$ $A_7 := h_7 \cdot w_7$ $y_7 := 23\cdot in$ $A_7 = 6.25\cdot ft^2$ $W_7 := 50\cdot lbf$

$F_{w_7} := p_w \cdot A_7$ $F_{p_7} := 2\cdot a_h \cdot W_7$ $F_{w_7} = 152\cdot lbf$ $F_{p_7} = 32\cdot lbf$

TB-4& LD-1364/1368 $h_8 := 24\cdot in$ $w_8 := 30\cdot in$ $A_8 := h_8 \cdot w_8$ $y_8 := 26\cdot in$ $A_8 = 5.00\cdot ft^2$ $W_8 := 100\cdot lbf$

$F_{w_8} := p_w \cdot A_8$ $F_{p_8} := a_h \cdot W_8$ $F_{w_8} = 121\cdot lbf$ $F_{p_8} = 32\cdot lbf$ Δ1

LKD-102-32 $h_9 := 16\cdot in$ $w_9 := 16\cdot in$ $A_9 := h_9 \cdot w_9$ $y_9 := 27\cdot in$ $A_9 = 1.78\cdot ft^2$ $W_9 := 30\cdot lbf$ Δ1

$F_{w_9} := p_w \cdot A_9$ $F_{p_9} := a_h \cdot W_9$ $F_{w_9} = 43\cdot lbf$ $F_{p_9} = 10\cdot lbf$ MRC 5/8/9

LD-1364/1368 $h_{10} := 24\cdot in$ $w_{10} := 30\cdot in$ $A_{10} := h_{10} \cdot w_{10}$ $y_{10} := 32\cdot in$ $A_{10} = 5.00\cdot ft^2$ $W_{10} := 30\cdot lbf$ Δ1

$F_{w_{10}} := p_w \cdot A_{10}$ $F_{p_{10}} := a_h \cdot W_{10}$ $F_{w_{10}} = 121\cdot lbf$ $F_{p_{10}} = 10\cdot lbf$

The maximum load occurs at 600A Safety Switch.

$P_w := F_{w_3}$ $P_w = 256.16\cdot lbf$ For simplicity and added conservatism use: $P_w := 275\cdot lbf$

Seismic load is also controlling at 600A Safety Switch.

$P_e := F_{p_3}$ $P_e = 35\cdot lbf$ Use: $P_e := 40\cdot lbf$

<u>Check the foundation, 3'-0"x4'-0"x0'-8" deep pad:</u> $a := 4\cdot ft$ $b := 3\cdot ft$ $d := 8\cdot in$

Average density of reinforced concrete is: $\gamma := 150\cdot pcf$

Dead Weight $W_e := W_3 + 2\cdot 1.9\cdot \frac{lbf}{ft}\cdot(2\cdot 73.5\cdot in + 26\cdot in) + 2\cdot 4.08\cdot lbf$ $W_e = 82.94\cdot lbf$

$W_c := a\cdot b\cdot d\cdot \gamma$ $W_c = 1200.00\cdot lbf$

Bearing capacity of the soil from UBC Table 29B for sandy gravel is: $p_a := 2000\cdot psf$

The load on the footing is:

$W := W_e + W_c$ $W = 1282.94\cdot lbf$ say $W := 1400\cdot lbf$

$M := P_w \cdot 5\cdot ft$ $M = 1375.00\cdot ft\cdot lbf$

RO 5/8/9 Δ1

Check for negative soil pressure:

$p := \frac{W}{a \cdot b} - \frac{6 \cdot M}{a \cdot b^2}$ $p = -112.5 \cdot psf$ uplift at the end of foundation will occur.

$\Delta 1$

Find actual pressure distribution due to eccentricity:

$\Sigma M=0$

$b_1 := \left(\frac{b}{2} - \frac{M}{W}\right) \cdot 3$ $b_1 = 1.55 \cdot ft$

$\Sigma Y=0$

$p_{max} := \frac{2 \cdot W}{a \cdot b_1}$ $p_{max} = 450.6 \cdot psf$ $p_{max} \le p_a$ soil pressure is acceptable.

Check footing for overturning:

$M_s := \frac{W \cdot b}{2}$ $FS_o := \frac{M_s}{M}$

$FS_o = 1.53$ $FS_o \ge 1.5$ stability of the foundation is satisfactory.

Check unistrut section for stress:

Bending about major axis:

$M_x := \frac{M}{2}$ $M_x = 8250.00 \cdot lbf \cdot in$

Bending about minor axis:

$P_{wy} := (7 \cdot ft \cdot 3.25 \cdot in + 12.5 \cdot in \cdot 60.75 \cdot in) \cdot p_w$ $P_{wy} = 174.1 \cdot lbf$

$P_{sy} := W_e \cdot a_h$ $P_{sy} = 26.4 \cdot lbf$

$M_y := P_{wy} \cdot \left(7 \cdot ft - \frac{60.75 \cdot in}{2}\right) \cdot 0.5$ $M_y = 4668.8 \cdot lbf \cdot in$

Properties for the channel P1001 are as follows:

$A := 1.11 \cdot in^2$ $S_x := 0.572 \cdot in^3$ $S_y := 0.588 \cdot in^3$ $r_x := 0.915 \cdot in$ $r_y := 0.656 \cdot in$

$\sigma_x := \frac{M_x}{S_x}$ $\sigma_x = 14.42 \cdot ksi$ $\sigma_y := \frac{M_y}{S_y}$ $\sigma_y = 7.94 \cdot ksi$

The stresses found above occur at different location of the member, also they are a result of two non-concurent events, the combination is therefore not required.

Check members for axial load.

$C := \frac{W_e}{2}$ $C = 41.5 \cdot lbf$

$\Delta 1$

FLUOR DANIEL NORTHWEST INC.

DESIGN ANALYSIS

Client: WHC
Subject: Structural analysis of Safety Related Electrical Equipment Supports.
Location: 241-C-106 & 241-AY-102

WO/Job No.: ER 4319/W 320
Date: 10/17/95 By: M.B. Lasota
Checked: 12/19/95 By: R.W. Davidson
Revised: 5/05/97 By: M.B. Lasota

$l_x := 5 \cdot ft \qquad K_x := 2 \qquad Sr_x := \frac{K_x \cdot l_x}{r_x} \qquad Sr_x = 131.15$ Maximum slenderness ratio.

$\Delta 1$

$l_y := 5 \cdot ft - \frac{41 \cdot in}{2} \qquad K_y := 2 \qquad Sr_y := \frac{K_y \cdot l_y}{r_y} \qquad Sr_y = 120.43$

$E := 29000 \cdot ksi \qquad F_y := 33 \cdot ksi \qquad \frac{F_y}{2} = 16.50 \cdot ksi$

$F_{ex} := \frac{\pi^2 \cdot E}{Sr_x^2} \qquad F_{ex} = 16.64 \cdot ksi \qquad F_{ex} \geq \frac{F_y}{2} \qquad F_n := \left(1 - \frac{F_y}{4 \cdot F_{ex}}\right) \cdot F_y \qquad F_n = 16.64 \cdot ksi$

$R := \sqrt{\frac{F_y}{2 \cdot F_{ex}}} \qquad R = 0.995757 \qquad \Omega_c := \frac{5}{3} + \frac{3}{8} \cdot R - \frac{1}{8} \cdot R^3 \qquad \Omega_c = 1.92$

$P_n := A \cdot F_n \qquad P_n = 18470.10 \cdot lbf \qquad P_a := \frac{P_n}{\Omega_c} \qquad P_a = 9636.61 \cdot lbf \qquad P_a \geq C$ O.K..

Check standard Base for capacity.

Unistrut nut slip capacity is (ref Unistrut catalog No. 11 page 9):

$V_1 := 1500 \cdot lbf$

$V_a := 2 \cdot V_1 \qquad V_a = 3000.00 \cdot lbf$

Distance between centers of the bolts for part P 2073 A is: $D := 3.25 \cdot in$

Shear in the bolt due to moment is:

$V := \frac{M_x}{D} \qquad V = 2538.46 \cdot lbf \qquad V \leq V_a$ Part P 2073 A is adequate.

Check expansion anchors:

$d := 3 \cdot in + 0.8 \cdot 1.625 \cdot in + 2 \cdot 0.25 \cdot in \qquad d = 4.80 \cdot in$

$T_b := \frac{M_x}{d} \qquad T_b = 1718.75 \cdot lbf \qquad V_b := \frac{P_w}{8} \qquad V_b = 34.38 \cdot lbf$

For 5/8" dia HKB II with 2 3/4" min embedment, installed in f'_c=4000psi allowable loads are:

$T_a := 2000 \cdot lbf \qquad V_a := 2530 \cdot lbf$ Ref. A/E Standard GC-ANCR-01 rev. 0, table 21.

Interaction factor is:

$IF := \frac{T_b}{T_a} + \frac{V_b}{V_a} \qquad IF = 0.87 \qquad IF \leq 1.0$ O.K..

320C20R1.MCD

ICF KAISER HANFORD COMPANY

DESIGN ANALYSIS

Client: WHC
Subject: Structural analysis of Safety Related Electrical Equipment Supports.
Location: 241-C-106 & 241-AY-102

WO/Job No.: ER 4319/W 320
Date: 04/18/1996 By: M.B. Lasota
Checked 4/22/96 By: R.W. Davidson
Revised By

During installation the minimum edge distance at ITB-0621 could not be satisfied. The following is an evaluation of that perticular case.

Recall: $F_{w2} = 121.44 \cdot lbf$

$M := F_{w2} \cdot 2.5 \cdot ft$ $\quad M = 3643.20 \cdot lbf \cdot in$ $\quad M_x := \frac{M}{2}$ $\quad M_x = 1821.60 \cdot lbf \cdot in$

Check expansion anchors:

$d := 3 \cdot in + 0.8 \cdot 1.625 \cdot in + 2 \cdot 0.25 \cdot in$ $\quad d = 4.80 \cdot in$

$T_b := \frac{M_x}{d}$ $\quad T_b = 379.50 \cdot lbf$ $\quad V_b := \frac{F_{w2}}{8}$ $\quad V_b = 15.18 \cdot lbf$

For 5/8" dia HKB II with 2 3/4" min embedment, installed in f'_c=4000psi allowable loads are:

$T_a := 2000 \cdot lbf$ $\quad V_a := 2530 \cdot lbf$ Ref. A/E Standard GC-ANCR-01 rev. 0, table 21.

Due to violation of the edge distance reduction in anchor capacity is necessary:

Reduction factor in tension

$e_{min} := 2.75 \cdot in$ $\quad e_{max} := 6.25 \cdot in$ $\quad e := 5.5 \cdot in$ $\quad r_t := \frac{e + e_{max} - 2 \cdot e_{min}}{2 \cdot (e_{max} - e_{min})}$ $\quad r_t = 0.89$

Reduction factor in shear

$e_{min} := 4.125 \cdot in$ $\quad e_{max} := 8.25 \cdot in$ $\quad e := 5.5 \cdot in$ $\quad r_v := \frac{e + e_{max} - 2 \cdot e_{min}}{2 \cdot (e_{max} - e_{min})}$ $\quad r_v = 0.67$

Interaction factor is:

$IF := \frac{T_b}{r_t \cdot T_a} + \frac{V_b}{r_v \cdot V_a}$ $\quad IF = 0.22$ $\quad IF \le 1.0$ $\quad$ ok.

MCAD FILE: 3202429C

Client: WHC
Subject: Structural analysis of Safety Related Electrical Equipment Supports.
Location: 241-C-106 & 241-AY-102

WO/Job No.: ER 4319/W 320
Date: 5/05/97 By: M.B. Lasota
Checked 5/8/97 By: M.R. Custer
Revised By

Athough the maximum load occurs at 600A Safety Switch, the foundation supplied is larger than the rest of the pads. The second largest load occurs at the rack for TB4&LD-1364/1368. This rack is located on 3'X3' pad.

F_{w_i} (lbf)	F_{p_i} (lbf)
54	13
121	24
256	35
29	6
121	24
97	16
152	32
121	32
43	10
121	10

$P_w := F_{w_8}$ $\quad P_w = 121 \cdot lbf$ For simplicity and added conservatism use: $P_w := 130 \cdot lbf$

Seismic load respecively is:

$P_e := F_{p_8}$ $\quad P_e = 32 \cdot lbf$ Use: $P_e := 40 \cdot lbf$

<u>Check the foundation, 3'-0"x3'-0"x0'-8" deep pad:</u> $a := 3 \cdot ft$ $\quad b := 3 \cdot ft$ $\quad d := 8 \cdot in$

Average density of reinforced concrete is: $\gamma := 150 \cdot pcf$

Dead Weight $\quad W_e := W_3 + 2 \cdot 1.9 \cdot \frac{lbf}{ft} \cdot (2 \cdot 36 \cdot in + 32 \cdot in) + 2 \cdot 4.08 \cdot lbf$ $\quad W_e = 61.09 \cdot lbf$

$W_c := a \cdot b \cdot d \cdot \gamma$ $\quad W_c = 900 \cdot lbf$

Bearing capacity of the soil from UBC Table 29B for sandy gravel is: $p_a := 2000 \cdot psf$

The load on the footing is:

$W := W_e + W_c$ $\quad W = 961 \cdot lbf$ say $W := 1000 \cdot lbf$

$M := P_w \cdot 26 \cdot in$ $\quad M = 282 \cdot ft \cdot lbf$

Check for negative soil pressure:

$p := \frac{W}{a \cdot b} - \frac{6 \cdot M}{a \cdot b^2}$ $\quad p = 48.5 \cdot psf$ uplift at the end of foundation will not occur.

Find maximum soil pressure:

$p_{max} := \frac{W}{a \cdot b} + \frac{6 \cdot M}{a \cdot b^2}$ $\quad p_{max} = 174 \cdot psf$ $\quad p_{max} \le p_a$ soil pressure is acceptable.

Check footing for overturning:

$M_s := \frac{W \cdot b}{2}$ $\quad FS_o := \frac{M_s}{M}$

$FS_o = 5.33$ $\quad FS_o \ge 1.5$ stability of the foundation is satisfactory.

Design of the members and connections based on the rack for 600A Safety Switch is still applicable.

ICF KAISER HANFORD COMPANY

DESIGN ANALYSIS

Client: WHC
Subject: Structural analysis of Safety Related Electrical Equipment Supports.
Location: 241-C-106 & 241-AY-102

WO/Job No.: ER 4319/W 320
Date: 07/11/1996 By: M.B. Lasota
Checked 7/12/96 By: R.W Davidson
Revised By

Evaluation of the conduit support outside Process Building - see Figure 11 pages 41 & 42.

Seismic Load

The weight per foot of the conduit and maximum span for each individual conduit on the governing Support #1 is:

3S019 - 3"	$d_1 := 3.5 \cdot in$	$dw_1 := 14.5 \cdot plf$	$l_1 := 20 \cdot ft$	$W_1 := dw_1 \cdot l_1$	$W_1 = 290.0 \cdot lbf$	$h_1 := 107.75 \cdot in$
3S027 - 2 1/2"	$d_2 := 2.875 \cdot in$	$dw_2 := 10.2 \cdot plf$	$l_2 := 16 \cdot ft$	$W_2 := dw_2 \cdot l_2$	$W_2 = 163.2 \cdot lbf$	$h_2 := 107.44 \cdot in$
3S021 - 1 1/2"	$d_3 := 1.9 \cdot in$	$dw_3 := 4.5 \cdot plf$	$l_3 := 14 \cdot ft$	$W_3 := dw_3 \cdot l_3$	$W_3 = 63.0 \cdot lbf$	$h_3 := 106.95 \cdot in$
3P240 - 1"	$d_4 := 1.315 \cdot in$	$dw_4 := 2.3 \cdot plf$	$l_4 := 12 \cdot ft$	$W_4 := dw_4 \cdot l_4$	$W_4 = 27.6 \cdot lbf$	$h_4 := 106.66 \cdot in$
3P002 - 1"	$d_5 := 1.315 \cdot in$	$dw_5 := 2.3 \cdot plf$	$l_5 := 12 \cdot ft$	$W_5 := dw_5 \cdot l_5$	$W_5 = 27.6 \cdot lbf$	$h_5 := 106.66 \cdot in$
3P006 - 1"	$d_6 := 1.315 \cdot in$	$dw_6 := 2.3 \cdot plf$	$l_6 := 12 \cdot ft$	$W_6 := dw_6 \cdot l_6$	$W_6 = 27.6 \cdot lbf$	$h_6 := 106.66 \cdot in$
3C014 - 1"	$d_7 := 1.315 \cdot in$	$dw_7 := 2.3 \cdot plf$	$l_7 := 12 \cdot ft$	$W_7 := dw_7 \cdot l_7$	$W_7 = 27.6 \cdot lbf$	$h_7 := 106.66 \cdot in$
3S022 - 3/4"	$d_8 := 1.05 \cdot in$	$dw_8 := 1.4 \cdot plf$	$l_8 := 10 \cdot ft$	$W_8 := dw_8 \cdot l_8$	$W_8 = 14.0 \cdot lbf$	$h_8 := 106.53 \cdot in$
3C012 - 3/4"	$d_9 := 1.05 \cdot in$	$dw_9 := 1.4 \cdot plf$	$l_9 := 10 \cdot ft$	$W_9 := dw_9 \cdot l_9$	$W_9 = 14.0 \cdot lbf$	$h_9 := 106.53 \cdot in$
3P007 - 3/4"	$d_{10} := 1.05 \cdot in$	$dw_{10} := 1.4 \cdot plf$	$l_{10} := 10 \cdot ft$	$W_{10} := dw_{10} \cdot l_{10}$	$W_{10} = 14.0 \cdot lbf$	$h_{10} := 106.53 \cdot in$
3S024 - 3/4"	$d_{11} := 1.05 \cdot in$	$dw_{11} := 1.4 \cdot plf$	$l_{11} := 10 \cdot ft$	$W_{11} := dw_{11} \cdot l_{11}$	$W_{11} = 14.0 \cdot lbf$	$h_{11} := 106.53 \cdot in$

Center of gravity of the conduit with respect to grade level is as follows:

$i := 1,2..11 \qquad M_x := \sum_i W_i \cdot h_i \qquad M_x = 6105.0 \cdot ft \cdot lbf$

$W := \sum_i W_i \qquad W = 682.6 \cdot lbf$

$y_o := \frac{M_x}{W} \qquad y_o = 107.33 \cdot in$

Assuming, support will develop negligible frame action the overturning moment will be distributed evenly between posts.

$W_{adj} := W + 2 \cdot 9 \cdot ft \cdot 6.87 \cdot \frac{lbf}{ft} + 2 \cdot 3.5 \cdot ft \cdot 1.9 \cdot \frac{lbf}{ft} \qquad W_{adj} = 819.56 \cdot lbf$

$M_{xadj} := M_x + 2 \cdot 9 \cdot ft \cdot 6.87 \cdot \frac{lbf}{ft} \cdot 4.5 \cdot ft + 3.5 \cdot ft \cdot 1.9 \cdot \frac{lbf}{ft} \cdot 94 \cdot in + 3.5 \cdot ft \cdot 1.9 \cdot \frac{lbf}{ft} \cdot 106 \cdot in \qquad M_{xadj} = 6772.35 \cdot ft \cdot lbf$

$y_{oadj} := \frac{M_{xadj}}{W_{adj}} \qquad y_{oadj} = 99.16 \cdot in \qquad F := a_h \cdot W_{adj} \qquad F = 260.62 \cdot lbf \qquad M_c := M_{xadj} \cdot a_h \qquad M_c = 25.84 \cdot in \cdot kips$

Client: WHC
Subject: Structural analysis of Safety Related Electrical Equipment Supports.
Location: 241-C-106 & 241-AY-102

WO/Job No.: ER 4319/W 320
Date: 07/11/1996 By: M.B. Lasota
Checked 7/12/96 By: R.W Davidson
Revised By

Wind Load

Wind pressure ref. ASCE 7-93 " Minimum Design Loads for Buildings and Other Structures".

From SDC 4.2 rev. 11 the following are parameters used in wind pressure calculation for Safety Class 3 structures:

Basic wind speed: $V := 70 \cdot mph$
Importance Factor: $I := 1.07$
Exposure Category: C

$K_z := 0.8$

$q_z := 0.00256 \cdot K_z \cdot \left(\frac{I \cdot V}{mph}\right)^2 \cdot psf$ $\qquad q_z = 11.49 \cdot psf$

use $\quad q_z := 11.5 \cdot psf$

From Table 4. for other structures: $G_h := 1.32$

Calculate wind exposure area.

Length of the conduit exposed to wind is:

$L_1 := 94 \cdot in + d_2 \qquad L_1 = 96.88 \cdot in$

$L_2 := 106 \cdot in + d_1 \qquad L_2 = 109.50 \cdot in$

Area of the conduit is: $\quad m := 3, 4 .. 7$

$$A_c := \left(d_1 + \sum_m d_m + d_{10}\right) \cdot (L_2 - 2 \cdot in) + (d_2 + d_8 + d_9 + d_{11}) \cdot (L_1 - 2 \cdot in) \qquad A_c = 12.71 \cdot ft^2$$

Area of the frame is:

$A_f := 2 \cdot (L_2 - 2 \cdot in + 3 \cdot in) \cdot 3 \cdot in + 4 \cdot 1.625 \cdot in \cdot 45 \cdot in \qquad A_f = 6.64 \cdot ft^2$

Solid area is:

$A_s := A_c + A_f \qquad A_s = 19.35 \cdot ft^2$

Gross area is:

$A_g := 45 \cdot in \cdot (L_2 - 2 \cdot in) \qquad A_g = 33.59 \cdot ft^2 \qquad \varepsilon := \frac{A_s}{A_g} \qquad \varepsilon = 0.58$

Average diameter of the round lattice member is:

$$d_{av} := \frac{\sum_i d_i + 2 \cdot 3 \cdot in + 4 \cdot 1.625 \cdot in}{11 + 6} \qquad d_{av} = 0.15 \cdot ft$$

$\frac{d_{av}}{ft} \cdot \sqrt{\frac{q_z}{psf}} = 0.50$ $\qquad$ from table 14, C_f is: $\qquad C_f := 1.5$

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DESIGN ANALYSIS

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$A_f := A_g$

Wind load therefore is:

$F_w := q_z \cdot G_h \cdot C_f A_f$ $\quad F_w = 764.93 \cdot lbf$

$M_w := F_w \cdot \dfrac{L_2 - 2 \cdot in}{2}$ $\quad M_w = 41.11 \cdot kips \cdot in$ $\quad M_w \ge M_c$ Wind case governs.

<u>Check the foundation, 5'-6"x4'-0"x0'-8" deep pad:</u> $a := 5.5 \cdot ft$ $\quad b := 4 \cdot ft$ $\quad d := 8 \cdot in$ $\quad w_t := 9.42 \cdot \dfrac{lbf}{ft}$

Assume density of concrete to be: $\gamma := 150 \cdot pcf$

Dead Weight: $W_{adj} = 819.56 \cdot lbf$

$W_c := a \cdot b \cdot d \cdot \gamma$ $\quad W_c = 2200.00 \cdot lbf$

Bearing capacity of the soil from UBC Table 29B for sandy gravel is:

$p_a := 2000 \cdot psf$

The load on the footing is:

$W := W_{adj} + W_c$ $\quad W = 3019.56 \cdot lbf$

$M := F_w \cdot \dfrac{L_2 - 2 \cdot in}{2}$ $\quad M = 3426.25 \cdot ft \cdot lbf$

Check for negative soil pressure:

$p := \dfrac{W}{a \cdot b} - \dfrac{6 \cdot M}{a \cdot b^2}$ $\quad p = -96.4 \cdot psf$ $\quad$ uplift at the end of foundation will occur.

Find actual pressure distribution due to eccentricity:

$\Sigma M=0$

$b_1 := \left(\dfrac{b}{2} - \dfrac{M}{W}\right) \cdot 3$ $\quad b_1 = 2.60 \cdot ft$

$\Sigma Y=0$

$p_{max} := \dfrac{2 \cdot W}{a \cdot b_1}$ $\quad p_{max} = 423 \cdot psf$ $\quad p_{max} \le p_a$ $\quad$ soil pressure is acceptable.

Check footing for overturning:

$M_s := \dfrac{W \cdot b}{2}$ $\quad FS_o := \dfrac{M_s}{M}$

$FS_o = 1.76$ $\quad FS_o \ge 1.5$ $\quad$ stability of the foundation is satisfactory.

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Check TS3X3X0.1875 column for stress.

$C := \frac{W_{adj}}{2}$ $C = 409.78 \cdot lbf$

$M_c := \frac{M}{2}$ $M_c = 20557.49 \cdot lbf \cdot in$

Properties of the column are (ASTM A500 Gr B): $F_y := 42 \cdot ksi$

$A := 2.02 \cdot in^2$ $S := 1.73 \cdot in^3$ $r := 1.13 \cdot in$ $l := 9 \cdot ft$ $K := 2.0$

$S_r := \frac{K \cdot l}{r}$ $S_r = 191.15$ $C_c = 126.10$ $S_r \ge C_c$

$F_a := \frac{12 \cdot \pi^2 \cdot E}{23 \cdot S_r^2}$ $F_a = 4086.96 \cdot psi$ $f_a := \frac{C}{A}$ $f_a = 202.86 \cdot psi$ $\frac{f_a}{F_a} = 0.05$

$F_{bx} := 0.6 \cdot F_y$ $F_{bx} = 25.20 \cdot ksi$ $f_{bx} := \frac{M_c}{S}$ $f_{bx} = 11.88 \cdot ksi$

$IF := \frac{f_a}{F_a} + \frac{f_{bx}}{F_{bx}}$ $IF = 0.52$ $IF \le 1.00$ O.K..

Check Base Plate for capacity. $t_{pl} := 0.625 \cdot in$ $a_{pl} := 10 \cdot in$ $b_{pl} := a_{pl}$

Check expansion anchors:

$l_1 := 2.125 \cdot in$ $l_{01} := 1.5 \cdot in + 2 \cdot t_{pl} + 0.5 \cdot a_{pl} - 1.25 \cdot in$ $l_{01} = 6.50 \cdot in$

$l_2 := 2.125 \cdot in$ $l_{02} := 1.5 \cdot in + 2 \cdot t_{pl} + 0.5 \cdot a_{pl} - 1.25 \cdot in$ $l_{02} = 6.50 \cdot in$

$M := M_c$ $M = 20.56 \cdot kips \cdot in$

$$M = T_{max} \cdot \left[l_{01} + \left(\frac{l_1}{l_2} \right)^2 \cdot l_{02} \right]$$

$T_{max} := \frac{M}{l_{01} + \left(\frac{l_1}{l_2} \right)^2 \cdot l_{02}}$ $T_{max} = 1581.35 \cdot lbf$ $T_{min} := T_{max} \cdot \left(\frac{l_1}{l_2} \right)^2$ $T_{min} = 1581.35 \cdot lbf$

$T_b := T_{max}$ $T_b = 1581.35 \cdot lbf$ $V_b := \frac{F_w}{8}$ $V_b = 95.62 \cdot lbf$

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DESIGN ANALYSIS

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Checked 7/12/96 By: R.W Davidson
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For 5/8" dia HKB II with 2 3/4" min. embedment, installed in f'_c=4000psi concrete, allowable loads are:

$T_a := 2000 \cdot lbf$ $V_a := 2530 \cdot lbf$ Ref. A/E Standard GC-ANCR-01 rev 0 table 21.

Interaction factor is:

$IF := \frac{T_b}{T_a} + \frac{V_b}{V_a}$ $IF = 0.83$ $IF \le 1.0$ O.K..

Check stress in the base plate (ASTM A36): $F_y := 36 \cdot ksi$

$t_{pl} := 0.625 \cdot in$

$f_b := \frac{6 \cdot T_b}{t_{pl}^2}$ $f_b = 24.29 \cdot ksi$ $F_b := 0.75 \cdot F_y$ $F_b = 27.00 \cdot ksi$ $f_b \le F_b$ O.K..

Client: WHC
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Location: 241-C-106 & 241-AY-102.

WO/Job No.: ER 4319/W 320
Date: 04/18/1996 By: M.B. Lasota
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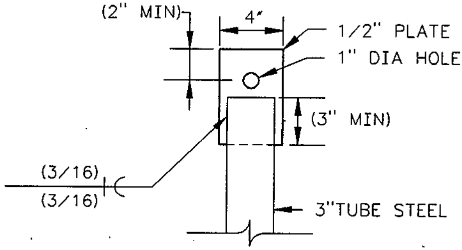
Revised By

Evaluation of the ECN W-320-251.



LIFTING EYE DETAIL

Determine weld capacity, electrode used E70XX:

$l_w := 3\cdot in - 2\cdot\frac{3}{16}\cdot in$ $\quad l_w = 2.62\cdot in$ $\quad$ length of the weld.

$t_w := \frac{3}{16}\cdot in$ $\quad$ effective throat of the weld.

$SF := 5 \qquad F_{uw} := 70\cdot ksi$

$P_{all} := \frac{2\cdot l_w\cdot t_w\cdot F_{uw}}{SF}$ $\qquad P_{all} = 13.78\cdot kips$

Determine capacity of the plate, material - ASTM A36:

Bearing, ref.: "Steel Structures, Design and Behavior" second edition C. G. Salmon, J. E. Johnson.

$t_{pl} := 0.5\cdot in \qquad F_{us} := 58\cdot ksi \qquad L_e := 2\cdot in \qquad SF = 5.00$

$P_{all} := \frac{F_{us}\cdot t_{pl}\cdot L_e}{SF}$ $\qquad P_{all} = 11.60\cdot kips$

Plate tension:

$F_{ys} := 36\cdot ksi \qquad SF := 3 \qquad b := 4\cdot in \qquad D := 1\cdot in$

$P_{all} := \frac{(b - D)\cdot t_{pl}\cdot F_{ys}}{SF}$ $\qquad P_{all} = 18.00\cdot kips$

Conclusion: Bearing strength governs thus the capacity of the Lifting Eye is: 11600 lbf.

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Foundation for Nitrogen Purge Bottle Station

Determine the Wind Load:

Exposure area:

$w := 5.25 \cdot ft$ $\quad h := 6.25 \cdot ft$ $\quad A := w \cdot h$ $\quad A = 32.81 \cdot ft^2$

From SDC 4.1 rev. 11 the following are parameters used in wind pressure calculation for Safety Class 3 structures:

Basic wind speed: $V := 70 \cdot mph$
Importance Factor: $I := 1.07$
Exposure Category: C

$K_z := 0.8$

$q_z := 0.00256 \cdot K_z \cdot \left(\frac{I \cdot V}{mph}\right)^2 \cdot psf$ $\quad q_z = 11.49 \cdot psf$

use $q_z := 11.5 \cdot psf$

From Table 4. for other structures: $G_h := 1.32$

and from table 13. $C_f := 1.6$ $\quad p_w := q_z \cdot G_h \cdot C_f$ $\quad p_w = 24.29 \cdot psf$

$F_w := p_w \cdot A$ $\quad F_w = 0.80 \cdot kips$

Dead weight of rack and the equipment is:

$w_{1x1} := 0.8 \cdot plf$ $\quad l_{1x1} := 6 \cdot 5.25 \cdot ft$ $\quad l_{1x1} = 31.50 \cdot ft$ $\quad W_{1x1} := w_{1x1} \cdot l_{1x1}$ $\quad W_{1x1} = 25.20 \cdot lbf$

$w_{2x2} := 3.19 \cdot plf$ $\quad l_{2x2} := (3 \cdot (6.25 + 3 + 1.17) + 5.25 + 3.5) \cdot ft$ $\quad l_{2x2} = 40.01 \cdot ft$

$W_{2x2} := w_{2x2} \cdot l_{2x2}$ $\quad W_{2x2} = 127.63 \cdot lbf$

$W_{n2} := 3 \cdot 150 \cdot lbf$ $\quad W_{n2} = 450.00 \cdot lbf$

Estimating miscellaneous equipment and hardware as 10% of the total weight, the design max weight is:

$W_{max} := \left(W_{1x1} + W_{2x2} + W_{n2}\right) \cdot 1.1$ $\quad W_{max} = 663.12 \cdot lbf$

Assume the minimum weight to be 80% of the maximum weight.

In order to satisfy FS=1.5 against overturn the foundation width should be no less than the following:

$d_f := 8 \cdot in$ $\quad \gamma_{rc} := 150 \cdot pcf$ $\quad l_f := 6.5 \cdot ft$ $\quad b_f = x$ $\quad FS := 1.5$

let $x := 12 \cdot in, 15 \cdot in .. 60 \cdot in$

Stabilizing weight is - $W_s(x) := 0.8 \cdot W_{max} + d_f \cdot \gamma_{rc} \cdot l_f \cdot x$

Stabilizing moment is - $M_s(x) := W_s(x) \cdot \frac{x}{2}$

MCAD FILE: 3202429C

Overturning moment is:

$M_o := F_w \cdot \frac{h}{2}$ $\quad M_o = 2490.47 \cdot ft \cdot lbf$

$M(x) := M_s(x) - FS \cdot M_o \quad x := 3.006749 \cdot ft \quad root(M(x), x) = 3.006749 \cdot ft \quad M(x) = 0.00 \cdot lbf \cdot ft$

$x := 4.0 \cdot ft$

$W_s(x) := 0.8 \cdot W_{max} + d_f \gamma_{rc} \cdot l_f x \quad W_s(x) = 3130.49 \cdot lbf \quad M_s(x) = 6260.98 \cdot lbf \cdot ft$

$b_f := x \quad W_s := W_s(b_f) \quad W_s = 3130.49 \cdot lbf$

$p := \frac{W_s}{l_f b_f} - \frac{6 \cdot M_o}{l_f b_f^2} \quad p = -23.3 \cdot psf$ uplift at the end of foundation will occur.

Find actual pressure distribution due to moment:

$\Sigma M=0$

$b_1 := \left(\frac{b_f}{2} - \frac{M_o}{W_s}\right) \cdot 3 \quad b_1 = 3.61 \cdot ft$

$\Sigma Y=0$

$W_s(x) := W_{max} + d_f \gamma_{rc} \cdot l_f x \quad W_s(x) = 3263.12 \cdot lbf$

$b_f := x \quad W_s := W_s(b_f) \quad W_s = 3263.12 \cdot lbf$

$p_{max} := \frac{2 \cdot W_s}{l_f b_1} \quad p_{max} = 277.9 \cdot psf \quad p_{max} \le p_a$ soil pressure is acceptable.

Check footing for overturning:

$FS := \frac{M_s(b_f)}{M_o}$

$FS = 2.51 \quad FS \ge 1.5$ stability of the foundation is satisfactory.

Provide foundation pad 4'-0"x6'-6"x0'-8".

Evaluation of the anchorage.

Overturning moment caused by wind must be resisted by the anchorage system. In further analysis weight of rack will be neglected for simplicity and added conservatism.

$M_o = 29.89 \cdot kips \cdot in$

The overturning moment will be resisted by three identical frames. Each frame will resist a portion of the moment proportional to a distance between frames. Middle frame will carry the highest moment that amounts to:

$l_1 := 19.75 \cdot in \qquad l_2 := 51 \cdot in - l_1$

$M_{om} := M_o \cdot \dfrac{l_1 + l_2}{2 \cdot (l_1 + l_2)} \qquad M_{om} = 14.94 \cdot kips \cdot in$

Tension in expansion anchor is:

$l_{base} := 17 \cdot in \qquad ed_{bolt} := 1.75 \cdot in \qquad a := 3 \cdot in$ *- distance to the compression member (base inflection point)*

$T_b := \dfrac{M_{om}}{l_{base} - a - ed_{bolt}} \qquad T_b = 1.22 \cdot kips$

$V_b := \dfrac{F_w}{2 \cdot 2} \qquad V_b = 0.20 \cdot kips$

Using HKBII 1/2 ϕ with 3.5 min embedment installed in f_c'=4000psi concrete, ref GC-ANCR-01 rev. 1 table 21, interaction equation is:

$T_{all} := 10.0 \cdot kN \qquad T_{all} = 2.25 \cdot kips \qquad V_{all} := 6.53 \cdot kN \qquad V_{all} = 1.47 \cdot kips$

$IF := \dfrac{T_b}{T_{all}} + \dfrac{V_b}{V_{all}} \qquad IF = 0.68$

Anchorage is adequate.

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Meter and Socket Mounting Rack - Figure 14, page 45, (ref dwg H-2-820752 sheet 3).

The analysis of the rack and its foundation will include an influence of the environmental loads i.e.. Wind and Seismic. The loads are calculated on the basis outlined in UBC.

Wind Load. $i := 1..8$

From observation, the critical wind exposure appears on the frontal area of the rack (maximum Area of exposure). The following is the calculation of the exposure area and its center of gravity.

Box :	$h_1 := 52\cdot in$	$w_1 := 36\cdot in$	$A_1 := h_1 \cdot w_1$	$y_1 := 42\cdot in$	$A_1 = 13.00\cdot ft^2$	$Q_1 := A_1 \cdot y_1$	$W_1 := 200\cdot lbf$
Uni 1:	$h_2 := 16\cdot in$	$w_2 := 1.625\cdot in$	$A_2 := h_2 \cdot w_2$	$y_2 := 8\cdot in$	$A_2 = 0.18\cdot ft^2$	$Q_2 := A_2 \cdot y_2$	$W_2 := 22.2\cdot lbf$
Uni 2:	$h_3 := 16\cdot in$	$w_3 := 1.625\cdot in$	$A_3 := h_3 \cdot w_3$	$y_3 := 8\cdot in$	$A_3 = 0.18\cdot ft^2$	$Q_3 := A_3 \cdot y_3$	$W_3 := 22.2\cdot lbf$
Uni 3:	$h_4 := 1.625\cdot in$	$w_4 := 36\cdot in$	$A_4 := h_4 \cdot w_4$	$y_4 := 5.8125\cdot in$	$A_4 = 0.41\cdot ft^2$	$Q_4 := A_4 \cdot y_4$	$W_4 := 6\cdot lbf$
Cond1:	$h_5 := 18\cdot in$	$w_5 := 4.5\cdot in$	$A_5 := h_5 \cdot w_5$	$y_5 := 9\cdot in$	$A_5 = 0.56\cdot ft^2$	$Q_5 := A_5 \cdot y_5$	$W_5 := 0\cdot lbf$
Cond2:	$h_6 := 18\cdot in$	$w_6 := 4.5\cdot in$	$A_6 := h_6 \cdot w_6$	$y_6 := 9\cdot in$	$A_6 = 0.56\cdot ft^2$	$Q_6 := A_6 \cdot y_6$	$W_6 := 0\cdot lbf$
Cond3:	$h_7 := 18\cdot in$	$w_7 := 4.5\cdot in$	$A_7 := h_7 \cdot w_7$	$y_7 := 9\cdot in$	$A_7 = 0.56\cdot ft^2$	$Q_7 := A_7 \cdot y_7$	$W_7 := 0\cdot lbf$
Cond4:	$h_8 := 18\cdot in$	$w_8 := 4.5\cdot in$	$A_8 := h_8 \cdot w_8$	$y_8 := 9\cdot in$	$A_8 = 0.56\cdot ft^2$	$Q_8 := A_8 \cdot y_8$	$W_8 := 0\cdot lbf$

$i := 1..8$

$A := \sum_i A_i \qquad A = 16.02\cdot ft^2$

$Q := \sum_i Q_i \qquad Q = 47.63\cdot ft^3$

$y_o := \dfrac{Q}{A} \qquad y_o = 35.68\cdot in$ for wind load computation increase area by 25% $A_f := 1.25\cdot A \qquad A_f = 20.02\cdot ft^2$

Wind pressure ref. ASCE 7-93 " Minimum Design Loads for Buildings and Other Structures".

From SDC 4.1 rev. 11 the following are parameters used in wind pressure calculation for Safety Class 3 structures:

Basic wind speed: $V := 70\cdot mph$
Importance Factor: $I := 1.07$
Exposure Category: C

$K_z := 0.8$

$$q_z := 0.00256\cdot K_z \cdot \left(\frac{I\cdot V}{mph}\right)^2 \cdot psf \qquad q_z = 11.49\cdot psf$$

use $q_z := 11.5\cdot psf$

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WO/Job No.: ER 4319/W 320
Date: 7/26/96 By: M.B. Lasota
Checked 7/29/96 By: R.W. Davidson
Revised By

From Table 4. for other structures: $G_h := 1.32$

and from table 13: $C_f := 1.6$

Wind load therefore is:

$F_w := q_z \cdot G_h \cdot C_f A_f$ $\quad F_w = 486.3 \cdot lbf$ $\quad M_w := F_w \cdot y_o$ $\quad M_w = 17351 \cdot lbf \cdot in$

Seismic load per UBC (36-1)

$F_p = Z \cdot I \cdot C_p \cdot W_p$

From SDC 4.1 rev 11 : $Z := 0.12$ $\quad I := 1.25$ $\quad C_p := 2.12$ $\quad a_h := Z \cdot I \cdot C_p$ $\quad a_h = 0.32$

Adjusting the location of the center of gravity of the vertical members to reflect the actual mass center of gravity rather than area center of gravity as formerly calculated, and adding the contribution of two horizontal P1001 channels, the mass center of gravity is as follows:

$y_2 := 35 \cdot in$ $\quad y_3 := 35 \cdot in$

Uni 4: $h_9 := 1.625 \cdot in$ $\quad w_9 := 36 \cdot in$ $\quad y_9 := 17.8125 \cdot in$ $\quad W_9 := 11.4 \cdot lbf$

Uni 5: $h_{10} := 1.625 \cdot in$ $\quad w_{10} := 36 \cdot in$ $\quad y_{10} := 66.1875 \cdot in$ $\quad W_{10} := 11.4 \cdot lbf$

The weight of four stubbed-out 4" conduits is indicated as 0, since they are relatively stiff and self-supported.

$j := 1 .. 10$

$M_x := \sum_j W_j \cdot y_j$ $\quad M_x = 10946.48 \cdot lbf \cdot in$

$W_x := \sum_j W_j$ $\quad W_x = 273.20 \cdot lbf$

$F_s := a_h \cdot W_x$ $\quad F_s = 86.9 \cdot lbf$

$M_s := a_h \cdot M_x$ $\quad M_s = 3481 \cdot lbf \cdot in$

Compare wind and seismic loads.

$F_s = 86.9 \cdot lbf$ $\quad M_s = 3481 \cdot lbf \cdot in$

$F_w = 486.3 \cdot lbf$ $\quad M_w = 17351 \cdot lbf \cdot in$

It is evident that the wind load governs.

From Shannon & Wilson inc. "Final Report of Geotechnical Studies W 320 Waste Retrieval and Sluicing System 200 East Area, Hanford Site", April 1994, soil properties are:

$\gamma := 115 \cdot pcf$ $\quad \phi := 37 \cdot deg$

Rankine passive lateral earth pressure is:

$p := \frac{1+\sin(\phi)}{1-\sin(\phi)} \cdot \gamma$ $\quad p = 462.62 \cdot \frac{psf}{ft}$

From UBC 2907 6 (g) 2.

$S_1 := p$

$b := 12 \cdot in$ $\quad h := y_o$ $\quad h = 35.68 \cdot in$

$P := \frac{F_w}{2}$ $\quad P = 0.24 \cdot kips$

$\alpha := 3 \cdot 2.34 \cdot \frac{P}{b \cdot S_1}$ $\quad \alpha = 3.69 \cdot ft^2$

Assume: $d := 33.80212 \cdot in$

$A_o := \frac{\alpha}{d}$ $\quad A_o = 1.31 \cdot ft$

$u := \frac{A_o}{2} \cdot \left(1 + \sqrt{1 + \frac{4.36 \cdot h}{A_o}}\right)$ $\quad u = 33.80212 \cdot in$

<u>Existing embedment depth of 5'-0" is adequate</u>

Check P1001 column for stress.

$C := \frac{W_x}{2}$ $\quad C = 136.60 \cdot lbf$ $\quad M := \frac{M_w}{2}$ $\quad M = 8675.37 \cdot lbf \cdot in$

Properties of the column are:

$A := 1.11 \cdot in^2$ $\quad S := .572 \cdot in^3$ $\quad r := .915 \cdot in$ $\quad l := 5.8333 \cdot ft$ $\quad K := 2.0$

$E := 29000 \cdot ksi$ $\quad F_y := 41.67 \cdot ksi$ $\quad C_c := \sqrt{\frac{2 \cdot \pi^2 \cdot E}{F_y}}$ $\quad C_c = 117.21$

$S_r := \frac{K \cdot l}{r}$ $\quad S_r = 153.00$ $\quad C_c = 117.21$ $\quad S_r \ge C_c$

$F_a := \frac{12 \cdot \pi^2 \cdot E}{23 \cdot S_r^2}$ $\quad F_a = 6378.85 \cdot psi$ $\quad f_a := \frac{C}{A}$ $\quad f_a = 123.06 \cdot psi$ $\quad \frac{f_a}{F_a} = 0.02$

$F_{bx} := 0.6 \cdot F_y$ $\quad F_{bx} = 25.00 \cdot ksi$ $\quad f_{bx} := \frac{M}{S}$ $\quad f_{bx} = 15.17 \cdot ksi$

$IF := \frac{f_a}{F_a} + \frac{f_{bx}}{F_{bx}}$ $\quad IF = 0.63$ $\quad IF \le 1.00$ $\quad$ O.K..

Buckling in the other direction is not critical due to a membrane action of the Box. All other members are adequate.

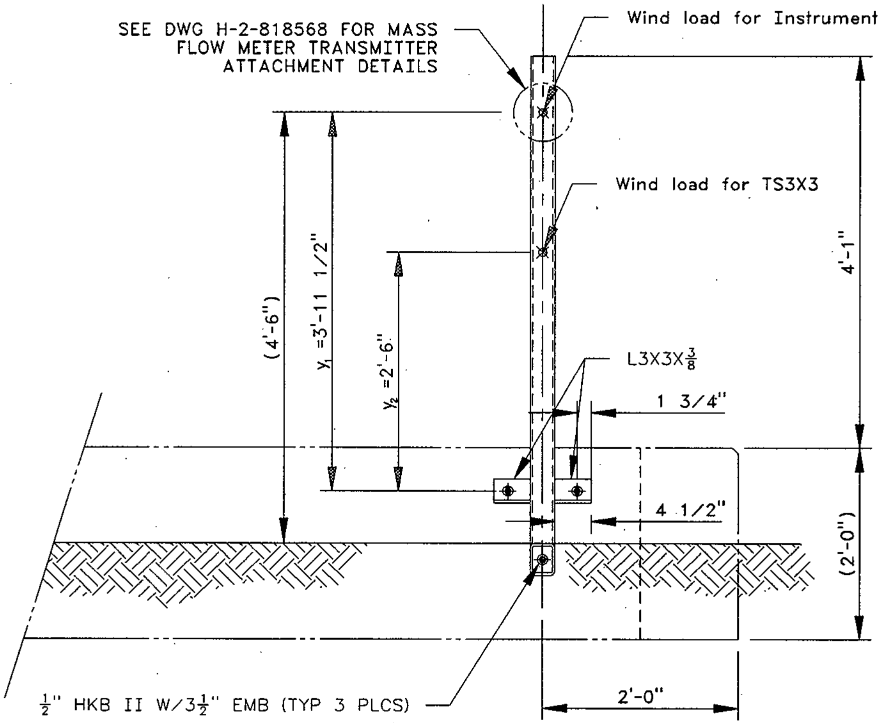
FLUOR DANIEL
NORTHWEST INC.

DESIGN ANALYSIS

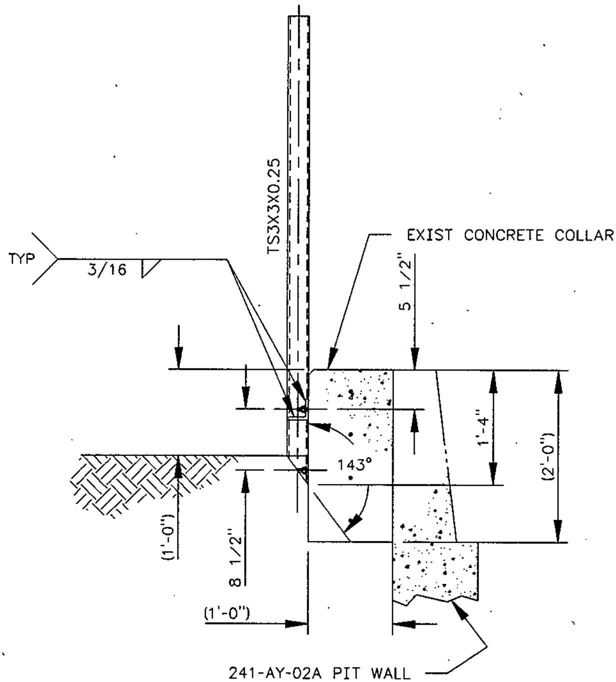
Client: NHC
Subject: Structural analysis of Safety Related Electrical Equipment Supports.
Location: 241-C-106 & 241-AY-102

WO/Job No.: ER 4319/W 320
Date: 3/06/97 By: M.B. Lasota
Checked 5/8/97 By: R.W. Davidson
Revised By

Design and analysis of the restraint for the Mass Flow Meter.



ELEVATION LOOKING SOUTH AT THE EQUIPMENT ATTACHED TO THE CONCRETE COLLAR



SECTION LOOKING EAST AT THE EQUIPMENT ATTACHED TO THE CONCRETE COLLAR

The analysis of the frame and its anchorage will include an influence of the environmental loads i.e.. Wind and Seismic. The loads are calculated on the basis outlined in UBC.

Wind Load. $i := 1..2$

From observation, the critical wind exposure appears on the frontal area of the frame (maximum Area of exposure). The following is the calculation of the exposure area and its center of gravity. Y=0 is at the elevation of top anchors.

Box :	$h_1 := 12 \cdot in$	$w_1 := 9 \cdot in$	$A_1 := h_1 \cdot w_1$	$y_1 := 47.5 \cdot in$	$A_1 = 0.75 \cdot ft^2$	$Q_1 := A_1 \cdot y_1$	$W_1 := 20 \cdot lbf$
TS3X3:	$h_2 := 49 \cdot in$	$w_2 := 3 \cdot in$	$A_2 := h_2 \cdot w_2$	$y_2 := 30 \cdot in$	$A_2 = 1.02 \cdot ft^2$	$Q_2 := A_2 \cdot y_2$	$W_2 := 26.3 \cdot lbf$

FLUOR DANIEL NORTHWEST INC.

DESIGN ANALYSIS

Client: NHC
Subject: Structural analysis of Safety Related Electrical Equipment Supports.
Location: 241-C-106 & 241-AY-102

WO/Job No.: ER 4319/W 320
Date: 3/10/97 By: M.B. Lasota
Checked 5/8/97 By: R.W. Davidson
Revised By

$i := 1..2$

$A := \sum_i A_i$ $A = 1.77 \cdot ft^2$ $Q := \sum_i Q_i$ $Q = 5.52 \cdot ft^3$

$y_o := \frac{Q}{A}$ $y_o = 37.41 \cdot in$ for wind load computation, increase area by 25% $A_f := 1.25 \cdot A$ $A_f = 2.21 \cdot ft^2$

Wind pressure ref. ASCE 7-93 " Minimum Design Loads for Buildings and Other Structures".

From SDC 4.1 rev. 11 the following are parameters used in wind pressure calculation for Safety Class 3 structures:

Basic wind speed: $V := 70 \cdot mph$
Importance Factor: $I := 1.07$
Exposure Category: C

$K_z := 0.8$

$q_z := 0.00256 \cdot K_z \cdot \left(\frac{I \cdot V}{mph}\right)^2 \cdot psf$ $q_z = 11.49 \cdot psf$

use $q_z := 11.5 \cdot psf$

From Table 4. for other structures: $G_h := 1.32$

and from table 13: $C_f := 1.6$

Wind load therefore is:

$F_w := q_z \cdot G_h \cdot C_f A_f$ $F_w = 53.8 \cdot lbf$ $M_w := F_w y_o$ $M_w = 2011 \cdot lbf \cdot in$

Seismic load per UBC (36-1)

$F_p = Z \cdot I \cdot C_p \cdot W_p$

From SDC 4.1 rev 11 : $Z := 0.12$ $I := 1.25$ $C_p := 2.12$ $a_h := Z \cdot I \cdot C_p$ $a_h = 0.32$

$j := 1..2$

$M_x := \sum_j W_j \cdot y_j$ $M_x = 1739 \cdot lbf \cdot in$ $W_x := \sum_j W_j$ $W_x = 46.30 \cdot lbf$

$F_s := a_h \cdot W_x$ $M_s := a_h \cdot M_x$

$F_s = 14.7 \cdot lbf$ $M_s = 553 \cdot lbf \cdot in$

The support frame for the Mass Flow Meter is located in the area where the maintenance work will take place. In order to prevent the frame from collapse when subject to a load resulting from the worker leaning on the frame, a standard horizontal load on the handrail will be applied. This load is equal to 200 lbf.

$F_l := 200 \cdot lbf$ $\quad M_l := F_l \cdot (y_1 + 7 \cdot in)$ $\quad M_l = 10900 \cdot lbf \cdot in$

Compare wind, seismic and live loads.

$F_s = 15 \cdot lbf$ $\quad M_s = 553 \cdot lbf \cdot in$

$F_w = 54 \cdot lbf$ $\quad M_w = 2011 \cdot lbf \cdot in$

$F_l = 200 \cdot lbf$ $\quad M_l = 10900 \cdot lbf \cdot in$

It is evident that the live load governs.

Check the member (TS3X3X0.25) stress.

$S_x := 2.10 \cdot in^3$

$f_b := \dfrac{M_l}{S_x}$ $\quad f_b = 5.19 \cdot ksi$ $\quad$ stress in the TS3X3X0.25 is acceptable.

Determine forces in the top anchors.

$T_{at} := \dfrac{M_l + F_l \cdot 10.5 \cdot in}{2 \cdot 10.5 \cdot in}$ $\quad T_{at} = 619 \cdot lbf$

Determine forces in the bottom anchor.

$T_{ab} := \dfrac{F_l \cdot (y_1 + 7 \cdot in - 5.5 \cdot in)}{16 \cdot in}$ $\quad T_{ab} = 613 \cdot lbf$

CG of anchor group is:

$y_o = \dfrac{A_b \cdot 10.5 \cdot in}{3 \cdot A_b}$ $\quad y_o := \dfrac{10.5 \cdot in}{3}$ $\quad y_o = 3.50 \cdot in$

$Tor := M_l + F_l \cdot y_o$ $\quad Tor = 11.60 \cdot in \cdot kips$

Shear in the bolt is: $\quad i := 1 .. 3$

$J_b = \sum_{i=1}^{3} A_b \cdot \left[(x_i)^2 + (y_i)^2 \right]$ $\quad$ or $\quad J_b = A_b \cdot \left[\sum_{i=1}^{3} \left[(x_i)^2 + (y_i)^2 \right] \right]$

$x_1 := -4.25 \cdot in$ $\quad y_1 := y_o$

$x_2 := 4.25 \cdot in$ $\quad y_2 := y_o$

$x_3 := 0 \cdot in$ $\quad y_3 := 7.0 \cdot in$

$$V_{b_i} = \sqrt{\left(\frac{F_l}{3} + \frac{Tor \cdot y_i}{J_b} \cdot A_b\right)^2 + \left(\frac{Tor \cdot x_i}{J_b} \cdot A_b\right)^2}$$

$$V_{b_i} := \sqrt{\left[\frac{F_l}{3} + \frac{Tor \cdot y_i}{\left[\sum_{i=1}^{3}\left[(x_i)^2 + (y_i)^2\right]\right]}\right]^2 + \left[\frac{Tor \cdot x_i}{\left[\sum_{i=1}^{3}\left[(x_i)^2 + (y_i)^2\right]\right]}\right]^2}$$

$V_{b_1} = 627 \cdot lbf$ $\quad V_{b_2} = 627 \cdot lbf$ $\quad V_{b_3} = 807 \cdot lbf$

$T_{b_1} := T_{at}$ $\quad T_{b_2} := T_{at}$ $\quad T_{b_3} := T_{ab}$

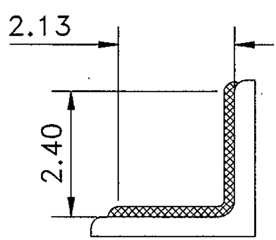
Try 1/2" Φ HKB II with 3 1/2 " embedment. For 3000psi concrete capacities are:

$T_a := 2.00 \cdot kips$ $\quad V_a := 1.47 \cdot kips$

Interaction factors for each bolt are:

$IF_i := \frac{T_{b_i}}{T_a} + \frac{V_{b_i}}{V_a}$ $\quad IF_1 = 0.74$ $\quad IF_2 = 0.74$ $\quad IF_3 = 0.86$ $\quad$ .OK.

Check stress in the horizontal L3X3X3/8 and the related weld.



DETAIL OF THE JOINT BETWEEN L3X3X3/8 AND TS3X3X0.25

$$V_{bx_i} := \frac{F_l}{3} + \frac{Tor \cdot y_i}{\left[\sum_{i=1}^{3}\left[(x_i)^2 + (y_i)^2\right]\right]} \qquad V_{by_i} := \frac{Tor \cdot x_i}{\left[\sum_{i=1}^{3}\left[(x_i)^2 + (y_i)^2\right]\right]}$$

$V_{bx_1} = 0.44 \cdot kips$ $\quad V_{bx_2} = 0.44 \cdot kips$ $\quad V_{by_1} = -0.45 \cdot kips$ $\quad V_{by_2} = 0.45 \cdot kips$

Forces in the joint. $\quad L := 2.25 \cdot in$

$T_j := V_{bx_2}$ $\quad V_{jy} := V_{by_2}$ $\quad V_{jz} := T_{b_2}$

$M_{jz} := V_{jy} \cdot L$ $\quad M_{jy} := V_{jz} \cdot L$ $\quad$ Torsion in the joint is negligible.

$T_j = 0.44 \cdot kips$ $\quad V_{jy} = 0.45 \cdot kips$ $\quad V_{jz} = 0.62 \cdot kips$

$M_{jz} = 1.01 \cdot in \cdot kips$ $\quad M_{jy} = 1.39 \cdot in \cdot kips$

Stress in the L3X3X3/8 is:

$A_x := 2.11 \cdot in^2$ $\quad S_z := 0.833 \cdot in^3$ $\quad S_y := 0.833 \cdot in^3$ $\quad A_y := 3 \cdot in \cdot 0.375 \cdot in$ $\quad A_y = 1.13 \cdot in^2$ $\quad A_z := A_y$

$\sigma := \frac{T_j}{A_x} + \frac{M_{jy}}{S_y} + \frac{M_{jz}}{S_z}$ $\quad \sigma = 3.09 \cdot ksi$ $\quad$ normal stress in the member is well within allowable.

$\tau_y := \frac{V_{jy}}{A_y}$ $\quad \tau_y = 0.40 \cdot ksi$ $\quad \tau_z := \frac{V_{jz}}{A_z}$ $\quad \tau_z = 0.55 \cdot ksi$ $\quad$ OK.

Check stress in the weld.

$w_y := 2.40 \cdot in$ $\quad w_z := 2.13 \cdot in$ $\quad A_w := w_y + w_z$ $\quad A_w = 4.53 \cdot in$

$S_{wy} := \frac{w_z^2 \cdot (4 \cdot w_y + w_z)}{6 \cdot (2 \cdot w_y + w_z)}$ $\quad S_{wy} = 1.28 \cdot in^2$ $\quad S_{wz} := \frac{w_y^2 \cdot (4 \cdot w_z + w_y)}{6 \cdot (2 \cdot w_z + w_y)}$ $\quad S_{wz} = 1.57 \cdot in^2$

$$f_w := \sqrt{\left(\frac{T_j}{A_w} + \frac{M_{jy}}{S_{wy}} + \frac{M_{jz}}{S_{wz}}\right)^2 + \left(\frac{V_{jy}}{w_y}\right)^2 + \left(\frac{V_{jz}}{w_z}\right)^2} \qquad f_w = 1.86 \cdot \frac{kips}{in}$$

Allowable stress in 3/16" fillet weld using electrode E70XX is: $\quad F_{uw} := 70 \cdot ksi$

$F_w := \frac{3}{16} \cdot in \cdot \frac{1}{\sqrt{2}} \cdot 0.3 \cdot F_{uw}$ $\quad F_w = 2.78 \cdot \frac{kips}{in}$ $\quad$ weld stresses are acceptable.

241-AY-102 - Rack for Building 241-AY-801 Pull-boxes - Figure 17 pages 48 & 49 (ref dwg. H-2-818695 sh 2 & 4).

Wind pressure ref. ASCE 7-93 " Minimum Design Loads for Buildings and Other Structures".

From SDC 4.2 rev. 11 the following are parameters used in wind pressure calculation for Safety Class 3 structures:

Basic wind speed: $V := 70 \cdot mph$
Importance Factor: $I := 1.07$
Exposure Category: C

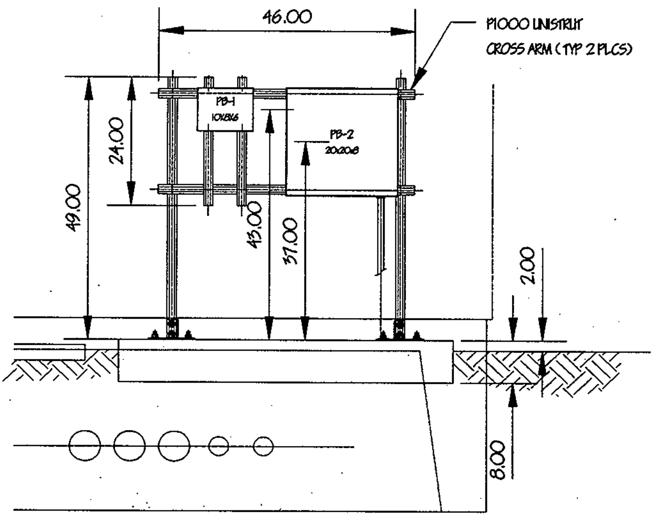
$K_z := 0.8$

$q_z := 0.00256 \cdot K_z \cdot \left(\frac{I \cdot V}{mph}\right)^2 \cdot psf$ $\qquad q_z = 11.49 \cdot psf$

use $q_z := 11.5 \cdot psf$

From Table 4. for other structures: $G_h := 1.32$

and from table 13. $C_f := 1.6$ $\quad p_w := q_z \cdot G_h \cdot C_f$ $\quad p_w = 24.29 \cdot psf$ $\quad F_w = p_w \cdot A$



RACK FOR BLDG 241-AY-801 PULL-BOXES

Seismic load per UBC (36-1)

$F_p = Z \cdot I \cdot C_p \cdot W_p$

From SDC 4.1 rev 11 : $Z := 0.12$ $I := 1.25$ $C_p := 2.12$ $a_h := Z \cdot I \cdot C_p$ $a_h = 0.32$

PB-1 $h_1 := 8 \cdot in$ $w_1 := 10 \cdot in$ $A_1 := h_1 \cdot w_1$ $y_1 := 43 \cdot in$ $A_1 = 0.56 \cdot ft^2$ $W_1 := 10 \cdot lbf$

$F_{w1} := p_w \cdot A_1$ $F_{p1} := a_h \cdot W_1$ $F_{w1} = 13 \cdot lbf$ $F_{p1} = 3 \cdot lbf$

PB-2 $h_2 := 20 \cdot in$ $w_2 := 20 \cdot in$ $A_2 := h_2 \cdot w_2$ $y_2 := 37 \cdot in$ $A_2 = 2.78 \cdot ft^2$ $W_2 := 30 \cdot lbf$

$F_{w2} := p_w \cdot A_2$ $F_{p2} := a_h \cdot W_2$ $F_{w2} = 67 \cdot lbf$ $F_{p2} = 10 \cdot lbf$

The wind load is:

$P_{w1} := F_{w1}$ $P_{w1} = 13 \cdot lbf$ $P_{w2} := F_{w2}$ $P_{w2} = 67 \cdot lbf$

For simplicity and added conservatism use:

$P_{w1} := 20 \cdot lbf$ $P_{w2} := 70 \cdot lbf$

Seismic load is:

$P_{e1} := F_{p1}$ $P_{e1} = 3 \cdot lbf$ $P_{e2} := F_{p2}$ $P_{e2} = 10 \cdot lbf$

Use:

$P_{e1} := 10 \cdot lbf$ $P_{e2} := 10 \cdot lbf$

Check the foundation, 3'-0"x5'-0"x0'-8" deep pad: $a := 5 \cdot ft$ $b := 3 \cdot ft$ $d := 8 \cdot in$

Average density of reinforced concrete is: $\gamma := 150 \cdot pcf$

Dead Weight $W_e := W_1 + W_2 + 2 \cdot 1.9 \cdot \frac{lbf}{ft} \cdot (2 \cdot 49 \cdot in + 46 \cdot in + 24 \cdot in) + 2 \cdot 4.08 \cdot lbf$ $W_e = 101 \cdot lbf$

$W_c := a \cdot b \cdot d \cdot \gamma$ $W_c = 1500.00 \cdot lbf$

Bearing capacity of the soil from UBC Table 29B for sandy gravel is: $p_a := 2000 \cdot psf$

The load on the footing is:

$W := W_e + W_c$ $W = 1601 \cdot lbf$

$M := P_{w1} \cdot y_1 + P_{w2} \cdot y_2$ $M = 287 \cdot ft \cdot lbf$

Increase moment by 20% to account for the unistrut frame: $M := 1.2 \cdot M$ $M = 345 \cdot ft \cdot lbf$

Check for negative soil pressure:

$$p := \frac{W}{a \cdot b} - \frac{6 \cdot M}{a \cdot b^2} \qquad p = 60.8 \cdot psf$$ uplift at the end of foundation will not occur.

Check footing for overturning:

$$M_s := \frac{W \cdot b}{2} \qquad FS_o := \frac{M_s}{M}$$

$FS_o = 6.96$ $\quad FS_o \ge 1.5$ stability of the foundation is satisfactory.

Check unistrut section for stress:

Bending about major axis:

$$M_x := \frac{M}{2} \qquad M_x = 2070 \cdot lbf \cdot in$$

Bending about minor axis:

$$P_{wy1} := 49 \cdot in \cdot 3.25 \cdot in \cdot p_w \qquad P_{wy1} = 26.9 \cdot lbf \qquad P_{wy2} := 10 \cdot in \cdot 24 \cdot in \cdot p_w \qquad P_{wy2} = 40.5 \cdot lbf$$

$$P_{sy} := W_e \cdot a_h \qquad P_{sy} = 32.2 \cdot lbf$$

$$M_y := \left(P_{wy1} \cdot 49 \cdot in + P_{wy2} \cdot y_2\right) \cdot 0.5 \qquad M_y = 1407 \cdot lbf \cdot in$$

Properties for the channel P1001 are as follows:

$$A := 1.11 \cdot in^2 \qquad S_x := 0.572 \cdot in^3 \qquad S_y := 0.588 \cdot in^3 \qquad r_x := 0.915 \cdot in \qquad r_y := 0.656 \cdot in$$

$$\sigma_x := \frac{M_x}{S_x} \qquad \sigma_x = 3.62 \cdot ksi \qquad \sigma_y := \frac{M_y}{S_y} \qquad \sigma_y = 2.39 \cdot ksi$$

The stresses found above occur at different location of the member, also they are a result of two non-concurent events, the combination is therefore not required.

Check members for axial load.

$$C := \frac{W_e}{2} \qquad C = 50.68 \cdot lbf$$

$$l_x := 49 \cdot in \qquad K_x := 2 \qquad Sr_x := \frac{K_x \cdot l_x}{r_x} \qquad Sr_x = 107.1$$

$$l_y := 49 \cdot in - \frac{20 \cdot in}{2} \qquad K_y := 2 \qquad Sr_y := \frac{K_y \cdot l_y}{r_y} \qquad Sr_y = 118.9$$ Maximum slenderness ratio.

$$E := 29000 \cdot ksi \qquad F_y := 33 \cdot ksi \qquad \frac{F_y}{2} = 16.50 \cdot ksi$$

$F_{ey} := \frac{\pi^2 \cdot E}{Sr_y^2}$ $F_{ey} = 20.24 \cdot ksi$ $F_{ey} \ge \frac{F_y}{2}$ $F_n := \left(1 - \frac{F_y}{4 \cdot F_{ey}}\right) \cdot F_y$ $F_n = 19.55 \cdot ksi$

$R := \sqrt{\frac{F_y}{2 \cdot F_{ey}}}$ $R = 0.902784$ $\Omega_c := \frac{5}{3} + \frac{3}{8} \cdot R - \frac{1}{8} \cdot R^3$ $\Omega_c = 1.91$

$P_n := A \cdot F_n$ $P_n = 21702.93 \cdot lbf$ $P_a := \frac{P_n}{\Omega_c}$ $P_a = 11344 \cdot lbf$ $P_a \ge C$ O.K..

Check standard Base for capacity.

Unistrut nut slip capacity is (ref Unistrut catalog No. 11 page 9):

$V_1 := 1500 \cdot lbf$

$V_a := 2 \cdot V_1$ $V_a = 3000.00 \cdot lbf$

Distance between centers of the bolts for part P 2073 A is: $D := 3.25 \cdot in$

Shear in the bolt due to moment is:

$V := \frac{M_x}{D}$ $V = 637 \cdot lbf$ $V \le V_a$ Part P 2073 A is adequate.

Check expansion anchors:

$d := 3 \cdot in + 0.8 \cdot 1.625 \cdot in + 2 \cdot 0.25 \cdot in$ $d = 4.80 \cdot in$

$T_b := \frac{M_x}{d}$ $T_b = 431 \cdot lbf$ $V_b := \frac{P_w}{8}$ $V_b = 16 \cdot lbf$

For 5/8" dia HKB II with 2 3/4" min embedment, installed in f'_c=4000psi allowable loads are:

$T_a := 2000 \cdot lbf$ $V_a := 2530 \cdot lbf$ Ref. A/E Standard GC-ANCR-01 rev. 0, table 21.

Interaction factor is:

$IF := \frac{T_b}{T_a} + \frac{V_b}{V_a}$ $IF = 0.22$ $IF \le 1.0$ O.K..

FLUOR DANIEL
NORTHWEST INC.

DESIGN ANALYSIS

Client: WHC
Subject: Structural analysis of Safety Related Electrical Equipment Supports.

Location: 241-C-106 & 241-AY-102

WO/Job No.: ER 4319/W 320
Date: 1/19/98 By: A. S. Langevin
Checkd: 1/20/98 By: M. B. Lasota
Revised: By:
Revised By:

The far north expansion anchor of the building 241-AY-801 pullbox rack was broken during installation and therefore not installed. (See ECN W-320-709) Need to verify that the remaining expansion anchors will be sufficient to carry the loads.

First check loads due to moments about the y-axis:
Due to frame action about the y-axis the moment at the base will be significantly lower than My. However with the anchor bolt missing we need to assume a total lack of fixity at the north post about the minor axis. (It becomes a pinned connection). With the loss of fixity at the north post the moment will be higher at the south post as follows:

$P_y := P_{wy1} + P_{wy2}$ $\quad P_y = 67.34 \cdot lbf$

Based on relative stiffness of the two leg members, $P_{south} = 2/2.5\, P_y = 0.8\, P_y$

$M_{ybase} := \dfrac{0.8 \cdot P_y \cdot 2.25 \cdot in}{8}$ $\quad M_{ybase} = 336.70 \cdot lbf \cdot in$

$M_x = 2070.00 \cdot lbf \cdot in$

$M_{ybase} < 1/2\, M_x = M_{xbase}$, Therefore, the moment about the x-axis governs

Check anchor bolt loads due to moment about the x axis:
Due to the missing anchor bolt location, T_b is not affected, because this bolt does not take tension in the moment direction. However V_b is affected. Assume only 6 bolts take the shear instead of 8.

$T_b = 431.25 \cdot lbf$

$V_b := \dfrac{P_w}{6}$ $\quad V_b = 21.67 \cdot lbf$

$IF := \dfrac{T_b}{T_a} + \dfrac{V_b}{V_a}$ $\quad IF = 0.22$ $\quad IF \le 1.0$ O.K.

320C29R2.MCD

241-AY-102 - Rack for electrical enclosure for NEMA 3R 60A SAFETY SWITCH (PIT COOLING) and Pneumatic Valve Actuator Control Station - Figure 2, (ref dwg H-2-818695 sh 2 & 4 and H-2-818540 sh 1,2 and 4)

Wind pressure ref. ASCE 7-93 " Minimum Design Loads for Buildings and Other Structures".

From SDC 4.2 rev. 11 the following are parameters used in wind pressure calculation for Safety Class 3 structures:

Basic wind speed: $V := 70 \cdot mph$
Importance Factor: $I := 1.07$
Exposure Category: C

$K_z := 0.8$

$q_z := 0.00256 \cdot K_z \cdot \left(\frac{I \cdot V}{mph}\right)^2 \cdot psf$ $\qquad q_z = 11.49 \cdot psf$

use $q_z := 11.5 \cdot psf$

From Table 4. for other structures: $G_h := 1.32$

and from table 13. $C_f := 1.6$ $\quad p_w := q_z \cdot G_h \cdot C_f$ $\quad p_w = 24.29 \cdot psf$ $\quad F_w = p_w \cdot A$

Seismic load per UBC (36-1) $F_p = Z \cdot I \cdot C_p \cdot W_p$

From SDC 4.1 rev 11 : $Z := 0.12$ $\quad I := 1.25$ $\quad C_p := 2.12$ $\quad a_h := Z \cdot I \cdot C_p$ $\quad a_h = 0.32$ $\quad i := 1..2$

NEMA 3R 60A S.S. $h_1 := 20 \cdot in$ $\quad w_1 := 8.5 \cdot in$ $\quad A_1 := h_1 \cdot w_1$ $\quad y_1 := 52.13 \cdot in$ $\quad A_1 = 1.18 \cdot ft^2$ $\quad W_1 := 20 \cdot lbf$

$F_{w_1} := p_w \cdot A_1$ $\quad F_{p_1} := a_h \cdot W_1$ $\quad F_{w_1} = 29 \cdot lbf$ $\quad F_{p_1} = 6 \cdot lbf$

Valve Station $h_2 := 20 \cdot in$ $\quad w_2 := 16 \cdot in$ $\quad A_2 := h_2 \cdot w_2$ $\quad y_2 := 53.5 \cdot in$ $\quad A_2 = 2.22 \cdot ft^2$ $\quad W_2 := 75 \cdot lbf$

$F_{w_2} := p_w \cdot A_2$ $\quad F_{p_2} := a_h \cdot W_2$ $\quad F_{w_2} = 54 \cdot lbf$ $\quad F_{p_2} = 24 \cdot lbf$

Check unistrut section for stress:

Bending about major axis:

Shear in west direction at the south west column is:

$$V_x := \left[h_2 \cdot 10 \cdot in \cdot \left(\frac{25}{20}\right) \cdot p_w + \frac{1}{2} \cdot (2 \cdot 5.5 \cdot ft \cdot 1.625 \cdot in + 3 \cdot 22 \cdot in \cdot 1.625 \cdot in + 8.5 \cdot in \cdot 20 \cdot in) \cdot p_w\right] \cdot \frac{1}{2} \qquad V_x = 42 \cdot lbf$$

$M_x := V_x \cdot (5.5 \cdot ft - 10 \cdot in)$ $\qquad M_x = 2342 \cdot lbf \cdot in$

Bending about minor axis:

Determine bending moment in the west column due to the wind acting in south direction:

Shear due to wind:

$A_f := 5.5\cdot ft\cdot 3.25\cdot in + \frac{3}{2}\cdot(29\cdot in - 3.25\cdot in)\cdot 3.25\cdot in \qquad A_f = 2.36\cdot ft^2$

$V_w := A_f p_w + F_{w_2}\cdot\frac{19}{29} \qquad V_w = 92.71\cdot lbf \qquad$ use $\qquad V_w := 100\cdot lbf$

Conservatively, apply resultant wind load at the location of the box and ampify the moment by eccentric weight:

$M_y := V_w\cdot y_2 + W_2\cdot\left(\frac{10\cdot in}{2} + 1.625\cdot in\right)\cdot\frac{19}{29} \qquad M_y = 5676\cdot in\cdot lbf$

Properties for the channel P1001 are as follows:

$A := 1.11\cdot in^2 \qquad S_x := 0.572\cdot in^3 \qquad S_y := 0.588\cdot in^3 \qquad r_x := 0.915\cdot in \qquad r_y := 0.656\cdot in$

$\sigma_x := \frac{M_x}{S_x} \qquad \sigma_x = 4.09\cdot ksi \qquad \sigma_y := \frac{M_y}{S_y} \qquad \sigma_y = 9.65\cdot ksi$

The stresses found above occur at different location of the member, also they are a result of two non-concurent events, the combination is therefore not required.

Check members for axial load:

$C := W_2\cdot\frac{19}{29} + \left[2\cdot 5.5\cdot ft + \frac{6\cdot(29\cdot in - 3.25\cdot in)}{2}\right]\cdot 1.9\cdot\frac{lbf}{ft} \qquad C = 82\cdot lbf$

$l_x := 5.5\cdot ft \qquad K_x := 2 \qquad Sr_x := \frac{K_x\cdot l_x}{r_x} \qquad Sr_x = 144.26 \qquad$ Maximum slenderness ratio.

$l_y := 5.5\cdot ft - \frac{41\cdot in}{2} \qquad K_y := 2 \qquad Sr_y := \frac{K_y\cdot l_y}{r_y} \qquad Sr_y = 138.72$

$E := 29000\cdot ksi \qquad F_y := 33\cdot ksi \qquad \frac{F_y}{2} = 16.50\cdot ksi$

$F_{ex} := \frac{\pi^2\cdot E}{Sr_x^{\,2}} \qquad F_{ex} = 13.75\cdot ksi \qquad F_{ex} \ge \frac{F_y}{2} \qquad F_n := \left(1 - \frac{F_y}{4\cdot F_{ex}}\right)\cdot F_y \qquad F_n = 13.20\cdot ksi$

$R := \sqrt{\frac{F_y}{2\cdot F_{ex}}} \qquad R = 1.095332 \qquad \Omega_c := \frac{5}{3} + \frac{3}{8}\cdot R - \frac{1}{8}\cdot R^3 \qquad \Omega_c = 1.91$

$P_n := A\cdot F_n \qquad P_n = 14656.52\cdot lbf \qquad P_a := \frac{P_n}{\Omega_c} \qquad P_a = 7660.94\cdot lbf \qquad P_a \ge C \qquad$ O.K..

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Checked 5/8/97 By: M.R. Custer MRC
Revised By

Check standard Base for capacity.

Unistrut nut slip capacity is (ref Unistrut catalog No. 11 page 9):

$V_1 := 1500 \cdot lbf$

$V_a := 2 \cdot V_1$ $\quad V_a = 3000.00 \cdot lbf$

Distance between centers of the bolts for part P 2073 A is: $D := 3.25 \cdot in$

Shear in the bolt due to moment is:

$V := \frac{M_x}{D}$ $\quad V = 720.57 \cdot lbf$ $\quad V \le V_a$ Part P 2073 A is adequate.

Check expansion anchors:

$d := 3 \cdot in + 0.8 \cdot 1.625 \cdot in + 2 \cdot 0.25 \cdot in$ $\quad d = 4.80 \cdot in$

$T_b := \frac{M_y}{d}$ $\quad T_b = 1182 \cdot lbf$ $\quad V_b := \frac{P_w}{8}$ $\quad V_b = 16 \cdot lbf$

For 5/8" dia HKB II with 2 3/4" min embedment, installed in f'_c=4000psi allowable loads are:

$T_a := 2000 \cdot lbf$ $\quad V_a := 2530 \cdot lbf$ Ref. A/E Standard GC-ANCR-01 rev. 0, table 21.

Interaction factor is:

$IF := \frac{T_b}{T_a} + \frac{V_b}{V_a}$ $\quad IF = 0.60$ $\quad IF \le 1.0$ O.K..

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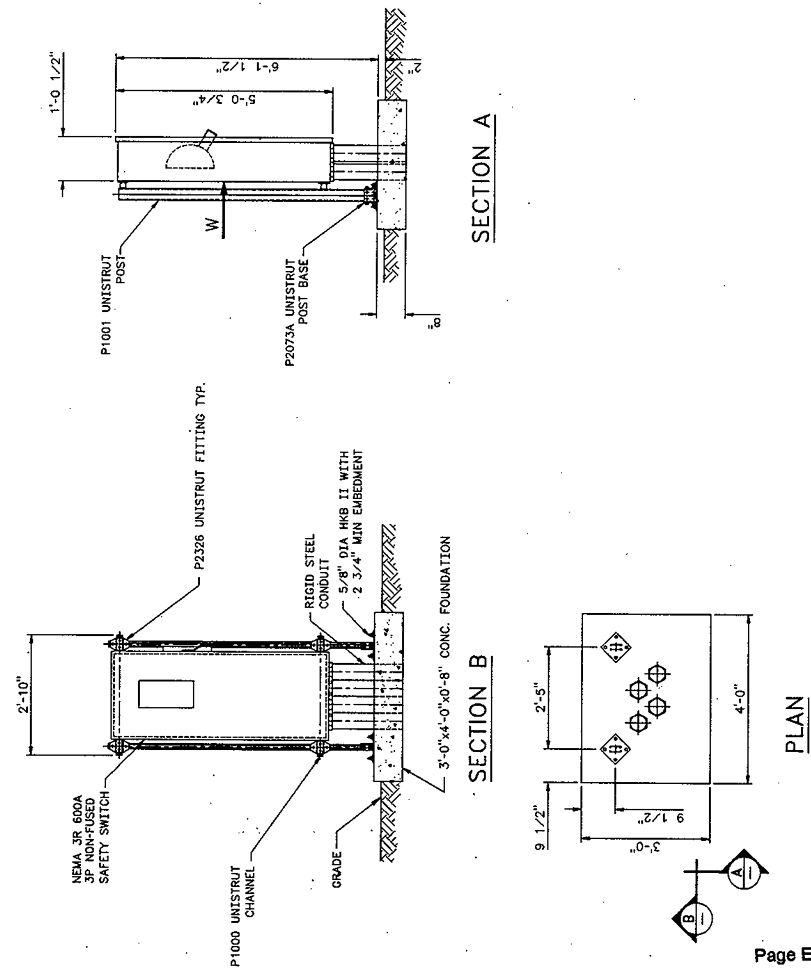

FIGURE 1
RACK FOR NEMA 3R 600A SWITCH
SCALE 1:36

ACAD FILE: 29FIG1

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By: R.W. Davidson
By:

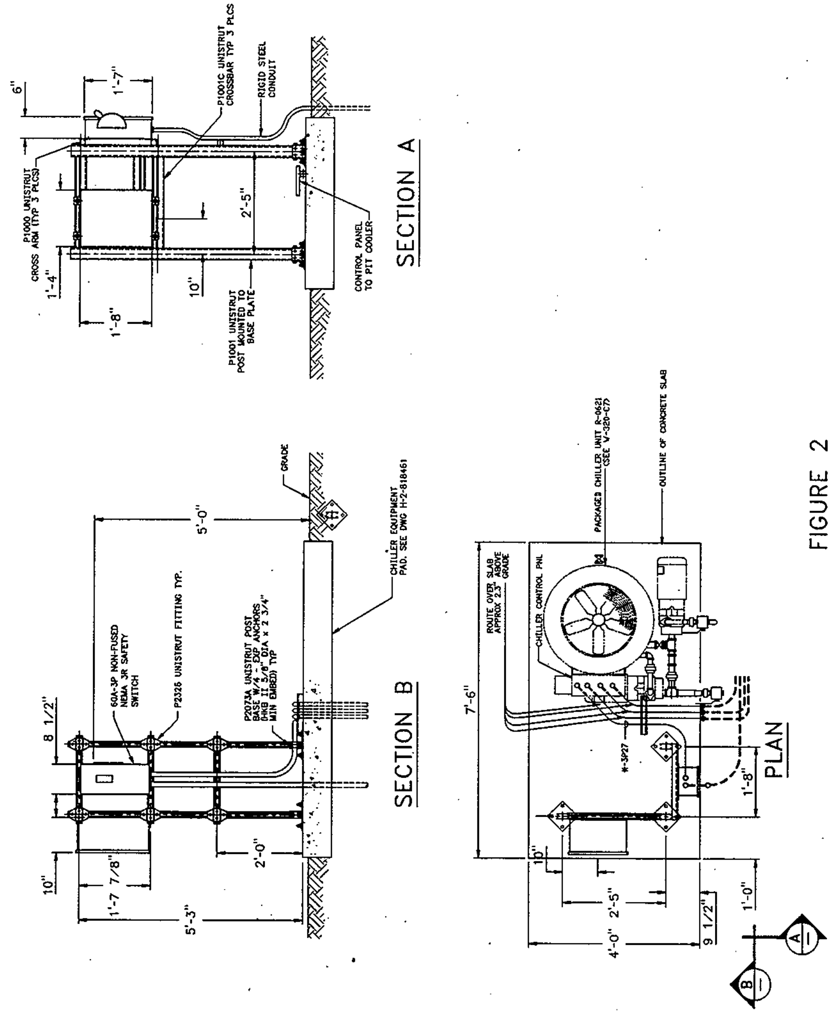

FIGURE 2
RACK FOR NEMA 3R 60A SWITCH AND PNEUMATIC VALVE ACTUATOR CONTROL STATION

1:36

ACAD FILE: 29FIG2

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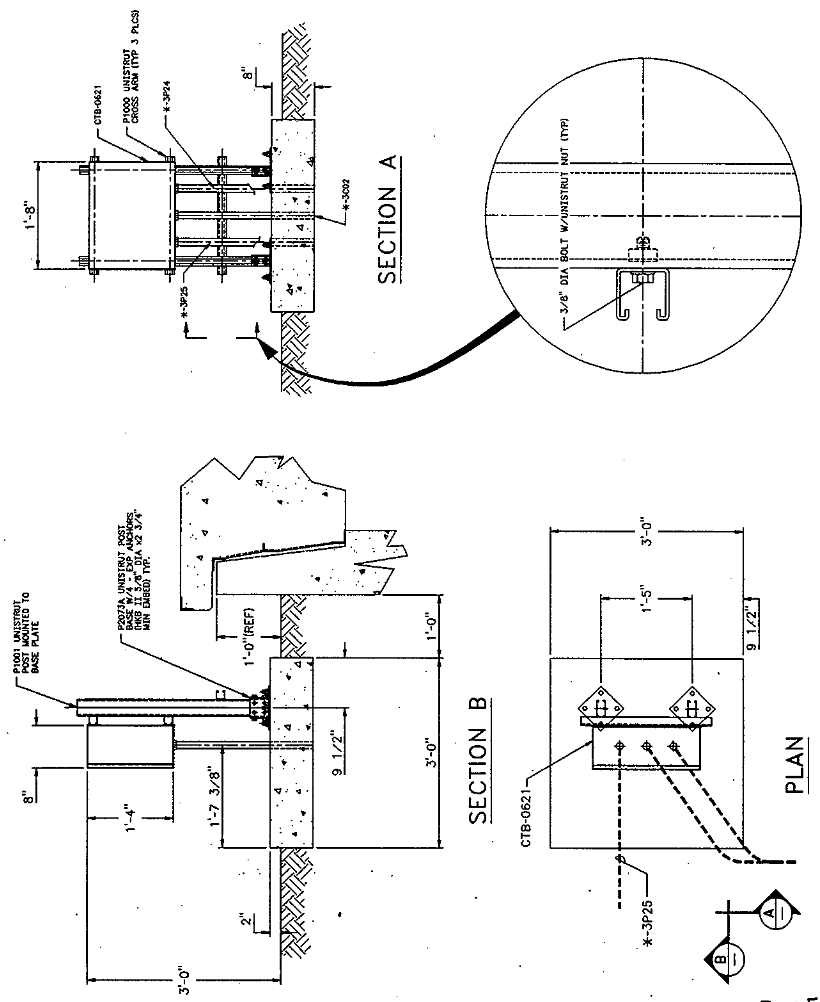

FIGURE 3
RACK FOR 16X20X8 BOX - CTB-0621
SCALE 1:24

ACAD FILE: 29FIG3

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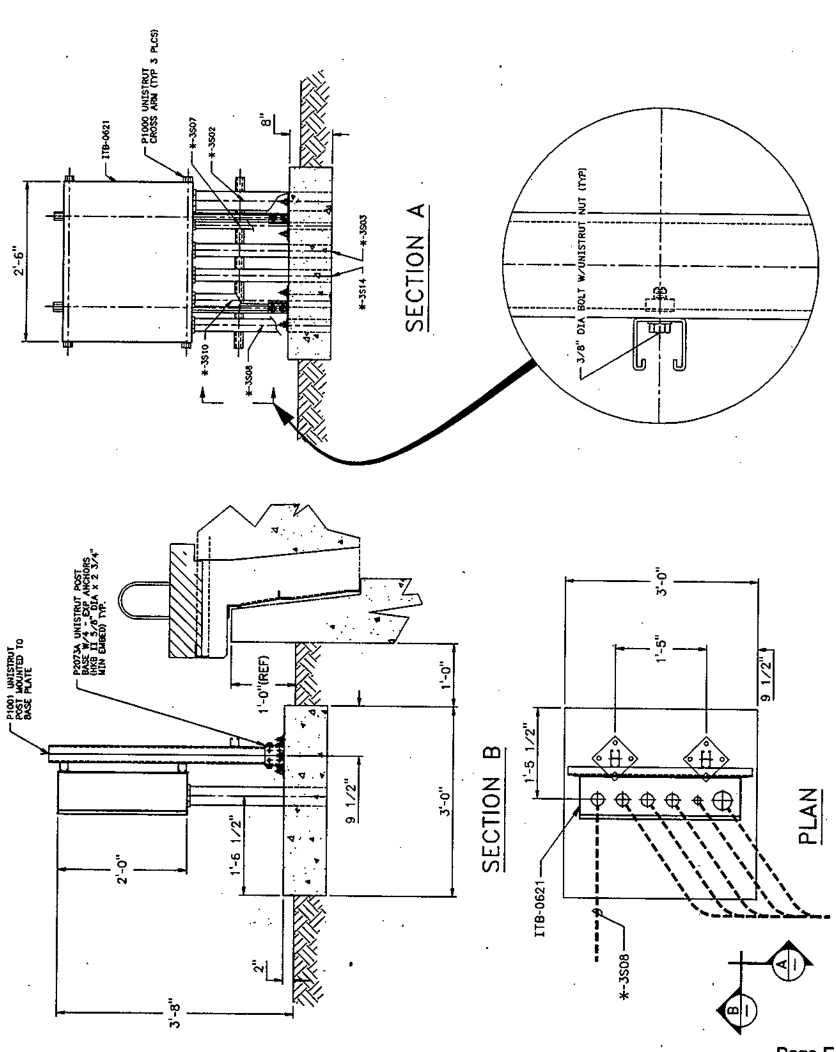

FIGURE 4
RACK FOR 24X30X8 BOX — ITB-0621
SCALE 1:24

ACAD FILE: 29FIG4

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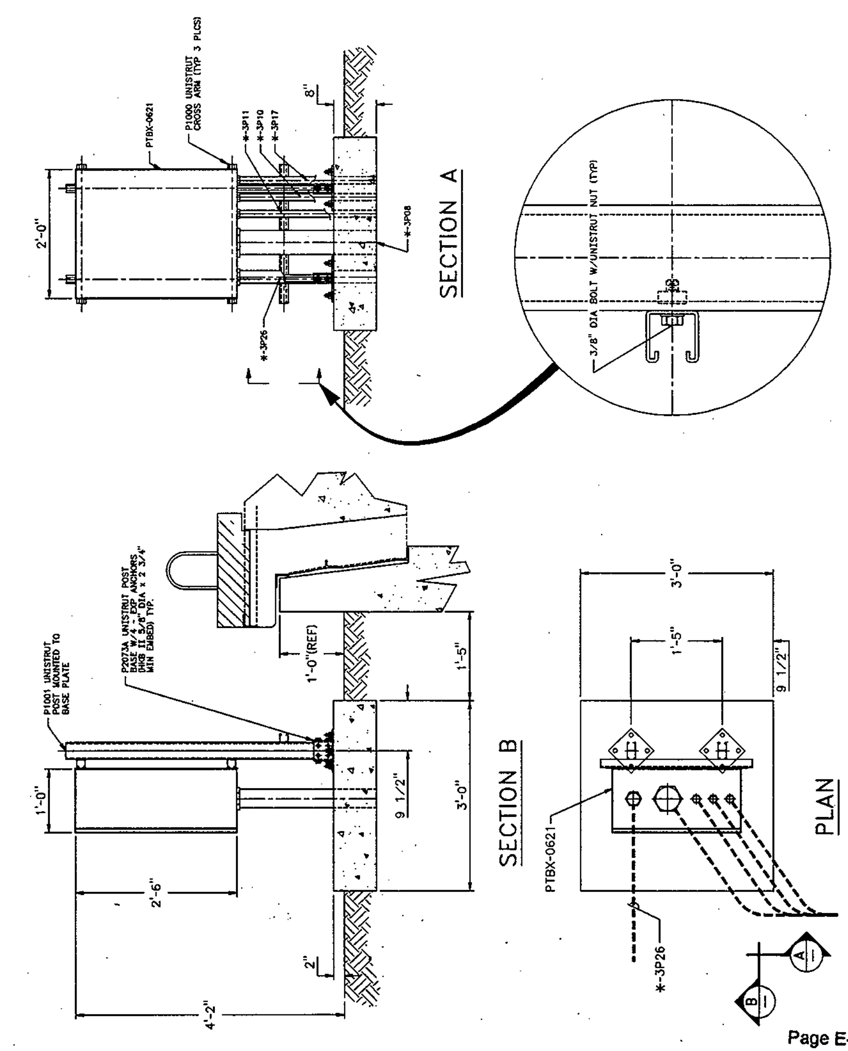

FIGURE 5
RACK FOR 30X24X12 BOX - PTBX-0621
SCALE 1:24

ACAD FILE: 29FIG5

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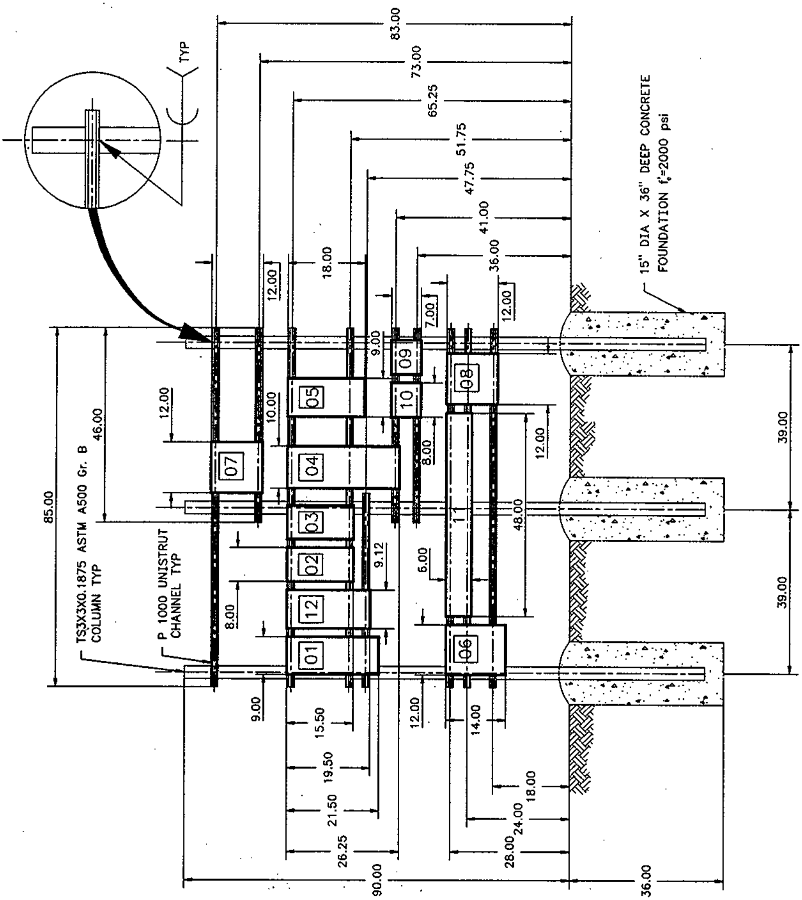

FIGURE 6
PROCESS BLDG ELECTR. RACK #1 ER-1361
SCALE 1:30

ACAD FILE: 29FIG6

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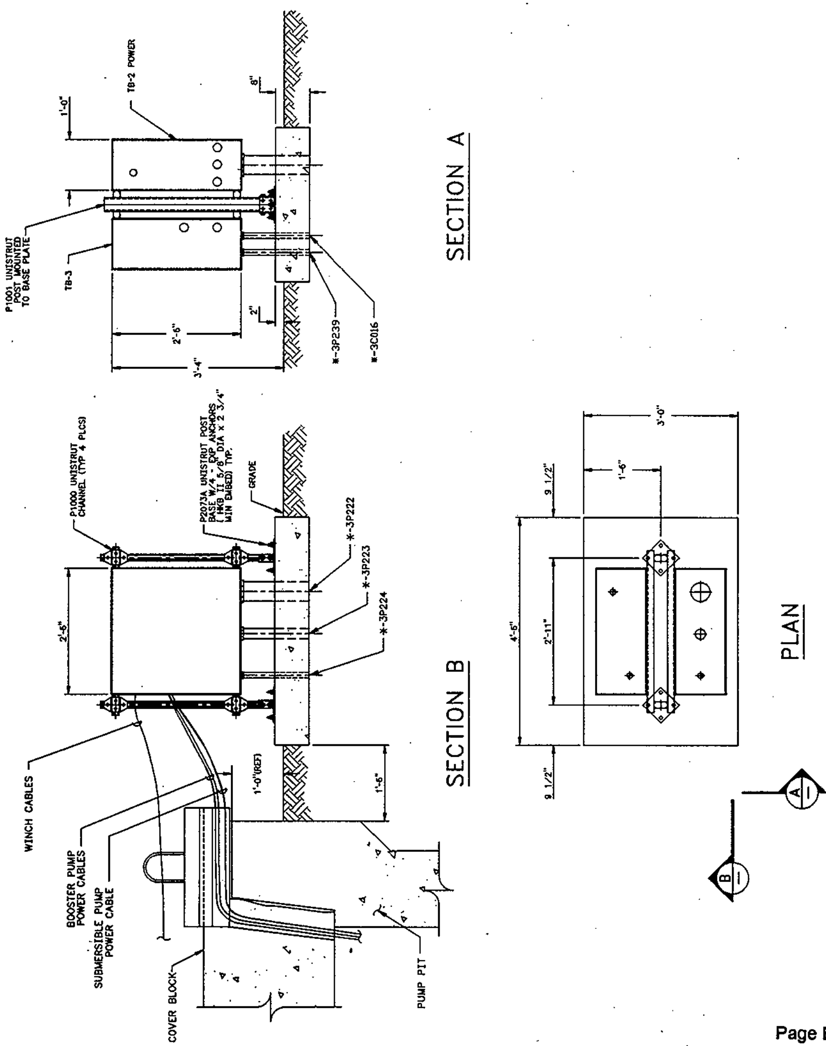

FIGURE 7
RACK FOR TWO 30X30X12 BOXES – TB-2 & TB-3
SCALE 1:30

ACAD FILE: 29FIG7

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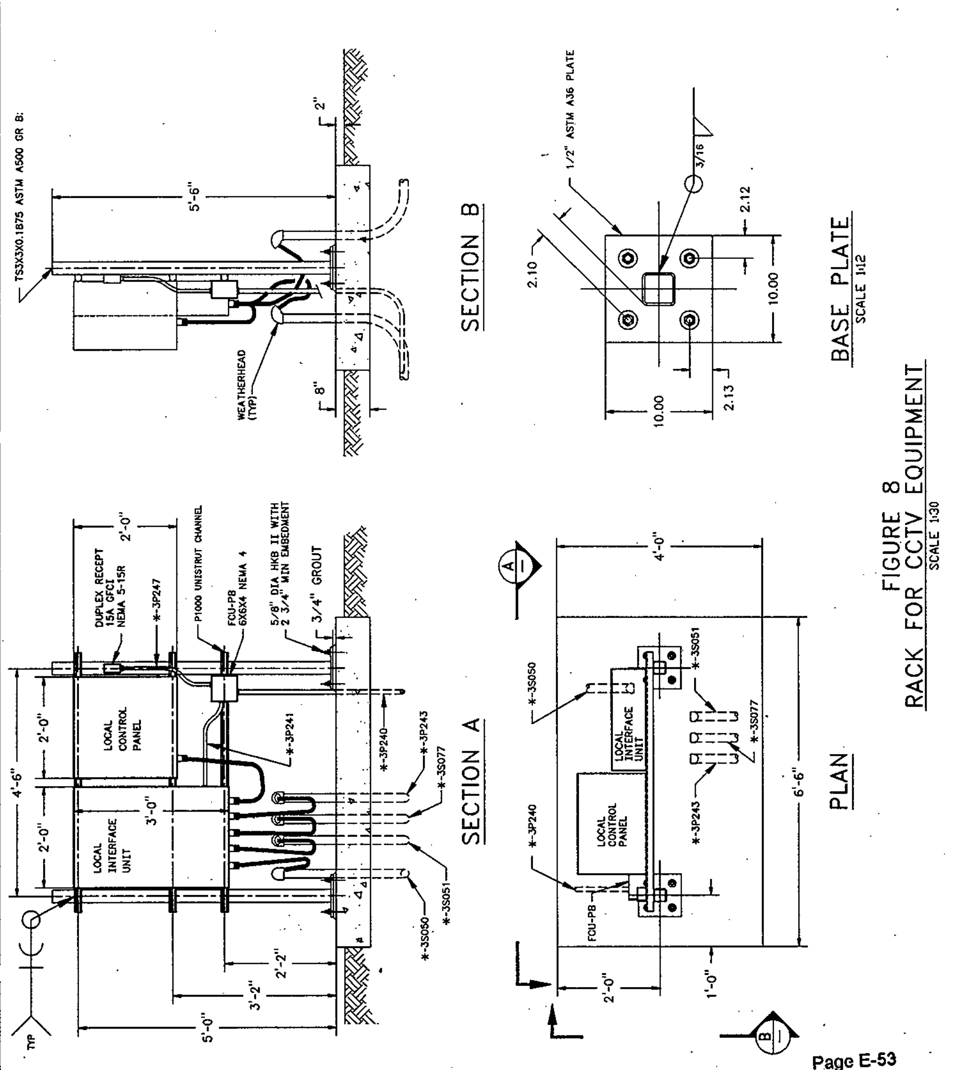

FIGURE 8
RACK FOR CCTV EQUIPMENT
SCALE 1:30

ACAD FILE: 29FIG8

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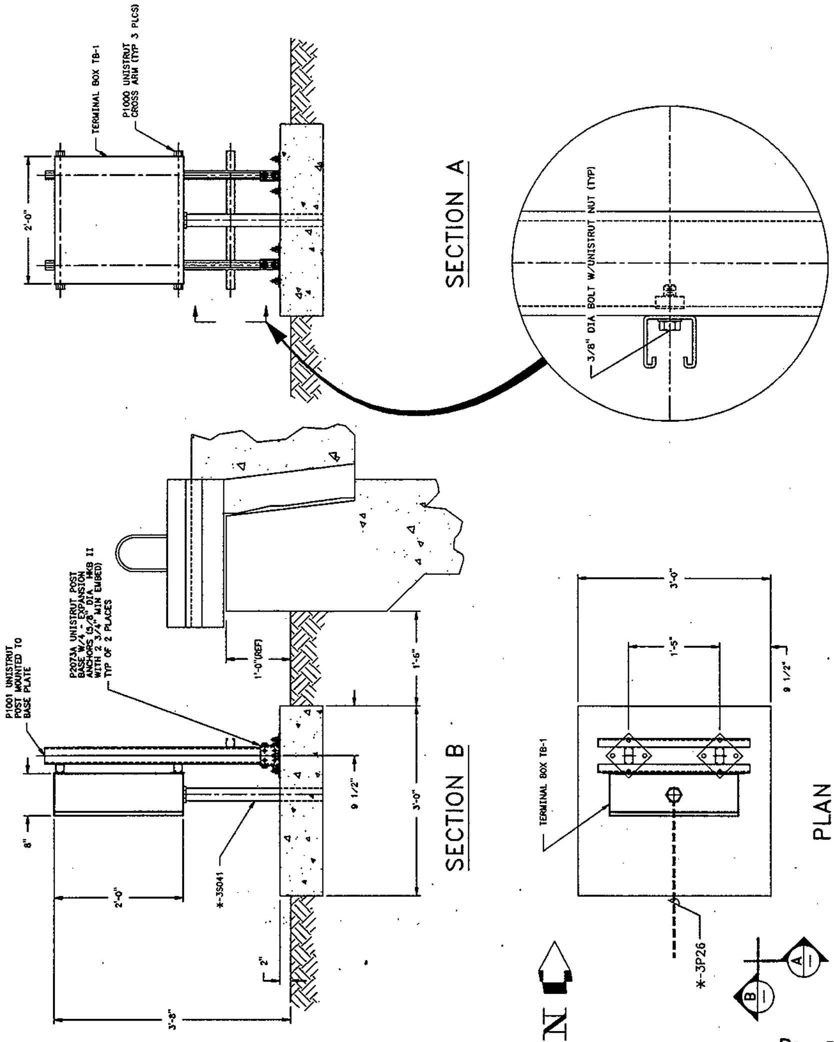

FIGURE 9
RACK FOR TERMINAL BOX - TB-1
SCALE 1:24

ACAD FILE: 29FIG9

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By: M.R. Custer *MRC*
By:

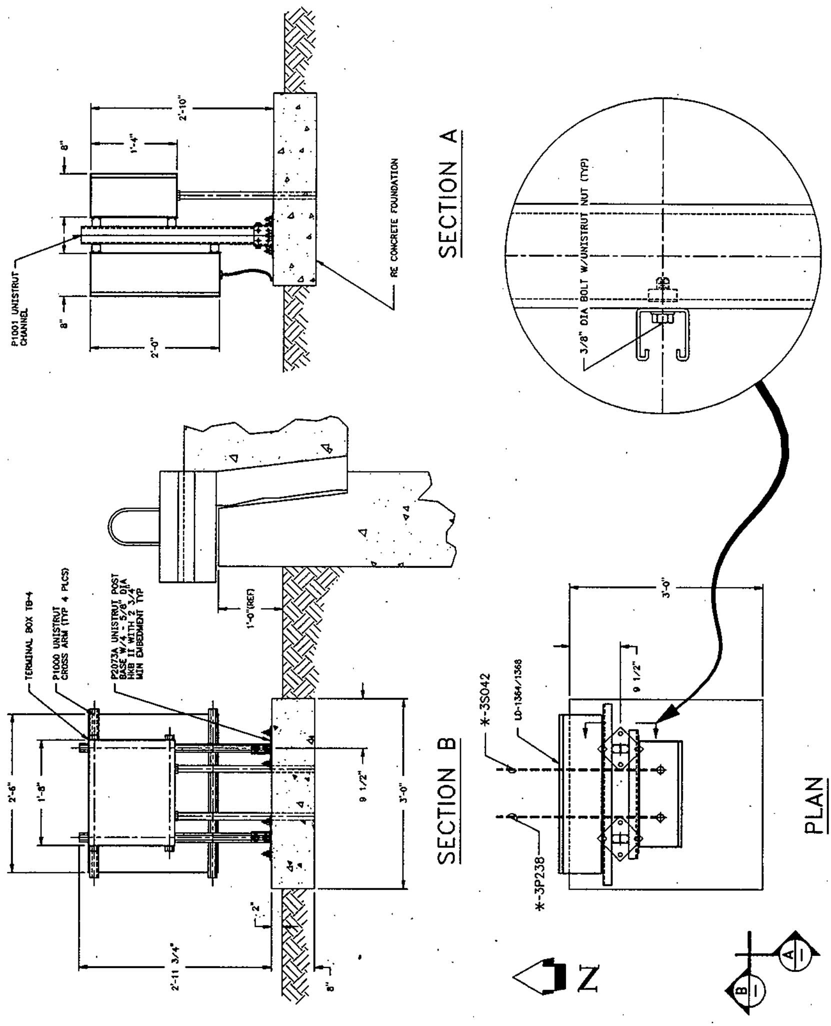

FIGURE 10
RACK FOR TB-4 AND LD-1364/1368
SCALE 1:24

ACAD FILE: 29FIG10

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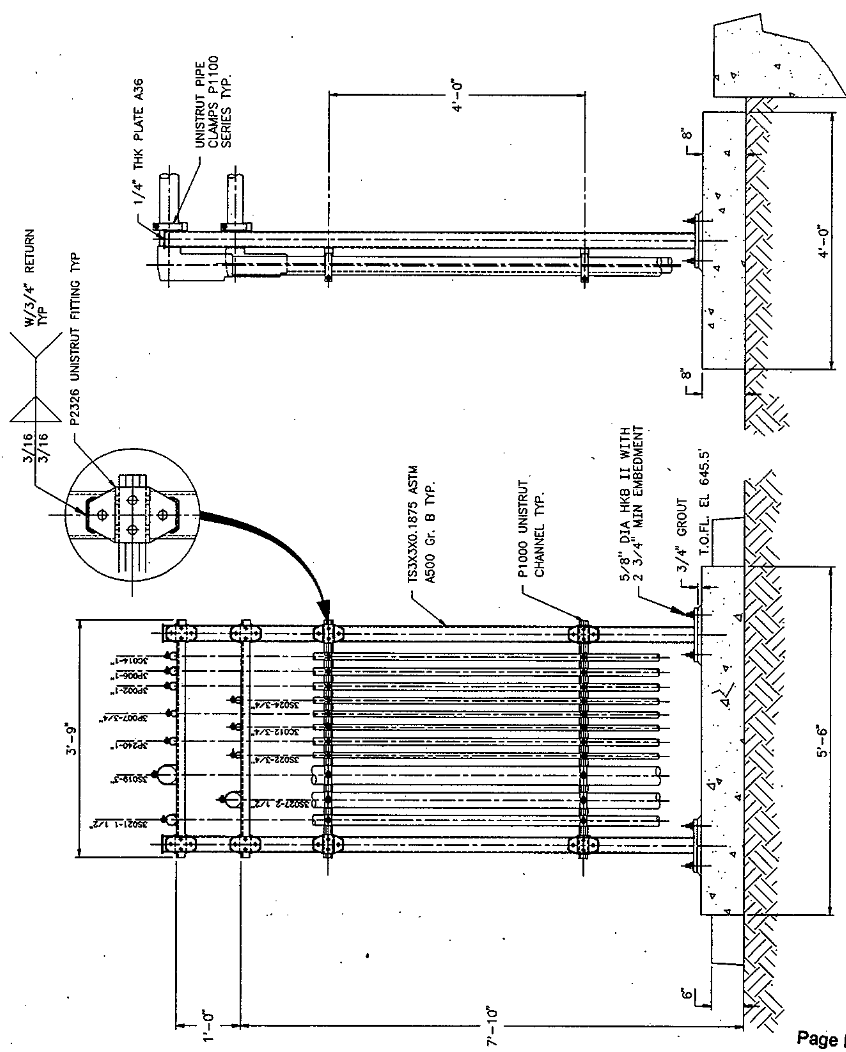

NOTE:
FOR BASE PLATE DETAIL AND PLAN OF THE FOUNDATION SEE SHEET 42

FIGURE 11
PROCESS BLDG CONDUIT SUPPORT #1
SCALE 1:24

ACAD FILE: 29FIG11

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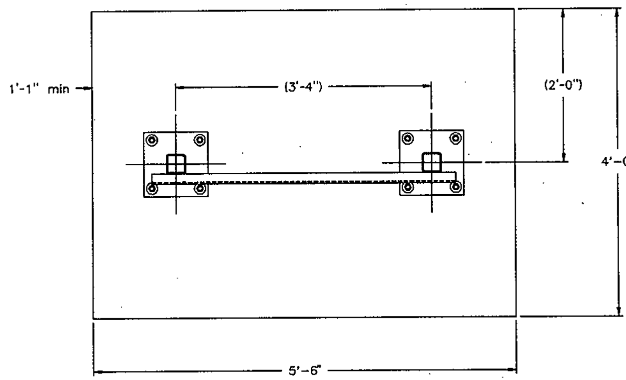
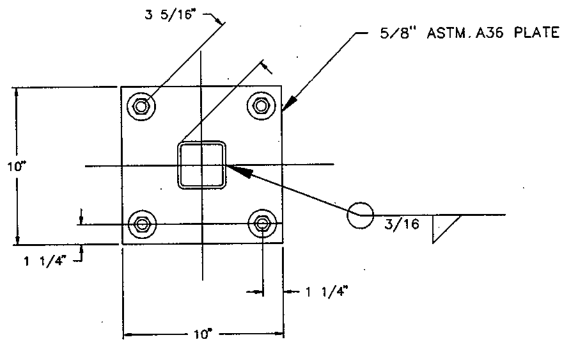


PLAN
SCALE 1:20



BASE PLATE
SCALE 1:12

ACAD FILE: 29FIG11A

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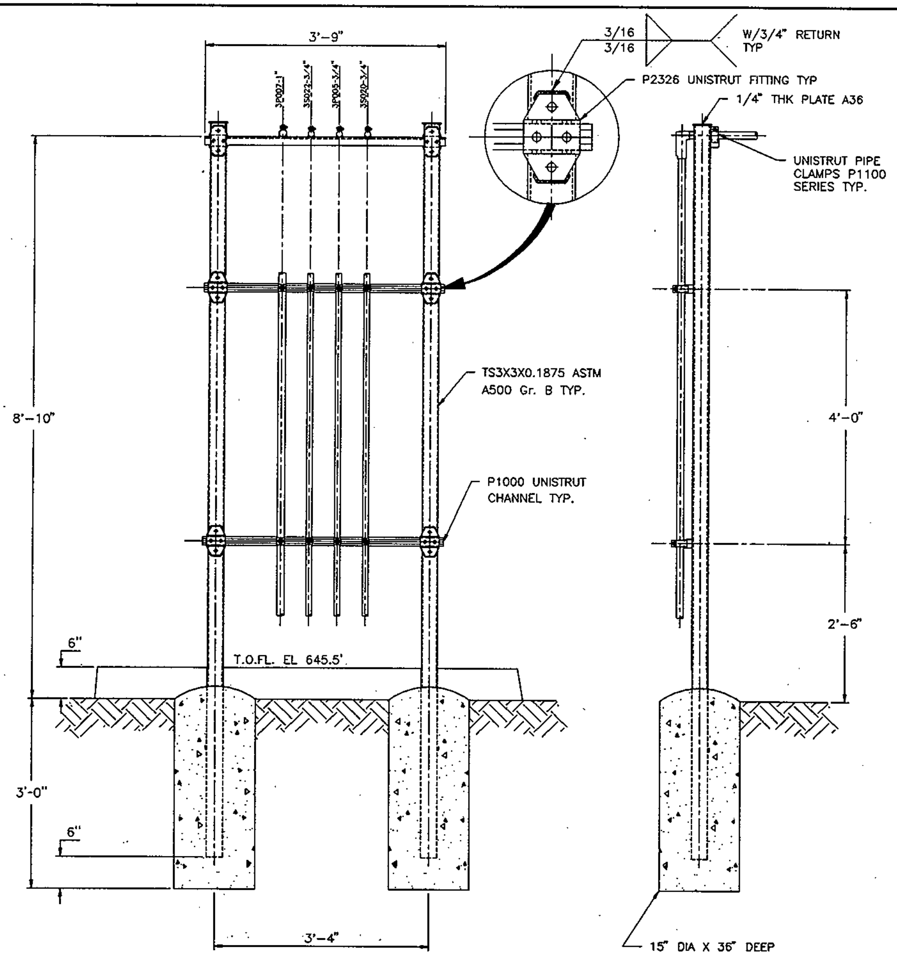

FIGURE 12
PROCESS BLDG CONDUIT SUPPORT #2
SCALE 1:24

ACAD FILE: 29FIG12

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Date: 11/30/1995
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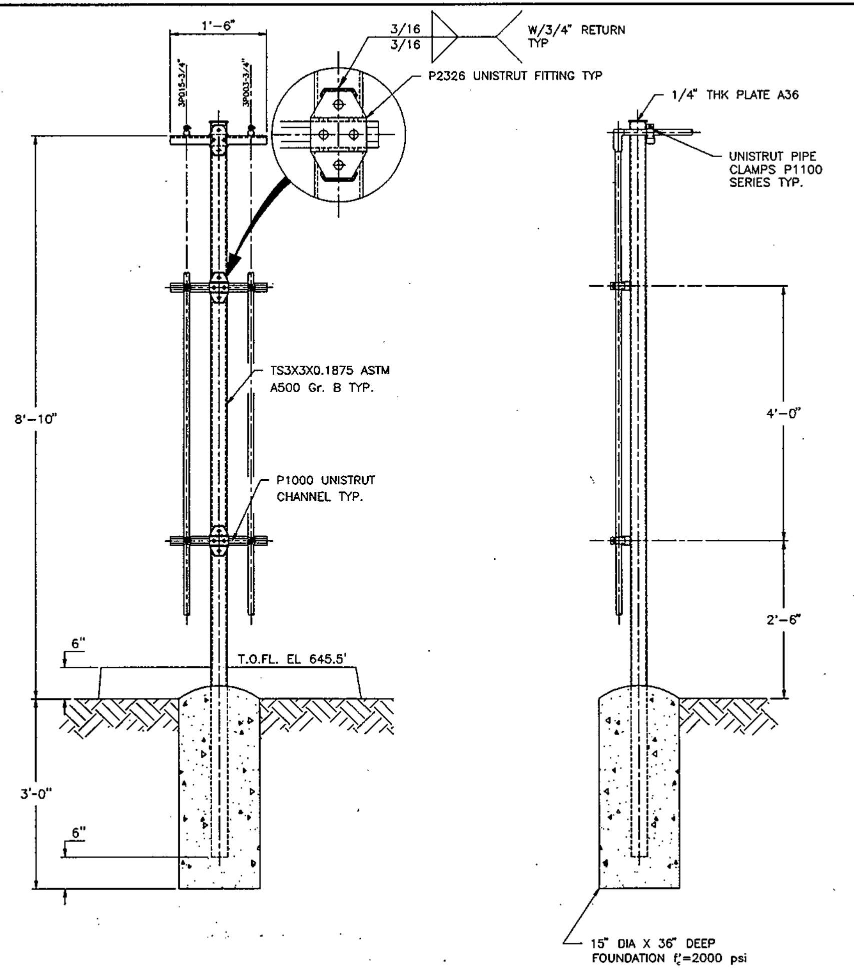

FIGURE 13
PROCESS BLDG CONDUIT SUPPORT #3
SCALE 1:24

ACAD FILE: 29FIG13

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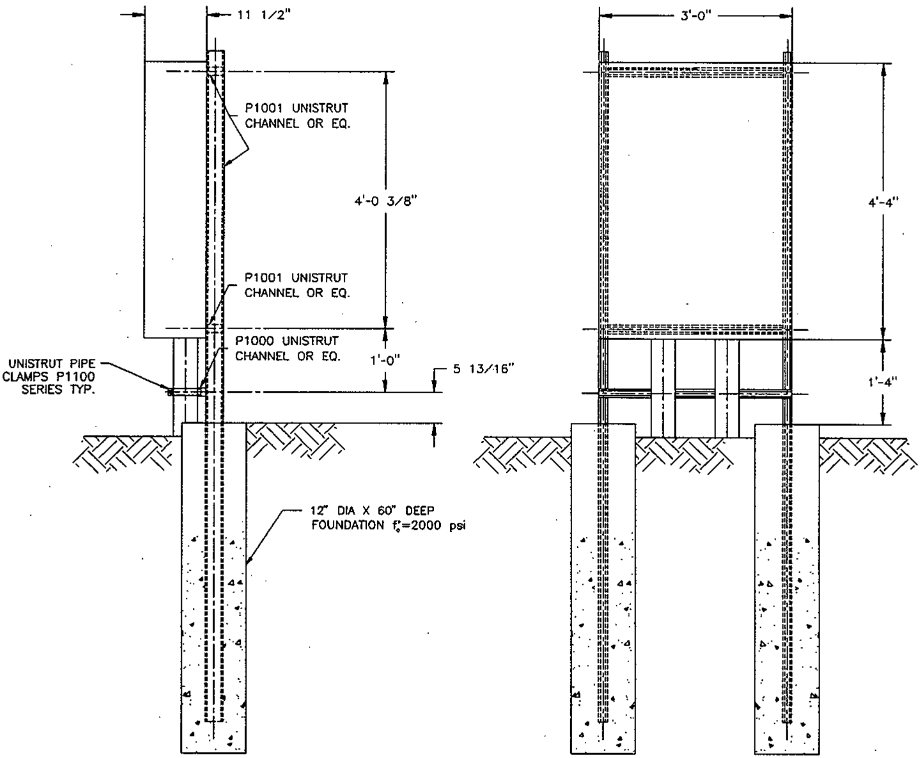

FIGURE 14
METER AND SOCKET MOUNTING RACK
SCALE 1:24

ACAD FILE: 29FIG14

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Checked: 5/08/97 By: M.R. Custer MRC
Revised: By:

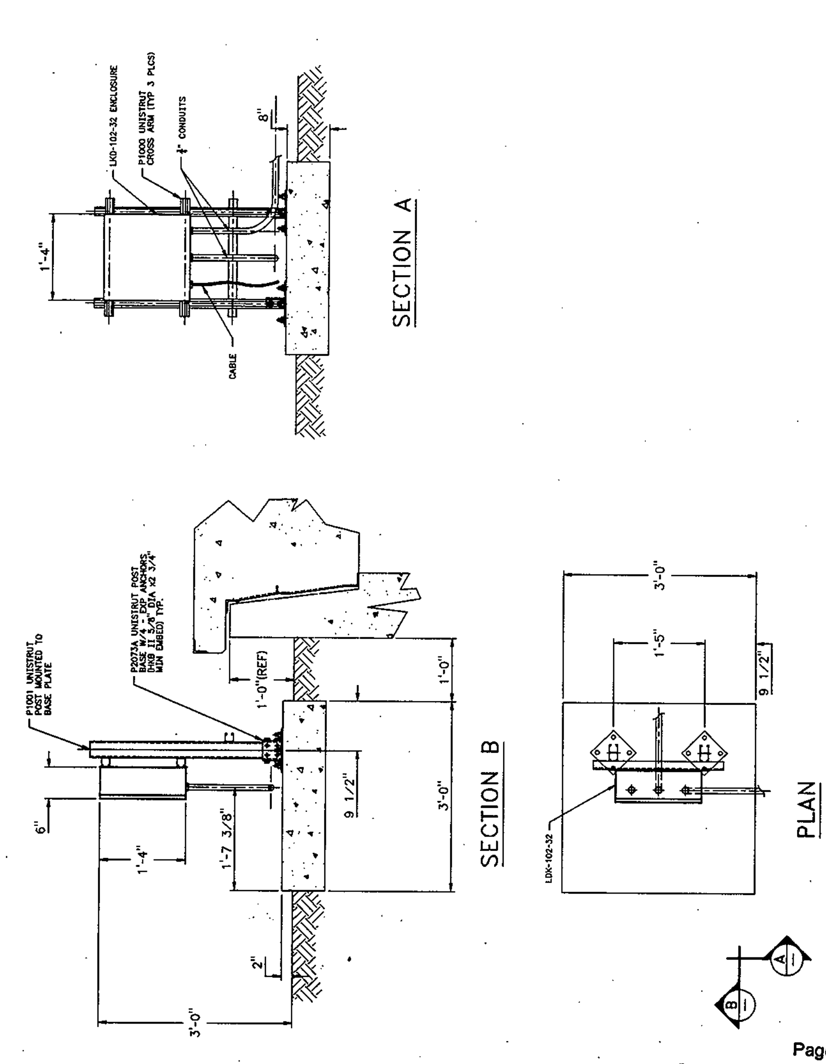

FIGURE 15
RACK FOR 16X16X6 NEMA4 ENCL. LDK-102-32
SCALE 1:24

ACAD FILE: 29FIG15

FLUOR DANIEL NORTHWEST INC.

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By: M.R. Custer MRC
By:

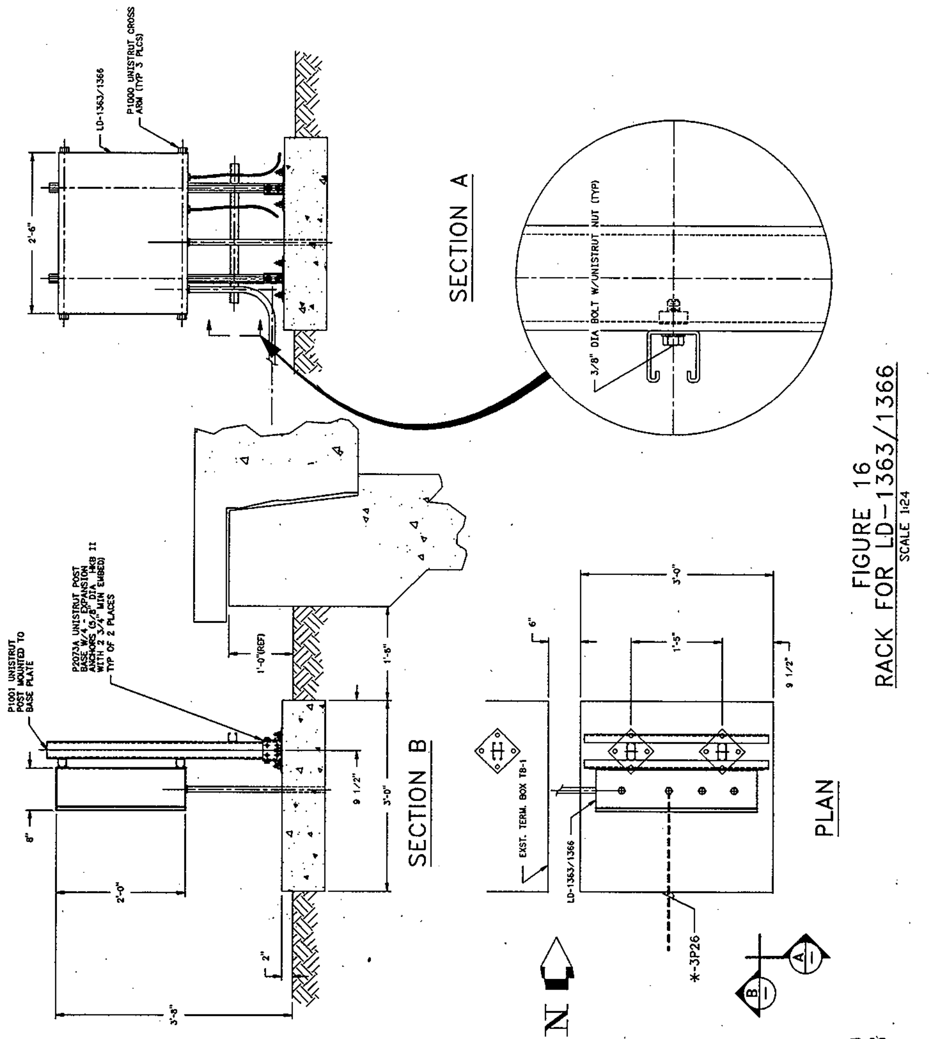

FIGURE 16
RACK FOR LD-1363/1366
SCALE 1:24

ACAD FILE: 29FIG16

FLUOR DANIEL NORTHWEST INC.

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By: M.B. Lasota *Mul*
By: *M.R. CUSTER* *MRC*
By:

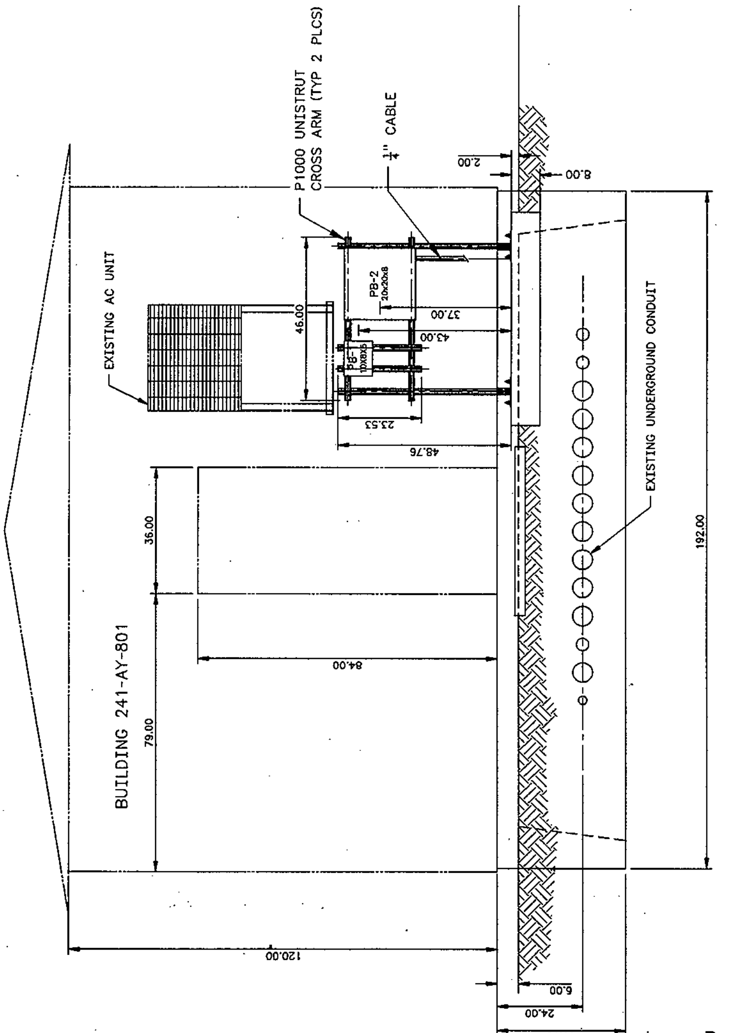

FIGURE 17 - ELEVATION LKG. WEST RACK FOR BLDG 241-AY-801 PULL BOXES
SCALE 1:36

ACAD FILE: ELE320X1

FLUOR DANIEL NORTHWEST INC.

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By:

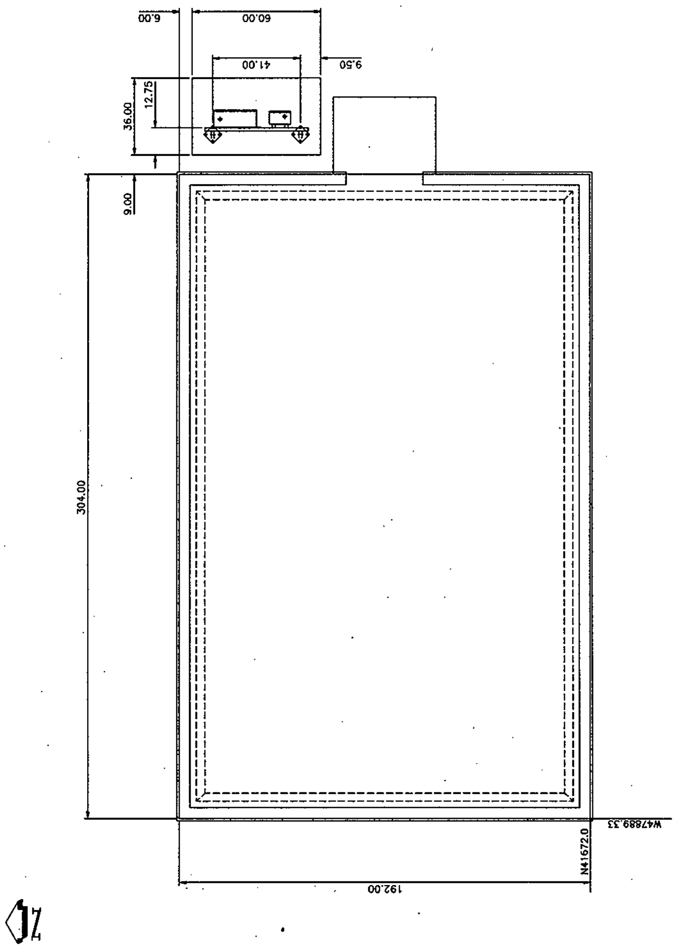

FIGURE 17
RACK FOR BLDG 241-AY-801 PULL BOXES
SCALE 1:60

ACAD FILE: 29FIG17A

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Client: WHC	WO/Job No.: ER4319/W 320
Subject: Structural analysis of Safety Related Electrical Equipment Supports.	Date: 05/06/1997 By: M. B. Lasota
	Checked: 5/8/97 By: R. W. Davidson
Location: 241-C-106 & 241-AY-102	Revised N/A By N/A

7. CONCLUSIONS.

The preceding calculations show that the Electrical Racks, Conduit Supports and Nitrogen Bottle Rack as designed and detailed are capable of effectively resisting Dead Load and Environmental (horizontal seismic and wind) Loads.

W320-24-030

Electrical Equipment and Conduit Supports
Process Building

	CALCULATION IDENTIFICATION AND INDEX	Page i of iii Date 10/26/95

This sheet shows the status and description of the attached Design Analysis sheets.

Discipline Civil WO/Job No. ER-6159/W-320 Calculation No. W320-24-030

Project No. & Name PROJECT W-320, TANK 241-C-106 WASTE RETRIEVAL

Calculation Item Electrical Equipment and Conduit Supports - Process Building

These calculations apply to:

Dwg. No. H-2-818455 sht.2 Rev. No. 0

Dwg. No. H-2-818678, Shts 1 and 5 Rev. No. 0,0

Other (Study, CDR) Rev. No.

The status of these calculations is:

[ ] Preliminary Calculations

[X] Final Calculations

[ ] Check Calculations (On Calculation Dated)

[ ] Void Calculation (Reason Voided)

Incorporated in Final Drawings? [X] Yes [ ] No

This calculation verified by independent "check" calculations? [ ] Yes [X] No

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	Michael R Custer 3/29/96		
Checked by	[signature] 5/13/96		
Approved by	[signature] 5/13/96		
Checked Against Approved Vendor Data	A Langevin 4/7/98		

INDEX

Design Analysis Page No.	Description
i	Calculation Identification and Index
ii	Calculation Cross Index
iii	Design Verification Screening Criteria
1,2	OBJECTIVES; CRITERIA; DATA; ASSUMPTIONS; METHODS; REFERENCES; CALCULATIONS; CONCLUSIONS
3-12	DESIGN/ANALYSIS
APPENDIX A	Figures 1 thru 7 (6 Pages)

CALCULATION CROSS INDEX (Typical)

Subject Calculation No. W320-24-030

Subject Calculation Revision No.	Superceded by Calculation No.	These interfacing calculation/documents provide input to the subject calculation, and if revised may require revision of the subject calculation.		Results and conclusions of the subject calculation are used in these interfacing calculations and/or documents.		Does the output interface calculation/ documents require revision?		Has the output interface calculation/ documents been revised?		Discipline manager's signature and date indicating evaluation complete.
		Calculation/Document No.	Revision No.	Calculation/Document No.	Revision No.	Yes	No	Yes	No	
0	N/A	H-2-818455 SHT. 2	0	H-2-818455 SHT. 2	0		✓		✓	[signature] 5/18/94
				H-2-818678 SHT. 1	0		✓		✓	
				H-2-818678 SHT. 5	0		✓		✓	

KEH 1975.00 (12/88)

SFS No. ____________

DESIGN VERIFICATION SCREENING CRITERIA

Project/Document No. W320/W320-24-030

When the design or design change affects hardware, formal design verification must be performed if one or more of the following questions must be answered affirmatively (YES).

YES	NO	
	✓	1. Does the design or design change involved meet the established criteria to be considered Safety Class 1?
	✓	2. Does this design or design change cause or permit changes to Safety Class 1 instrument or alarm setpoints outside of previously approved operational limits?
	✓	3. Does this design or design change significantly affect the nuclear or environmental safety consequences of a malfunction or failure of the structure, system, or component?
	✓	4. Does this design or design change involve or change design that has previously undergone formal design verification?

[signature] 5/13/96
Assigned Lead Engineer — Date

[signature] 5/13/96
Responsible Discipline Manager — Date

Original Design Package Distribution:

- Project Manager
- Design Verification Officer
- Engineering Document Control

Design Change Distribution:

- Attach to Engineering Change Notice

KEH-1981.00 (09/92)

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Subject Electrical Equipment and Conduit Support - Process Building	Date 10/26/95	By M.R Custer MRC
	Checked 5/13/96	By RSD
Location TANK 241-C-106	Revised	By

OBJECTIVE:

The objective of this calculation is to provide a detailed design of a Safety Class 3 support for electrical panels C106-PP1 and SCP-1361 (Equipment No. ER-1362) and an intermediate support for conduits routed from outside the Process Building into panel IE-1361.

CRITERIA:

1. DOE ORDER 6430.1A (04/06/89)
2. HANFORD PLANT STANDARDS, STANDARD ARCH./CIVIL DESIGN CRITERIA, SDC-4.1, REV.11
3. FUNCTIONAL DESIGN CRITERIA, WHC-SD-W320-FDC-001, REV.2

DATA:

1. The equipment and conduit to be supported are Safety Class 3 per Reference 6, therefore the supports are Safety Class 3.

ASSUMPTIONS:

1. None

METHODS:

Hand calculations

REFERENCES:

1. AISC Manual of Steel Construction, Ninth Edition
2. ICBO, Uniform Building Code (UBC), 1991 Edition
3. American Welding Society (AWS), Standard D1.1, Structural Welding Code
4. ASCE 7-93, Minimum Design Loads for Buildings and Other Structures
5. HANFORD PLANT STANDARDS, Standard Arch./ Civil Design Criteria, SDC-4.1
6. WHC-SD-WM-SEL-033, Rev.0-C, Interim Safety Equipment List for 241-C-106 Waste Retrieval
7. Design of Welded Structures, Blodgett (Eighth Edition)

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CALCULATIONS:

REFER TO DESIGN/ANALYSIS SECTION

CONCLUSIONS:

Based on the evaluation performed, the designed structures are adequate to support the Seismic Class 3 equipment and conduits.

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Location TANK 241-C-106	Revised By

DESIGN/ANALYSIS:

The design and analysis of the equipment and conduit supports involves the development of the loads on the structures and design of the support structures and associated connections to the Prefiltration/ Recirculation equipment skid. The equipment and conduits shall be located inside the Process Building, therefore the design loads included in determining the governing load combination, consists of dead and seismic load components only.

DESIGN EQUIPMENT SUPPORT, ER-1362 (Reference Figures 1 and 2)

DESIGN LOADS:

DEAD LOADS

- Electrical equipment:
  - Mini-power Panel (C106-PP1), 200 lbs
  - SCR Temporary Power Control Panel (SCP-1361), 100 lbs
- Tributary conduit weights: (Based on the following conduit diameters used)
  - 0.50", 1.3 lbs/ ft
  - 0.75", 1.9 "
  - 1.00", 2.9 "
  - 1.50", 5.8 "
  - 2.00", 8.7 "
  - 2.50", 13.0 "
  - 3.00", 18.5 "
  - 3.50", 23.8 "
  - 4.00", 29.9 "

Equipment and conduit supports located inside the Process Building, so:

LIVE LOAD, L = 0 (Not Applicable)

SNOW LOAD, S = 0 (Not Applicable)

ROOF LIVE LOAD, Lr = 0 (Not Applicable)

RAIN LOAD, R = 0 (Not Applicable)

WIND LOAD, W = 0 (Not Applicable)

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EARTHQUAKE LOADS (Seismic loads distributed based on mass distribution)

• Lateral Seismic Force Components

$F_p = ZIC_p W_p$, where:

$Z = 0.20$ (Zone 2B)

$I = 1.25$

$C_p = 0.75 \times 2 = 1.5$

$F_p = (0.20)(1.25)(1.5) W_p = 0.375 W_p$

$E_{n\text{-}s} = F_p$ (100% max.) $= 0.375 W_p (1.0) = 0.375 W_p$

$E_{e\text{-}w} = F_p$ (30% max.) $= 0.375 W_p (0.30) = 0.113 W_p$

GOVERNING LOAD COMBINATION/ MAXIMUM LOADS ON THE EQUIPMENT STRUCTURE:

1) D

2) D + L + (Lr or S or R); L, Lr, S and R = 0, then D

3) D + (W or E), W = 0, then D + E

4) D + L + (Lr or S or R) + (W or E); L, Lr, S, R and W = 0, then D + E

Governing load combination for the design is: (D + E)

EQUIPMENT/ CONDUIT SEISMIC LOAD COMPONENTS:

Dead Load (1), Wt of Mini Power Panel = 200 lbs

Seismic Load (1), $E_{n\text{-}s} = 0.375 (200) = 75.0$ lbs

$E_{e\text{-}w} = 0.113 (200) = 23.0$ lbs

Dead Load (2), Wt of Control Panel = 100 lbs

Seismic Load (2), $E_{n\text{-}s} = 0.375 (100) = 38$ lbs

$E_{e\text{-}w} = 0.113 (100) = 11$ lbs

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Dead Load (3), Wt of conduits:

Conduit No.	Conduit size	Tributary Length	Weight, lb/ft	Total Wt.lbs
3C011	3/4"	5 ft	2	10
3C014	3/4"	"	2	10
3P002	1"	"	3	15
3P006	1"	"	3	15
3P007	1"	"	3	15
3P008	3/4"	"	2	10
3P016	3/4"	"	2	10
3P240	1"	"	3	15
3P248	1"	"	3	15
3S023	3/4"	"	2	10
			Total weight =	125 lbs

Seismic Loads (3), En-s = 0.375 (125) = 47 lbs
Ee-w = 0.113 (125) = 14 lbs

MOMENTS AND FORCES ON EACH COLUMN: (Equipment loads)

- Moments due to seismic component about the Z-axis of the TS:

  Mze1 = [Ee-w(1) (60.0") + Ee-w(2) (24.0")]/ 2 =
  Mze1 = [23 lbs (60.0") + 11 lbs (24.0")]/ 2 = 822 in-lbs

- Moments due to seismic component about the X-axis of the TS:

  Mxe1 = [En-s(1) (60.0") + En-s(2) (24.0")]/ 2 =
  Mxe1 = [75 lbs (60.0") + 38 lbs (24.0")]/ 2 = 2706 in-lbs

- Axial Force, Pae on each TS, Pae = (200 lbs + 100 lbs)/2 = 150 lbs

- Moment, Mxe2 on each column due to eccentric, dead load = P x 7.5"

  Mxe2 = 150 lb (7.5") = 1125 in-lb

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MOMENTS AND FORCES ON EACH TS COLUMN: (Tributary conduit loads)

Conservatively, 50 % of the load due to the dead load of the conduit is applied, as a concentrated load at the vertical centerline of each TS support column with the horizontal seismic component applied at 84" above the base of the TS columns.

- **Moments due to the seismic component about the Z-axis of the TS:**

  Mzc1 = Ee-w (84")/ 2 =

  Mzc1 = 14 lbs (84")/ 2 = 588 in-lb

- **Moments due to the seismic component about the X-axis of the TS:**

  Mxc1 = En-s (84")/ 2 =

  Mxc1 = 47 lbs (84")/ 2 = 1974 in-lb

- **Axial Force, Pac on each TS member, Pac = 125/ 2 = 63 lbs**

- **Moment, Mxc2 on each column due to eccentric, dead load =**

  Mxc2 = 63 lb (4") = 252 in-lb

COMBINED MOMENTS AND FORCES ON EACH TS COLUMN:

Mxt = Mxe1 + Mxe2 + Mxc1 + Mxc2 =

Mxt = 2706 + 1125 + 1974 + 252 = 6057 in-lb

Mzt = Mze1 + Mzc1 =

Mzt = 822 + 588 = 1410 in-lb

Pta = 150 lb + 63 lb = 213 lbs

DESIGN COLUMN per AISC: (TS 3 X 3 X 0.25 column) (Reference 1, page 5-54)

fa/ Fa < or = 0.15, then use AISC, Equation H1-3

fa = P/A = 213 lb/ 2.59 in^2 = 0.082 ksi

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Determine Kl/r and Fa:

K = 2.1, l = 7.0 ft = 84 in,

r = 1.10", Sx = Sz = 2.10 in^3, Ix = Iz = 3.16 in^4

Kl/ r = 2.10 (84 in)/ 1.1 = 160.1

Cc = 126.1, since Kl/r > Cc

then Fa $= 12\pi^2 E/ 23(Kl/r)^2 =$ 5.83 ksi

fa/ FA = 0.082/ 5.83 = 0.014 < 0.15 , Use AISC formula H1-3

fa/ Fa + fbx/ Fbx + fby/ Fby < or = 1.0

fbx = 6.1 k-in/ 2.10 = 2.88 ksi

fbz = 1.4 k-in/ 2.10 = 0.67 ksi

Fy = 46 ksi

Fb = 0.60 Fy = 27.6 ksi

0.014 + 2.88/ 27.6 + 0.67/ 27.6 = 0.14 < 1.0 ......o.k

Use TS 3 x 3 x 0.25

DESIGN WELD TS 3 x 3 TO SKID:

$fw = [(Mzt/Swz + Mxt/Swx)^2 + (Fx/Aw)^2 + (Fz/Aw)^2]^{0.5}$

$Sw = bd + d^2/3 = 2(2) + (2)^2/3 = 5.33\ in^2$, Aw = 8" (conservative)

$fw = [(1410/ 5.33 + 6057/ 5.33)^2 + (24/8)^2 + (80/8)^2]^{0.5}$

fw = 1401 lb/in = 1.4 k/in

Minimum weld size required:

S = 21000 psi = 21.0 ksi

w = fw/ 0.707 S = 1.4/ 0.707(21.0) = 0.09 = 3/32" fillet

Use 3/16" fillet weld, all-around TS column

Weld capacity = 0.707(3/16")(21.0 ksi) = 2.8 k/in > 1.4 k/in ..OK

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DESIGN CONDUIT SUPPORT No. 1 (Reference Figures 3, 4, and 5)

DESIGN LOADS:
DEAD LOADS:

Conduit No. No.	Dia. (in.)	Wt/ft (ft.)	Tributary Lgth (ft.)	Total Wt. (lbs.)
3S021	1.5	6.0	4.0	24
3S019	3.0	20.0	"	80
3P240	1.0	3.0	"	12
3P007	0.75	2.0	"	8
3P002	1.0	3.0	"	12
3P006	1.0	3.0	"	12
3C014	1.0	3.0	"	12
3S027	2.5	13.0	"	52
3S024	0.75	2.0	"	8
3C012	0.75	2.0	"	8
3S022	0.75	2.0	"	8

Total Dead Weight of Conduit = Wp = 236 lbs

SEISMIC LOADS:

En-s = 0.375 (100%) Wp = 0.375 (236) = 89 lbs

Ee-w = 0.375 (30%) Wp = 0.113 (236) = 27 lbs

Fx = 89/ 2 = 45 lbs

Fy = 236/ 2 = 118 lbs

Fz = 27/ 2 = 14 lbs

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Mx = (14 lb)(48") = 672 in-lb

My = 0

Mz = (45 lb)(100") = 4500 in-lb

Design Support Members and Connections:

Since the applied forces and moments on Conduit Support No. 1 are less than those on the Equipment Support No. ER-1362, the same member size and connection welds are adequate for Conduit Support No. 1.

Horizontal cross members shall be provided for attachment of "unistrut" type members connecting the conduits to the TS support. These members shall be provided with fillet welds 2" long on the top and bottom sides of each horizontal TS 3 x 3, typical each end of the TS. Stitch welds, 1/8" - 2" long at 6" o.c will be provided on both the top and bottom to attach the "unistrut" type member to the TS (typ.).

The bracing members which are oriented in the Z-direction, provide additional horizontal support to minimize deflection of the vertical TS members and are adequate by engineering judgement. Welding of the braces to be provided shall be 3/16" fillet (or equivalent), 2" long, two opposite sides at the connection to the vertical column and at the base of the brace.

DESIGN EQUIPMENT SUPPORT No. IE-1361 (Reference Figure 6 and 7)

DESIGN LOADS:

DEAD LOADS:

Weight of Instrument Cabinet, including contents: 450 lbs

SEISMIC LOADS:

En-s = 0.375 (100%) Wp = 0.375 (450) = 169 lbs

Ee-w = 0.375 (30%) Wp = 0.375 (0.30)(450) = 51 lbs

The En-s seismic component is applied parallel to the 24" dimension at the centerline of the cabinet and 72"(2/3) above the base of the cabinet (conservative) which will result in the worst case loading on the anchorage. The Ee-w component is applied parallel to the 36" dimension at the centerline of the panel and 72"(2/3) above the base of the panel.

The reactions from Conduit Support No. 1 will be added to the reactions from Instrument Panel IE-1361 for the design of the equipment/ conduit support anchorage.

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Location TANK 241-C-106	Revised By

Forces and Moments from Equipment No. IE-1361: (Orientation based on Figure 6)

Fx = 51 lbs

Fy = 450 lbs

Fz = 169 lbs

Mx = 72"(2/3)(169 lbs) = 8112 lb-in = 8.1 k-in

My = 0

Mz = 72"(2/3)(51 lbs) = 2448 lb-in = 2.5 k-in

Forces and Moments from Conduit Support No. 1: (orientation based on Figure 6)

Fx = 45 lbs	Mx = 672 in-lb
Fy = 118 lbs	My = 0
Fz = 14 lbs	Mz = 4500 in-lb

Maximum combined Loading on the connection:

Fx = 51/ 4 = 13 lbs + 45 lbs = 58 lbs

Fy = [2448 in-lb/ 42 (2)] + [8112 in-lb/ 18 (2)] = 29 lb + 225 lb = 254 lb

In addition, Fy due to the overturning moments of the conduit support no. 1 are resolved to vertical reactions on the angle at the centerline of the TS member):

Fy = 672 in-lb/ 18" + 4500 in-lb/ 42" = 146 lbs

Fy (total) = 254 + 146 = 400 lbs

Fz = 169/ 4 = 42 lbs + 14 lbs = 56 lbs

Design Instrument Cabinet to Skid connection:

Try (1) connection angle 3 x 5 x 0.5, 6" long (LLH) at each corner of the Instrument Cabinet with (3) - 5/8" dia. A-307 (min.) bolts.

Check ∠ 3 x 5: (Bending in angle due to eccentric vertical loading)

Moment = Vert. force x distance to the C.G of the weld configuration (Ny)

DESIGN ANALYSIS

Client WHC

Subject Electrical Equipment and Conduit Support - Process Building

Location TANK 241-C-106

WO/Job No. ER-6159/W-320

Date 10/26/95 By M.R Custer MRC

Checked 5/13/96 By [signature]

Revised By

$Ny = 5" - (d^2/b + 2d) = 5 - [5^2/ 6 + 2(5)] = 3.43"$ (Distance from weld C.G to outside of vertical leg of angle)

$Mzt = (254 \text{ lb})(3.43") + (58 \text{ lb})(3.0") = 1045.2$ in-lb = 1.05 k-in

$Fb = 22$ ksi

$fb = M/ Sx$, $Sx = bd^2/ 6 = 6(.5)^2/6 = 0.25 \text{ in}^3$

$fb = 1.05/ .25 = 4.2 \text{ ksi} < 22$ ksi ... ok

Check A-307 bolts: (3) bolts per connection

Area/ bolts = $Ab = 0.202 \text{ in}^2 \times 3 = 0.606$

Allowable shear load/ bolt group = 0.606 (10 ksi) = 6.1 k (min. per AISC, 6 k).. ok

$fvz = P/ Ab = 56 \text{ lb}/ 0.606 = 0.09$ ksi (negligible)

$fvy = P/ Ab = 254 \text{ lb}/ 0.606 = 0.42$ ksi

SRSS stress = 0.44 ksi < Fv = 10 ksi ... ok

Check weld configuration: (fillet weld 3 sides, typ.)

Combined Forces and moments on the weld due to the reactions from the Instrument Cabinet and TS Conduit Support:

$Fxc + Fts = 58$ lbs

$Fyc = 254$ lbs — $Fyts = 700 \text{ in-lb}/18" = 39$ lbs

$Fzc = 42$ lbs — $Fzts = 14$ lbs

$Mxc = 42 \text{ lbs } (2") = 84$ in-lb — $Mxts = 0$

Myc, Myts = negligible

$Mzc = 194 \text{ lbs } (3.43") = 665$ in-lb — $Mzts = 4500$ in-lb

Weld Properties:

$Aw = 16"$

$Swx = db + d^2/6 = 6(5) + 6^2/6 = 36 \text{ in}^2$

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$Swz = d^2 (2b + d)/3 (b + d) = 5^2 [2(6) + 5]/3 (6 + 5) = 12.9 \text{ in}^2$

$fw = [(Fy/ Aw + Mx/ Swx + Mz/ Swz)^2 + (Fx/ Aw)^2 + (Fz/ Aw)^2]^{1/2}$

$fw = [(254 + 39)/ 16 + 84/36 + (4500 +665)/ 12.9)^2 + (58/16)^2 + (42 + 14)/16)^2 =$

$fw = 421$ lbs/in

Try 1/4" fillet weld:

Weld capacity = 1/4" (.707)(21000 lb/in) = 3712 lb/in > 421 lb/in ...ok

Use ∠ 3 x 5, 6" long w/ 3 - 5/8" dia., A-307 bolts (min.) to connect the cabinet to the angle and a 1/4" fillet weld on (3) sides to connect the angle to the skid.

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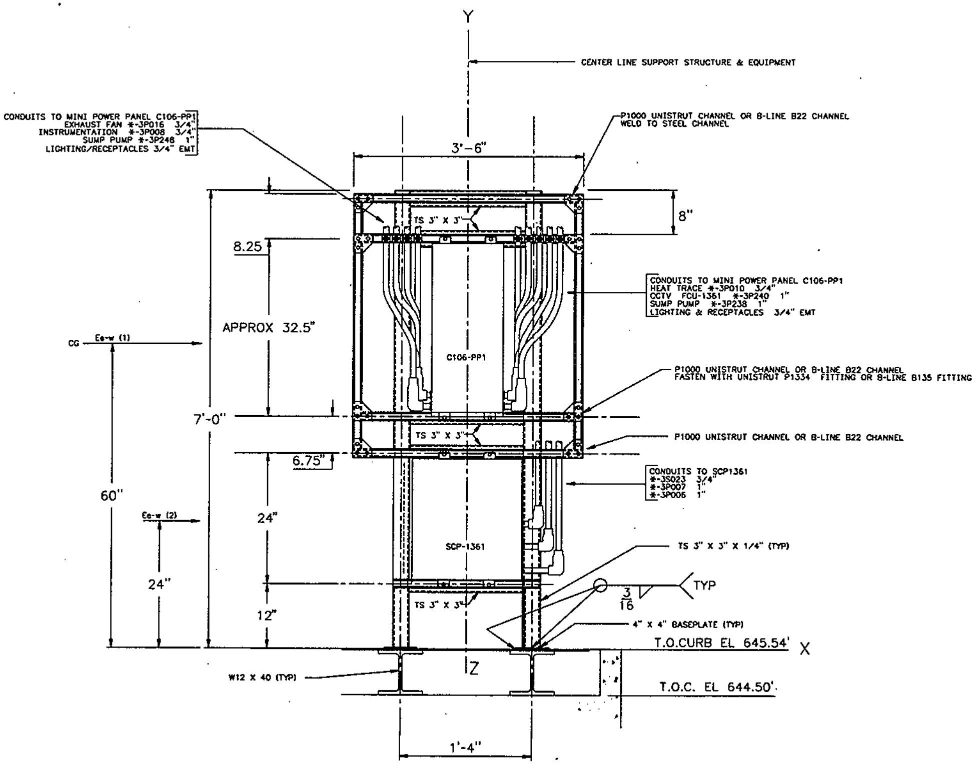

NOTES: CONDUITS ARE FIELD ROUTED.
CONDUIT INSTALLATION MAY DIFFER FROM WHAT IS SHOWN.

FIGURE 1

(ELECTRICAL RACK ER-1362)

ACAD FILE: CUSTER-1

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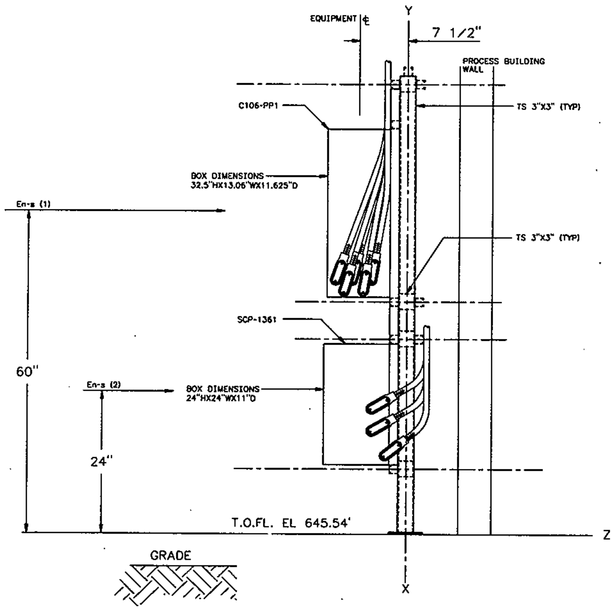

NOTES: CONDUITS ARE FIELD ROUTED.
CONDUIT INSTALLATION MAY DIFFER FROM WHAT IS SHOWN.

FIGURE 2

(ELECTRICAL RACK ER-1362)

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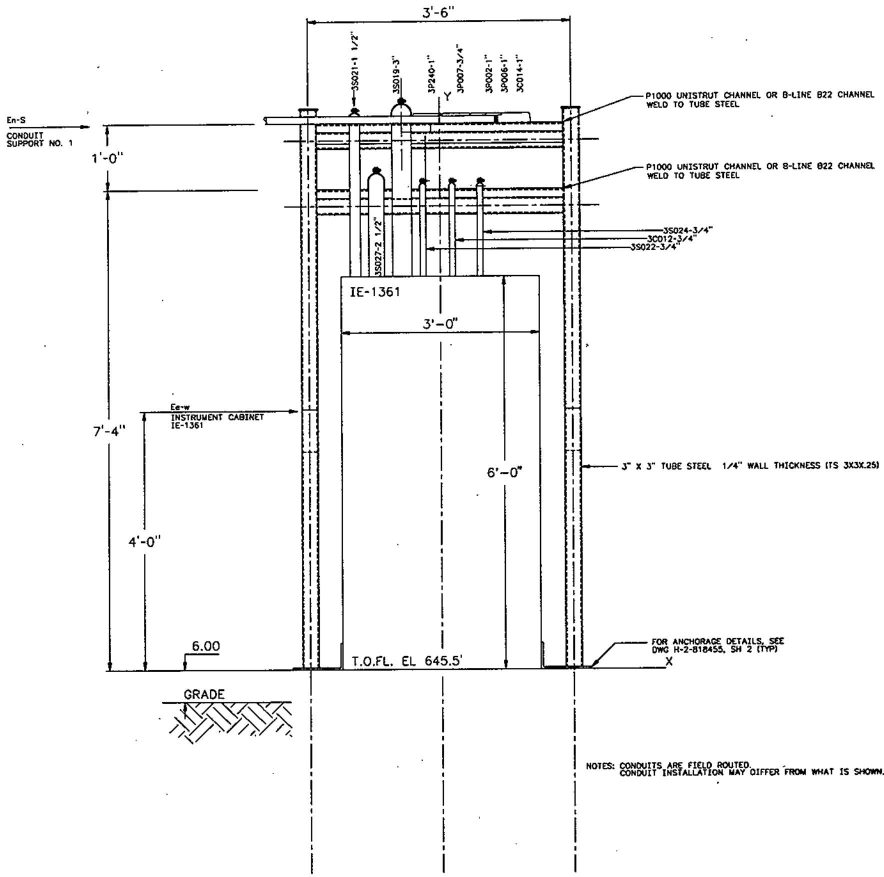

FIGURE 3

(EQUIPMENT NO. IE-1361/CONDUIT SUPPORT #1)

ACAD FILE: CUSTER-1

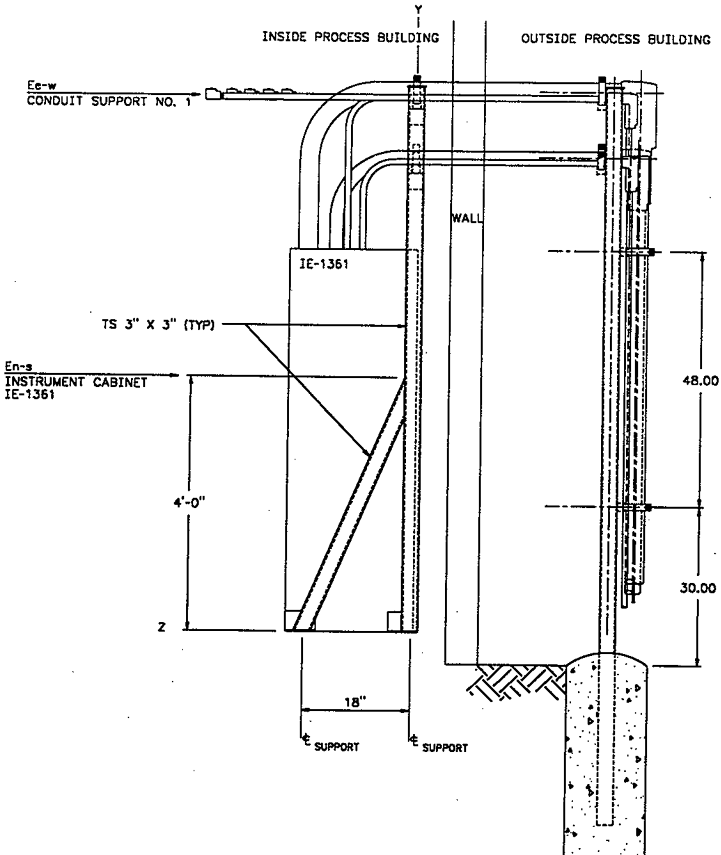

FIGURE 4

(PROCESS BLDG CONDUIT SUPPORT #1)

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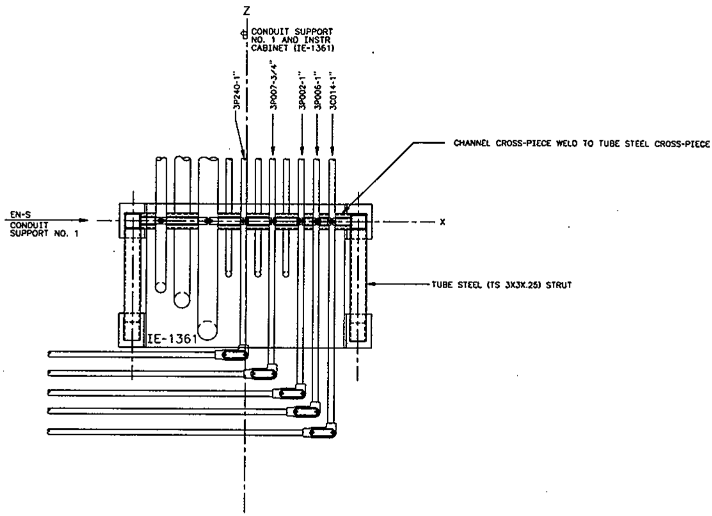
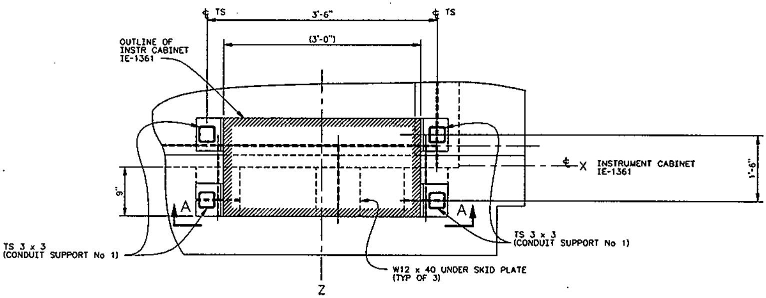


NOTES: CONDUITS ARE FIELD ROUTED.
* CONDUIT INSTALLATION MAY DIFFER FROM WHAT IS SHOWN.

FIGURE 5

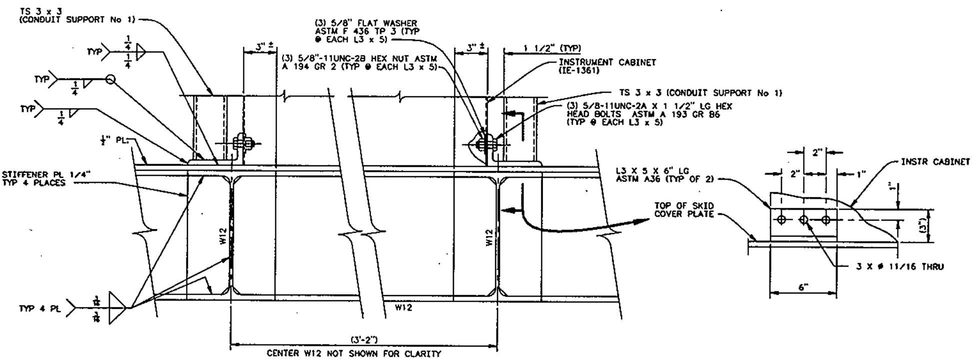
(PROCESS BLDG CONDUIT SUPPORT #1)

Appendix A
Calc. No.: W320-24-030
Revision: 0
Page No.: 6 of 6



PLAN

FIGURE 6



SECTION A-A

FIGURE 7

ACAD FILE: FIG455A

W320-24-031

Process Building Equipment Skid
Adjustable Lifting Beam Frame

KAISER ENGINEERS
HANFORD

	CALCULATION IDENTIFICATION AND INDEX	Page i of iii Date 02/12/96

This sheet shows the status and description of the attached Design Analysis sheets.

Discipline Civil WO/Job No. ER-6159/W-320 Calculation No. W320-24-031

Project No. & Name PROJECT W-320, TANK 241-C-106 SLUICING

Calculation Item Process Building Equipment Skid - Adjustable Lifting Beam Frame Modifications

These calculations apply to:

Dwg. No. H-2-83689, Sh 1 Rev. No. 0,

Dwg. No. Rev. No.

Other (Study, CDR) Rev. No.

The status of these calculations is:

[ ] Preliminary Calculations

[X] Final Calculations

[ ] Check Calculations (On Calculation Dated)

[ ] Void Calculation (Reason Voided)

Incorporated in Final Drawings? [X] Yes [ ] No

This calculation verified by independent "check" calculations? [ ] Yes [X] No

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	Michael R Custer 3/7/96		
Checked by	RW Daniels 3/13/96		
Approved by	RW Daniels 3/13/96		
Checked Against Approved Vendor Data	Ann Langevin 4/7/98		

INDEX

Design Analysis Page No.	Description
i	Calculation Identification and Index
ii	Calculation Cross Index
iii	Design Verification Screening Form
1,2	OBJECTIVES; CRITERIA; DATA; ASSUMPTIONS; METHODS; REFERENCES; CALCULATIONS; CONCLUSIONS
3-5	DESIGN/ANALYSIS
APPENDIX A	Drawing H-2-83689, Sh 1 (ECN)

CALCULATION CROSS INDEX (ypical)

Subject Calculation No. W320-24-031, REV. 0

Subject Calculation Revision No.	Superceded by Calculation No.	These interfacing calculation/documents provide input to the subject calculation, and if revised may require revision of the subject calculation.		Results and conclusions of the subject calculation are used in these interfacing calculations and/or documents.		Does the output interface calculation/documents require revision?		Has the output interface calculation/documents been revised?		Discipline manager's signature and date indicating evaluation complete.
		Calculation/Document No.	Revision No.	Calculation/Document No.	Revision No.	Yes	No	Yes	No	
0	N/A	H-2-83689 SH 1	0	H-2-83689 SH. 1	0		✓		✓	[signature] 3/13/96
		H-2-83689 SH 2	0							
		H-2-83689 SH 3	0							
		H-2-83689 SH 4	0							

KEH 1975.00 (12/88)

SFS No. ______

DESIGN VERIFICATION SCREENING CRITERIA

Project/Document No. W-320/CALCULATION W320-24-031, REV. 0

When the design or design change affects hardware, formal design verification must be performed if one or more of the following questions must be answered affirmatively (YES).

YES	NO	
____	✓	1. Does the design or design change involved meet the established criteria to be considered Safety Class 1?
____	✓	2. Does this design or design change cause or permit changes to Safety Class 1 instrument or alarm setpoints outside of previously approved operational limits?
____	✓	3. Does this design or design change significantly affect the nuclear or environmental safety consequences of a malfunction or failure of the structure, system, or component?
____	✓	4. Does this design or design change involve or change design that has previously undergone formal design verification?

[signature] 3/13/94
Assigned Lead Engineer — Date

[signature] 3/13/94
Responsible Discipline Manager — Date

Original Design Package Distribution:

- Project Manager
- Design Verification Officer
- Engineering Document Control

Design Change Distribution:

Attach to Engineering Change Notice

KEH-1981.00 (09/92)

KAISER ENGINEERS HANFORD

Calc. No. W320-24-031
Revision 0
Page No. 1 of 5

DESIGN ANALYSIS

Client WHC
WO/Job No. ER-6159/W-320
Subject Process Building Equipment Skid - Rigging Frame
Date 02/12/96 By M.R Custer MRC
Checked 3/13/96 By [signature]
Location TANK 241-C-106
Revised By

OBJECTIVE:

The objective of this calculation is to provide an evaluation of modifications to an existing adjustable lifting beam frame configuration, as shown on drawings H-2-83689 Sh 1 thru 4, Rev 0 (References 3 thru 6). The modifications include a replacement of the existing W10 x 49 spreader beam with a W12 x 35, use of fixed-frame dimensions of 12'- 1 1/4" x 14'- 1" and a reduction of the maximum lifted load on the rigging frame.

CRITERIA:

1. DOE ORDER 6430.1A (04/06/89)
2. DOE-RL-92-36, Hanford Rigging and Hoisting Manual, January 15, 1993

DATA:

1. The data consists of the information provided on drawings H-2-83689 Shts 1 thru 4, modified as described in the preceding "OBJECTIVE" section of the calculation.

ASSUMPTIONS:

1. None

METHODS:

Hand calculations

REFERENCES:

1. AISC Manual of Steel Construction, Ninth Edition
2. DOE-RL-92-36, Hanford Rigging and Hoisting Manual, January 15, 1993
3. Drawing H-2-83689, Sh 1, Rev 0
4. Drawing H-2-83689, Sh 2, Rev 0
5. Drawing H-2-83689, Sh 3, Rev 0
6. Drawing H-2-83689, Sh 4, Rev 0
7. Drawing H-2-818455, Sh 1, Rev 0
8. Vendor drawing A-1759 submitted per Specification W-320-P05

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HANFORD

Calc. No. W320-24-031
Revision 0
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DESIGN ANALYSIS

Client WHC

Subject Process Building Equipment Skid - Rigging Frame

Location TANK 241-C-106

WO/Job No. ER-6159/W-320

Date 02/12/96 By M.R Custer

Checked 3/13/96 By [signature]

Revised By

CALCULATIONS:

Refer to the DESIGN/ANALYSIS section of the calculation.

CONCLUSIONS:

Based on the evaluation performed, the modifications made to the adjustable lifting beam frame, as shown on Appendix A, ECN to drawing H-2-83689, Sh 1 and as referenced to drawings H-2-83689, Shts 1, 2, 3 and 4 is structurally adequate to support the loads applied during the lifting and placement of the Process Building equipment skid.

KAISER ENGINEERS HANFORD	Calc. No. W320-24-031
	Revision 0
DESIGN ANALYSIS	Page No. 3 of 5 MRC
Client WHC	WO/Job No. ER-6159/W-320
Subject Process Building Equipment Skid - Rigging Frame	Date 02/12/96 By M.R Custer MRC
	Checked 3/13/96 By [signature]
Location TANK 241-C-106	Revised By

DESIGN/ANALYSIS:

The design and analysis of the lifting beam involves the development of the applied loads on the frame and a re-evaluation of the frame assembly, based on modified dimensions and member sizes. The evaluation includes determining the magnitude and distribution of forces resulting from a lifted load of 12,000 lbs applied at each of four pick points for a total lifted load of 48,000 lbs.

The total weight of the equipment skid was reduced from the original design value due to a reduction in the estimated, dry weight of the HEME equipment from 27000 lbs to 8900 lbs, as provided by the vendor drawing submittal of drawing A-1759, Project Specification W-320-P05 (Reference 8). Reference 7, drawing H-2-818455, Sh 1, Note 2 provides the magnitude of the lifted load.

DETERMINE FRAME MEMBER FORCES:

- Vertical load at each of (4) pick points, 12000 lbs
- Dimensions of Rigging Frame, 12'- 10 1/2" x 14'- 1" at points of sling attachment
- Vertical angle of slings: 60° (minimum)
- Length of each sling: 20 ft (minimum)

Determine force components on the members, based the proposed rigging geometry: (The lifting hook of the crane is located at the center of the frame dimensions)

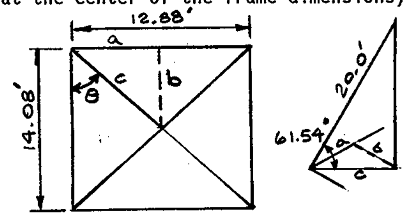
$a = 12.88 \text{ ft}/2 = 6.44 \text{ ft.}$

$b = 14.08 \text{ ft}/2 = 7.04 \text{ ft.}$

$c = (6.44^2 + 7.04^2)^{1/2} = 9.54 \text{ ft}$

$\tan\theta = 6.44/7.04$

$\theta = 42.45°$



Determine the vertical angle of the sling, based on a 20 ft sling length: (c = 9.53 ft)

$\cos\varnothing = 9.53 \text{ ft}/20.0$

$\varnothing = 61.54°$

Determine the force components in the members:

- The lifted load, vertical component, b = 12,000 lbs
- Horizontal component, d = 12000/tan 61.54° = 6505 lbs
- Horizontal component, x = cos θ (6505 lbs) = 4800 lbs
- Horizontal component, y = sin θ (6505 lbs) = 4391 lbs

KAISER ENGINEERS HANFORD

Calc. No. W320-24-031
Revision 0
Page No. 4 of 5

DESIGN ANALYSIS

Client WHC
WO/Job No. ER-6159/W-320
Subject Process Building Equipment Skid - Rigging Frame
Date 02/12/96 By M.R Custer MRC
Checked 3/13/96 By [signature]
Location TANK 241-C-106
Revised By

CHECK THE LIFTING FRAME MEMBERS:

Members used consist of the following:

MEMBER SIZE	W12 X 72	W12 X 35
LENGTH (ft)	12.88	14.08
LOAD (lbs)	4391	4800
Sx (in3)	97.4	45.6
Sy (in3)	32.4	7.47
A (in2)	21.1	10.3
rx (in)	5.28	5.25
ry (in)	3.02	1.54
rT (in)	3.29	1.74
Lc (in)	152.4	82.8
Lu (in)	366.0	151.2

Check W12 X 35: (Reference 1 and 2)

Axial load = 4800 lbs,

Moment, Mx = (12.25" + 12.5")/2 (4800lbs) = 59400 in-lb = 59.4 k-in

Moment, My = (13.88")(4800 lb) = 66600 in-lb = 66.6 k-in

$f_a = P/A = 4800/\ 10.3 = 466$ psi

$Kl/r_y = 1.0\ (14.08)(12)/1.54 = 109.7 < C_c = 126.1$, Use $F_a = 11.67$ ksi

$f_a/F_a = 0.466/\ 11.67 = 0.040 \angle 0.15$, Use $f_a/F_a + f_{bx}/F_{bx} + f_{by}/F_{by} \leq 1.0$

$l/r_T = 14.08(12)/1.74 = 97.1$

Use $F_b = [2/3 - F_y(l/r_T)^2/\ 1530(10)^3\ C_b]F_y = 16.0$ ksi

$f_{bx} = 59.4$ k-in/ $45.6 = 1.3$ ksi

KAISER ENGINEERS
HANFORD

Calc. No. W320-24-031
Revision 0
Page No. 5 of 5

DESIGN ANALYSIS

Client WHC		WO/Job No. ER-6159/W-320	
Subject Process Building Equipment Skid - Rigging Frame		Date 02/12/96	By M.R Custer MRC
		Checked 3/13/96	By [signature]
Location TANK 241-C-106		Revised	By

fby = 66.6 k-in/ 7.47 = 8.9 ksi

fbx/Fbx = 1.3/ 16.0 = 0.08

fby/Fby = 8.9/ 22.0 = 0.41

0.040 + 0.08 + 0.41 = 0.53 < 1.0 ....ok

Use W12 X 35

Check W12 X 72:

Axial load = 4391 lbs

Moment, Mx = (4.63") 12000 lb + (12.25"/2 + 2.5") 4391 lbs = 93.4 k-in

Moment, My = (13.88")(4800 lbs) = 66.6 k-in

fa = 4391/ 21.1 = 208 psi

Kl/r = 1.0 (12.88)(12)/3.02 = 51 < Cc = 126.1, Fa = 18.3 ksi

fa/Fa = 0.208/ 18.3 = 0.01 < 0.15, Use fa/Fa + fbx/Fbx + fby/Fby < / = 1.0

l/rT = 12.88(12)/3.29 = 46.9

Fbx = Fby = 22 ksi

fbx = 93.4 k-in/ 97.4 = 0.96 ksi

fby = 66.6 k-in/ 32.4 = 2.06 ksi

fbx/ Fbx = 0.96/ 22 = 0.04

fby/ Fby = 2.06/ 22 = 0.09

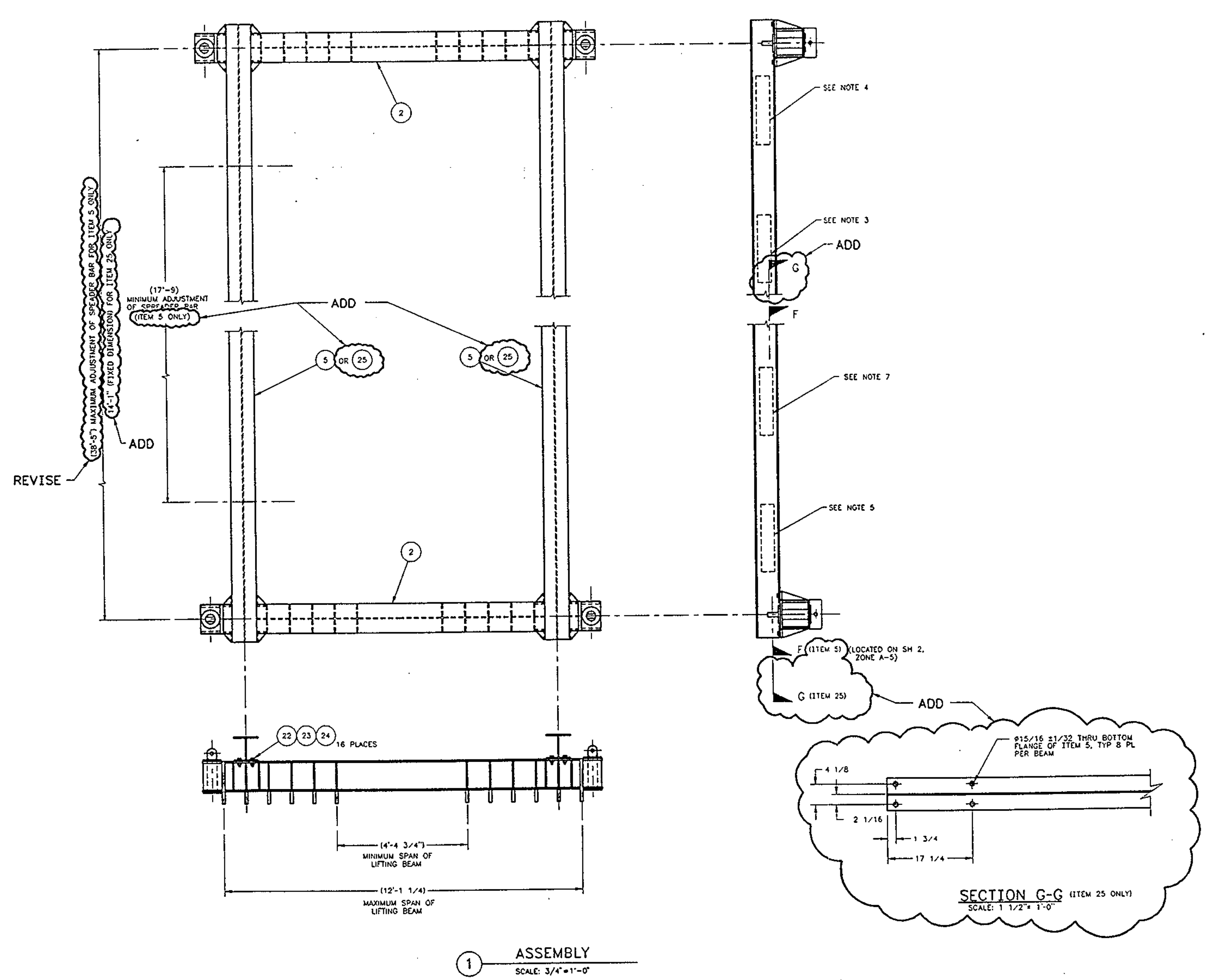
fa/Fa + fbx/Fbx + fby/Fby = 0.01 + 0.04 + 0.09 = 0.14 < 1.0 ....ok

Use W12 X 72

Check Connections:

Based on Engineering Judgement, the original design for the connections, as shown on drawings H-2-83689 Shts 1, 2, 3 and 4 is structurally adequate for the new rigging frame configuration, based on the reduced member spans and magnitude of loads, resulting in lower stresses in the connections.

ICF KAISER HANFORD	ENGINEERING CHANGE NOTICE SKETCH					
Ref Dwg H-2-83689	Sh 1	Rev 0	Prepared By BA MEYER	Checked By 3/13/9[illegible]	ECN No	Page 3



PARTS LIST - MATERIAL LIST

QTY	QTY	PART DASH NUMBER	DESCRIPTION	MATERIAL/REFERENCE	SHEET	ITEM NO
	[illegible]	-010	ASSEMBLY			1
	2	-020	ASSEMBLY		2	2
						3
						4
	2	-001	W10x49x40'-0" LONG	ASTM A36 CS		5
2		-002	W12x72x12'-0" LONG	ASTM A36 CS		6
20		-003	LIFTING LUG, 1 1/4" THICK	ASTM A36 CS	2	7
4		-004	LIFTING LUG, 1 1/4" THICK	ASTM A36 CS	4	8
8		-005	STIFFENER PLATE 7 5/8" x 10 3/4" x 3/4"	ASTM A36 CS		9
16		-006	STIFFENER PLATE, 1/2" THICK	ASTM A36 CS	4	10
8		-007	STIFFENER PLATE, 1/2" THICK	ASTM A36 CS	4	11
32		-008	STIFFENER PLATE (SEE NOTE 8) 5 3/4 x 10 7/8 x 1/2	ASTM A36 CS		12
8		-009	STIFFENER PLATE (SEE NOTE 8) 8 3/8 x 10 7/8 x 3/4	ASTM A36 CS		13
8		-011	STIFFENER PLATE (SEE NOTE 8) 8 3/4 x 10 7/8 x 3/4	ASTM A36 CS		14
8		-012	PLATE, 3/4" THICK	ASTM A36 CS	2	15
8		-013	PLATE, 3/4" THICK	ASTM A36 CS	4	16
4		-014	PLATE, 3/4" THICK	ASTM A36 CS	4	17
4		-015	PLATE, 1/2" THICK	ASTM A36 CS	4	18
4		-016	PIN	ASTM A36 CS	4	19
		-017				20
		-018				21
	16	-019	HEX HEAD BOLT 7/8-9UNC-2A x 2 3/4" LONG	ASTM A325 CS		22
	16	-021	HEX NUT, 7/8-9UNC-2B	ASTM A325 CS		23
	[illegible]	-022	FLAT WASHER, 7/8" DIAMETER	ASTM A325 CS		24
	2	-023	W12x35x15'-8" LONG	ASTM A36 CS		25

ADD

GENERAL NOTES

1. REMOVE ALL BURRS AND BREAK SHARP EDGES.
2. WELD AND INSPECT PER AWS D1.1. VT FINAL PASS OF ALL WELDS. MT DESIGNATED WELDS AFTER LOAD TESTING. WELDS SHALL BE DOCUMENTED ON AN APPROVED INSPECTION DOCUMENT. WELD QUALIFICATIONS PER ASME SECTION IX ARE AN ACCEPTABLE SUBSTITUTION.
3. IDENTIFY ASSEMBLY WITH DRAWING NUMBER AND DRAWING REVISION NUMBER IN THE LOCATION INDICATED ON THE DRAWING. CHARACTERS SHALL BE 1" HIGH AND SHALL BE PAINTED WITH BLACK ENAMEL.
4. PAINT "ASSEMBLY WEIGHT **** LBS" IN THE LOCATION INDICATED ON BOTH SIDES OF THE WEB OF ITEM 5 AND ITEM 25. THE ASSEMBLY SHALL BE WEIGHED PRIOR TO PAINTING THE ABOVE ON BOTH SIDES OF THE WEB AND THE WEIGHT TO THE NEAREST POUND SHALL BE INSERTED WHERE THE **** ARE. CHARACTERS SHALL BE 2" HIGH AND SHALL BE BLACK ENAMEL ON A YELLOW ENAMEL BACKGROUND.
5. PAINT "CAPACITY XX TONS" IN THE LOCATION INDICATED ON BOTH SIDES OF THE WEB OF ITEM 5 AND ITEM 25. CHARACTERS SHALL BE 2" HIGH AND SHALL BE BLACK ENAMEL ON A YELLOW ENAMEL BACKGROUND. CAPACITIES ARE AS FOLLOWS:
   - ITEM 5, "CAPACITY 25 TONS"
   - ITEM 25, "CAPACITY 24 TONS"
6. THE ASSEMBLY SHALL BE LOAD TESTED PER HANFORD HOISTING AND RIGGING MANUAL WHC-CM-6-4. IF THE ASSEMBLY FAILS TO PASS THE LOAD TEST, NECESSARY REPAIRS SHALL BE MADE AND THE LOAD TEST REPEATED. ANY REPAIRS MADE TO THE WELDING WILL REQUIRE RE-INSPECTION OF THE WELDS.
7. PAINT THE FOLLOWING IN THE LOCATION INDICATED ON BOTH SIDES OF THE WEB OF ITEM 5 AND ITEM 25:
   "TORQUE BOLTS TO 300 FOOT POUNDS"
   "REPLACE A325 BOLTS, NUTS AND WASHERS ANNUALLY"
   "GREASE ROTATING PIN AS REQUIRED"
   CHARACTERS SHALL BE 2" HIGH AND SHALL BE BLACK ENAMEL ON A YELLOW ENAMEL BACKROUND.
8. DIMENSIONS SHOWN FOR ITEMS 10 THROUGH 14 ARE NOMINAL. ITEMS 10 THROUGH 14 SHALL BE FABRICATED TO FIT INSIDE THE FLANGES OF ITEM 6 AS SHOWN ON THE DRAWINGS AND FABRICATED SO THAT THE TOP SURFACE OF ITEM 16 SHALL BE LEVEL WITH THE TOP SURFACE OF THE FLANGE OF ITEM 6.
9. ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE INDICATED
10. AFTER FABRICATION, PREPARE AND PAINT ALL EXPOSED CARBON STEEL SURFACES WITH ONE COAT OF AMERCOAT #187 PRIMER AND TWO FINISH COATS OF MEDIUM GREY AMERCOAT #33. PREPARATION AND APPLICATION SHALL BE PER MANUFACTURER'S INTSRUCTIONS.

ADD

REVISE

ADD

ADD

HNF-2468, Rev.0

APPENDIX A
CALC. W320-24-031
SHT. 1 OF 1

W320-24-032

Sluice Pit AY-02E Analysis and Design of the Cover Block

ICF KAISER HANFORD COMPANY	CALCULATION IDENTIFICATION AND INDEX	Page i of iii Date 4/16/96

This sheet shows the status and description of the attached Design Analysis sheets.

Discipline *Structural* WO/Job No. *ER 4319/W 320* Calculation No. *W320-24-032*

Project No. & Name *W320, Tank 241-C-106 Sluicing*

Calculation Item *Sluice Pit AY-02E Analysis and Design of the Cover Block.*

These calculations apply to:

Dwg. No. *H-2-818454 sht 1 through sht 4* Rev. No. *0/0/0/0*

Dwg. No. *N/A* Rev. No. *N/A*

Other (Study, CDR) Rev. No. *0*

The status of these calculations is:

[] Preliminary Calculations

[X] Final Calculations

[] Check Calculations (On Calculation Dated)

[] Void Calculation (Reason Voided)

Incorporated in Final Drawings? [X] Yes [] No

This calculation verified by independent "check" calculations? [] Yes [X] No

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	Michael B. Lasota 4/16/96		
Checked by	William J. Magruder 4/16/96 William J. Magruder		
Approved by	4/18/96		
Checked Against Approved Vendor Data	8/22/96		

INDEX

Design Analysis Page No.	Description
1	*Objectives*
1	*Criteria and assumptions*
1	*References*
2 to 21	*Calculations*
22	*Conclusions*

ICFKH 0378.00 (02/96) KEF072

CALCULATION CROSS INDEX (Typical)

Subject Calculation No.: W320-24-032

Page ii of iii

Subject Calculation Revision No.	Superseded by Calculation No.	These interfacing calculation/documents provide input to the subject calculation, and if revised may require revision of the subject calculation.		Results and conclusions of the subject calculation are used in these interfacing calculations and/or documents		Does the output interface calculation/ documents require revision?		Has the output interface calculation/ documents been revised?		Discipline manager's signature and date indicating evaluation complete.
		Calculation/Document No.	Revision No.	Calculation/Document No.	Revision No.	Yes	No	Yes	No	
1	N/A	W320-33-009	0							

KEH 1975.00 (12/86)

DESIGN VERIFICATION SCREENING CRITERIA

Project/Document No. W-320/W320-24-032

When the design or design change affects hardware, formal design verification must be performed if one or more of the following questions must be answered affirmatively (YES).

YES	NO	
	✓	1. Does the design or design change involved meet the established criteria to be considered Safety Class 1?
	✓	2. Does this design or design change cause or permit changes to Safety Class 1 instrument or alarm setpoints outside of previously approved operational limits?
	✓	3. Does this design or design change significantly affect the nuclear or environmental safety consequences of a malfunction or failure of the structure, system, or component?
	✓	4. Does this design or design change involve or change design that has previously undergone formal design verification?

RW Davidson — 4/18/96
Assigned Lead Engineer — Date

RW Davidson — 4/18/96
Responsible Discipline Manager — Date

Original Design Package Distribution:

Project Manager
Design Verification Officer
Engineering Document Control

Design Change Distribution:

Attach to Engineering Change Notice

KEH-1981.00 (09/92)

ICF KAISER HANFORD COMPANY	Calc. No. W320-24-032
	Revision: 0
DESIGN ANALYSIS	Page No. 1 of 22
Client WHC	WO/Job No. ER 4319/W 320
Subject Sluice Pit AY-02E Analysis and Design of the Cover Block.	Date 03/21/1996 By M. B. Lasota *MBL*
	Checked 4/16/96 By W. J. Magruder *WJM*
Location 241-AY-02E, Sluice Pit	Revised N/A By N/A

1. OBJECTIVES

The purpose of these calculations is to determine whether the design of Cover Blocks for the 241-AY-02E Sluice Pit meets or exceeds the criteria outlined in SDC-4.1.

2. CRITERIA AND ASSUMPTIONS

DESIGN CRITERIA

Functional Design Criteria WHC-SD-W320-FDC-001, REV. 2 for Tank 241-C-106 Waste Retrieval Project, W-320. The criteria for evaluation of cover blocks is outlined in SDC 4.1 Rev 11. The cover blocks, although classified as Safety Class 3 are located above and supported from Safety Class 1 structure. In order to protect Safety Class 1 structure, Cover Blocks will be subjected to the design loads applicable to Safety Class 1 structures. The safety classification thus becomes "3 over 1".

METHODS

MATHCAD 4.0 (A474) was used for evaluation of the Cover Blocks.

4. REFERENCES

1. SDC-4.1 "Standard Arch-civil Design Criteria, Design Loads for Facilities", Rev 11, 9-6-89.
2. "Uniform Building Code", 1994.
3. ASCE 7-93, "Minimum Design Loads for Buildings and Other Structures".
4. ACI 318-89, rev'd 1992, "Building Code Requirements for Reinforced Concrete".
5. ACI 349-90, "Code Requirements for Nuclear Safety Related Concrete Structures".
6. ACI -340.1R-91, "Design Handbook Volume 1 - Beams, One Way Slabs, Brackets, Footings and Pile Caps".
7. Wang and Salmon, "Reinforced Concrete Design", 3rd Edition.
8. ICF KH calculations W320-33-009 rev 1.
9. UCRL 15910.

ICF KAISER HANFORD COMPANY

DESIGN ANALYSIS

Calc. No.: W320-24-032
Revision: 0

Client: WHC		WO/Job No.: ER 4319/W 320	
Subject:	Sluice Pit AY-02E Analysis and Design of the Cover Block.	Date: 03/19/1996	By: Michael B. Lasota *MBL*
		Checked: *4/16/96*	By: William J. Magruder *WJM*
Location: 241-AY-02E (Sluice Pit)		Revised:	By:

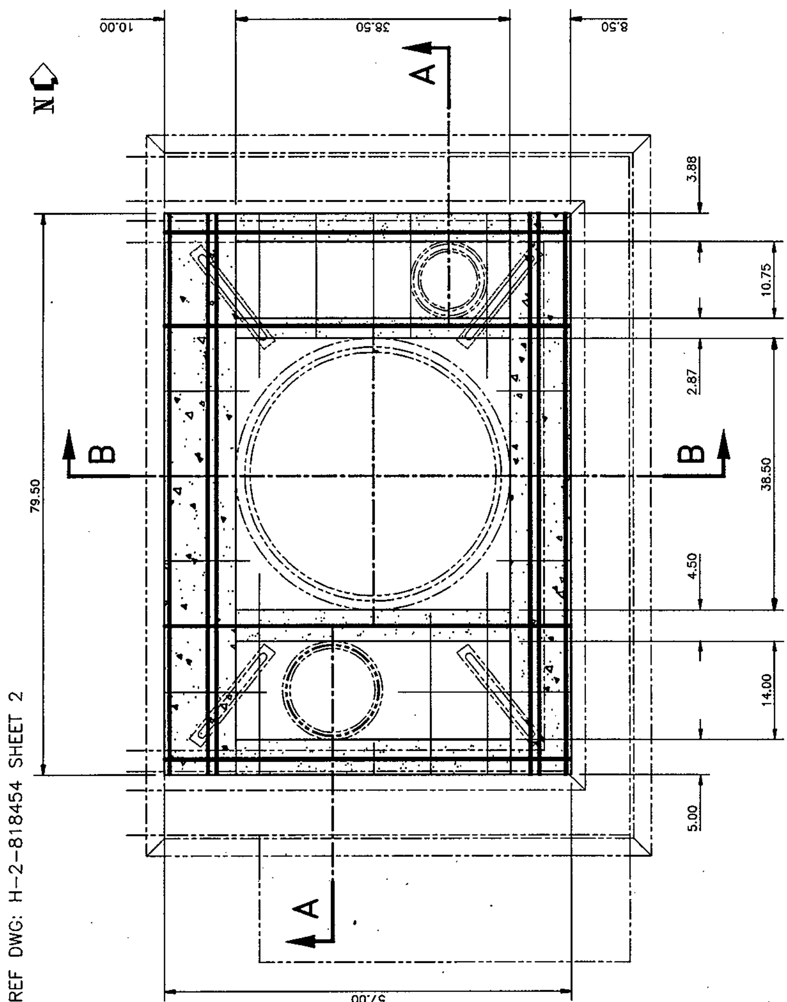


FIGURE 1
AY-02E EAST COVER BLOCK
SCALE 1:24
(PLAN AT MIDDLE OF THE DEPTH)

ACAD FILE: 3202432A

ICF KAISER HANFORD COMPANY

DESIGN ANALYSIS

Calc. No.: W320-24-032
Revision: 0
Page No.: 3 of 22

Client: WHC
Subject: Sluice Pit AY-02E Analysis and Design of the Cover Block.
Location: 241-AY-02E (Sluice Pit)

WO/Job No.: ER 4319/W 320
Date: 03/19/1996 By: Michael B. Lasota
Checked: 4/16/96 By: William J. Magruder WJM
Revised: By:

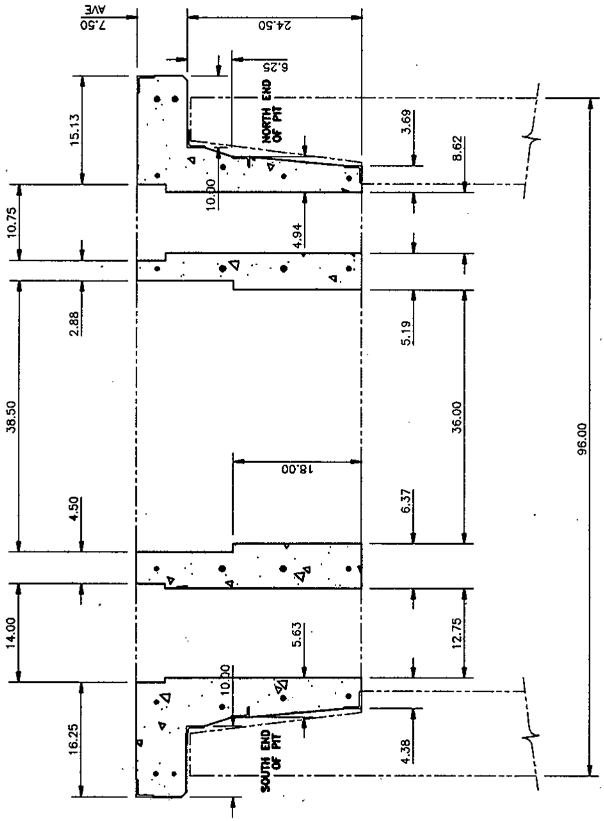


FIGURE 2
SECTION A–A FROM FIGURE 1
SCALE 1:24

ACAD FILE: 32024328

ICF KAISER HANFORD COMPANY

DESIGN ANALYSIS

Calc. No.: W320-24-032
Revision: 0

Client: WHC
Subject: Sluice Pit AY-02E Analysis and Design of the Cover Block.
Location: 241-AY-02E (Sluice Pit)

WO/Job No.: ER 4319/W 320
Date: 03/19/1996
Checked: 4/16/96
Revised:

By: Michael B. Lasota
By: William J. Magruder WJM
By:

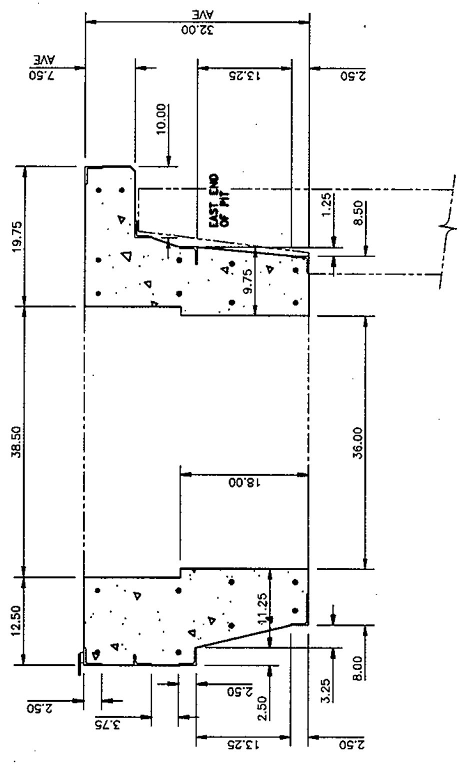


FIGURE 3
SECTION B-B FROM FIGURE 1
SCALE 1:24

ACAD FILE: 3202432C

ICF KAISER HANFORD COMPANY

DESIGN ANALYSIS

Calc. No.: W320-24-032
Revision: 0
Page No.: 5 of 22

Client: WHC
Subject: Sluice Pit AY-02E Analysis and Design of the Cover Block.
Location: 241-AY-02E (Sluice Pit)

WO/Job No.: ER 4319/W 320
Date: 03/18/1996 By: Michael B. Lasota
Checked: 4/16/96 By: William J. Magruder
Revised: By:

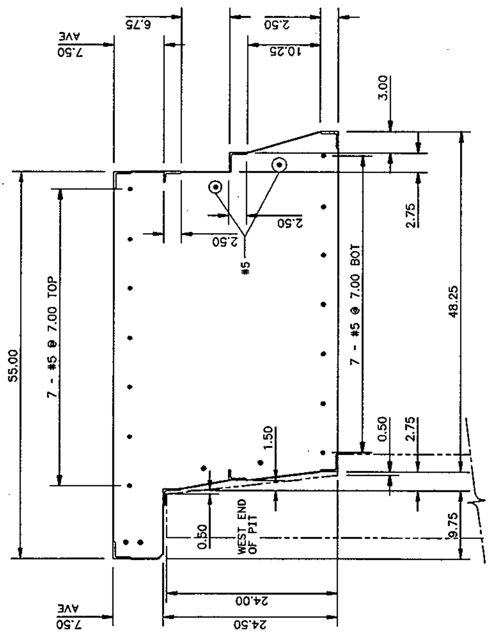


FIGURE 4
SECTION OF THE WEST COVER BLOCK
SCALE 1:24

ACAD FILE: 3202432E

ICF KAISER HANFORD COMPANY

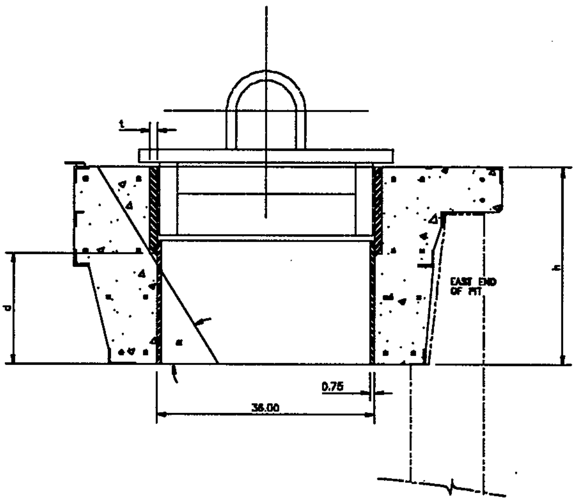
DESIGN ANALYSIS

Client: WHC
Subject: Sluice Pit AY-02E Analysis and Design of the Cover Block.
Location: Tank 241-AY-102, Sluice Pit.

WO/Job No.: W320/ER4319
Date: 03/14/1996 By: M.B. Lasota
Checked: 4/16/96 By: W.J. Magruder WJM
Revised: By:

The following calculations will determine if the new arrangement for motor compartment in the cover block will satisfy minimum radiological shielding requirements. Minimum shielding requirements - 18 inches of reinforced concrete reference 8.

The calculations of the depth and thickness of the upper sleeve based on the lower sleeve thickness of 0.75".



$$18\cdot in = \frac{h-d}{\sin(\alpha)} + \frac{t}{\cos(\alpha)} + \frac{t_{la}}{\cos(\alpha)} \qquad \gamma_s := 490\cdot pcf \qquad \gamma_c := 150\cdot pcf \qquad t_{la} := 0.75\cdot in\cdot\frac{\gamma_s}{\gamma_c} \qquad t_{la} = 2.450\cdot in$$

Substitution in the first eqation for t_{la} yields:

$$18\cdot in = \frac{h-d}{\sin(\alpha)} + \frac{t}{\cos(\alpha)} + \frac{2.45\cdot in}{\cos(\alpha)}$$

Let:

$$\tan\left(\frac{\alpha}{2}\right) = x \qquad \text{than:}$$

$$\sin(\alpha) = \frac{2\cdot x}{1+x^2} \qquad \cos(\alpha) = \frac{1-x^2}{1+x^2} \qquad \text{substitution yields:}$$

$$18\cdot in = \frac{(h-d)\cdot\left(1+x^2\right)}{2\cdot x} + \frac{t\cdot\left(1+x^2\right)}{1-x^2} + \frac{2.45\cdot in\cdot\left(1+x^2\right)}{1-x^2}$$

$$h - d = \frac{36\cdot x}{1+x^2} - \frac{2\cdot x}{1-x^2}\cdot\left(\frac{t}{in} + 2.45\right) \qquad \text{let} \qquad t := 1.25\cdot in$$

ICF KAISER HANFORD COMPANY

DESIGN ANALYSIS

Client: WHC
Subject: Sluice Pit AY-02E Analysis and Design of the Cover Block.
Location: Tank 241-AY-102, Sluice Pit.

WO/Job No.: W320/ER4319
Date: 03/14/1996 By: M.B. Lasota
Checked: 4/16/96 By: W.J. Magruder
Revised: By:

$$f(x) := \frac{36 \cdot x}{1+x^2} - \frac{2 \cdot x}{1-x^2} \cdot \left(\frac{t}{in} + 2.45\right)$$

$g(x) := \frac{d}{dx} f(x)$ $\quad x := 0.507669123 \quad a := root(g(x), x) \quad a = 0.507669123$

$f(a) = 9.469883083$

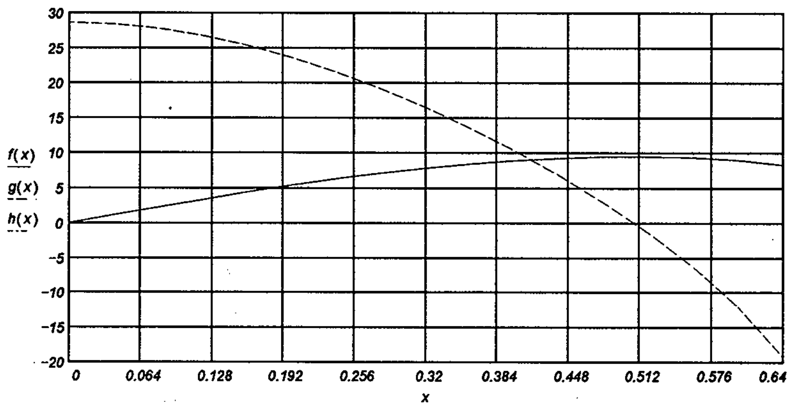
$g(a) = 0.000000000$

$\alpha := 2 \cdot atan(a) \quad \alpha = 53.830996878 \cdot deg$

Angle α constitutes the critical angle, at which shielding properties of the above arrangement will be equivalent to 18 inches of the concrete, ref 8. At this angle the least value of the depth of the upper sleeve is reflected in terms of f(i). The value of the depth of upper sleeve used in further design is 13.0". The following is the graph of the function of the sleeve depth with respect to the value of angle α reflected in in terms of the tangent of half-angle.

$x := 0.0, 0.04 .. 0.66 \quad t := 1.25 \cdot in$

$$f(x) := \left[\frac{36 \cdot in \cdot x}{1+x^2} - \frac{2 \cdot x}{1-x^2} \cdot (t + 2.45 \cdot in)\right] \cdot \frac{1}{in} \qquad g(x) := \frac{d}{dx} f(x) \qquad h(x) := 0$$



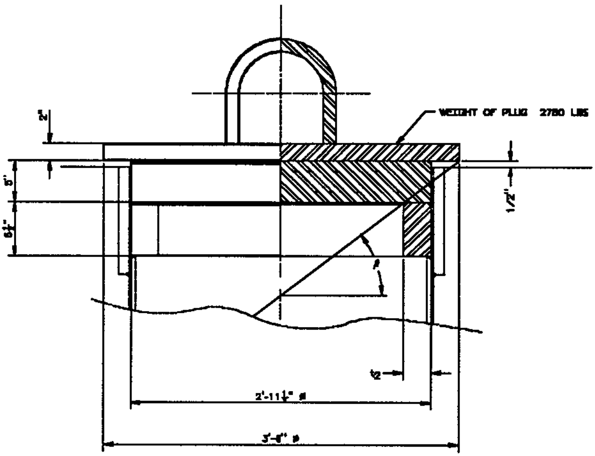
The distance from the bottom of the lower sleeve to the bottom of the upper sleeve is:

$h_{min} := 31 \cdot in$

$d := h_{min} - f(a) \cdot in \qquad d = 21.530116917 \cdot in$

Use d=18 in.

Determine minimum thickness of the plugs lower cylinder.



$$18\cdot in = \left(\frac{t_2}{\cos(\beta)} + \frac{1.25\cdot in}{\cos(\beta)}\right)\cdot\frac{\gamma_s}{\gamma_c} + \frac{4.5\cdot in - (t_2 + 1.5\cdot in)\cdot \tan\beta}{\sin\beta}$$

$$18\cdot in = (t_2 + 1.25\cdot in)\cdot\frac{\gamma_s}{\gamma_c}\cdot\frac{1}{\cos\beta} + \frac{4.5\cdot in}{\sin\beta} - \frac{t_2 + 1.5\cdot in}{\cos\beta}$$

Let:

$\tan\left(\frac{\alpha}{2}\right) = x$ than: $\sin(\alpha) = \frac{2\cdot x}{1+x^2}$ $\cos(\alpha) = \frac{1-x^2}{1+x^2}$ substitution yields:

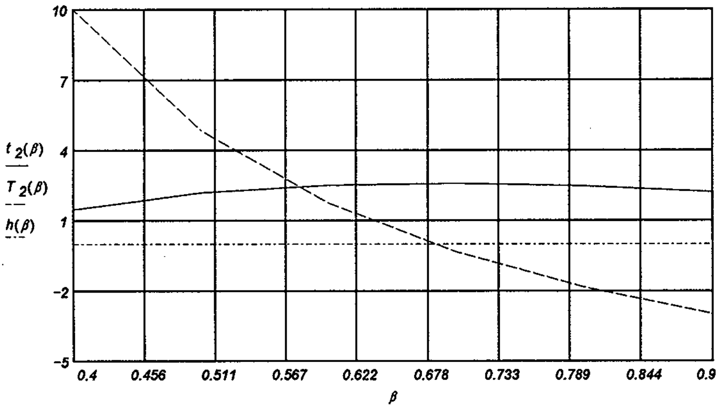
$$t_2(\beta) := \left[\frac{18\cdot in\cdot\cos(\beta)}{\frac{\gamma_s}{\gamma_c} - 1} - \frac{1.25\cdot in\cdot\frac{\gamma_s}{\gamma_c} - 1.5\cdot in}{\frac{\gamma_s}{\gamma_c} - 1} - \frac{4.5\cdot in\cdot\cos(\beta)}{\left(\frac{\gamma_s}{\gamma_c} - 1\right)\cdot\sin(\beta)}\right]\cdot\frac{1}{in}$$

$T_2(\beta) := \frac{d}{d\beta}t_2(\beta)$ $\beta := 0.681502382$ $a := root(T_2(\beta), \beta)$ $a = 0.681502382$

$t_2(a) = 2.580119567$ $T_2(a) = 0.000000000$

$\beta := 0.4, 0.5 .. 0.9$

$h(\beta) := 0$



Minimum thickness of the lower cylinder of the plug is:

$t_{min} := t_2(a) \cdot in$ $\quad t_{min} = 2.58 \cdot in$

In design use:

$t_{cyl} := 3 \cdot in$

WEIGHT OF WEST COVER BLOCK

For the reference, see Figure 4.

$b_1 := 55\cdot in$ $h_1 := 7.5\cdot in$ $l_1 := 102\cdot in$ $h_{12} := 2.5\cdot in$ $b_{2u} := 45\cdot in$ $b_{2m} := 44.375\cdot in$

$b_{2l} := 43.75\cdot in$ $l_{2u} := 82\cdot in$ $l_{2m} := 80.75\cdot in$ $l_{2l} := 79.5\cdot in$ $h_2 := 6.75\cdot in$ $b_{3u} := 46.5\cdot in$

$h_{23} := 2.5\cdot in$ $b_{3m} := 47.375\cdot in$ $b_{3l} := 48.25\cdot in$ $l_{3u} := 79.5\cdot in$ $l_{3m} := 78.25\cdot in$ $l_{3l} := 77\cdot in$

$h_3 := 10.25\cdot in$ $h_{34} := 2.5\cdot in$ $h := h_1 + h_2 + h_3 + h_{12} + h_{23} + h_{34}$ $h = 32.000\cdot in$

Volume of the west cover block is:

$V_1 := b_1\cdot l_1\cdot h_1$ $V_1 = 24.349\cdot ft^3$ $V_{12} := (b_{2u} + 0.25\cdot in)\cdot(l_{2u} + 0.5\cdot in)\cdot h_{12}$ $V_{12} = 5.401\cdot ft^3$

$A_{2u} := b_{2u}\cdot l_{2u}$ $A_{2u} = 3690.000\cdot in^2$

$A_{2m} := b_{2m}\cdot l_{2m}$ $A_{2m} = 3583.281\cdot in^2$ $A_{2l} := b_{2l}\cdot l_{2l}$ $A_{2l} = 3478.125\cdot in^2$

$V_2 := \dfrac{h_2\cdot(A_{2u} + 4\cdot A_{2m} + A_{2l})}{6}$ $V_2 = 13.998\cdot ft^3$ $V_{23} := b_{3u}\cdot l_{3u}\cdot h_{23}$ $V_{23} = 5.348\cdot ft^3$

$A_{3u} := b_{3u}\cdot l_{3u}$ $A_{3u} = 3696.750\cdot in^2$

$A_{3m} := b_{3m}\cdot l_{3m}$ $A_{3m} = 3707.094\cdot in^2$ $A_{3l} := b_{3l}\cdot l_{3l}$ $A_{3l} = 3715.250\cdot in^2$

$V_3 := \dfrac{h_3\cdot(A_{3u} + 4\cdot A_{3m} + A_{3l})}{6}$ $V_3 = 21.987\cdot ft^3$ $V_{34} := b_{3l}\cdot l_{3l}\cdot h_{34}$ $V_{34} = 5.375\cdot ft^3$

$V_w := V_1 + V_{12} + V_2 + V_{23} + V_3 + V_{34}$ $V_w = 76.459\cdot ft^3$

Volume displaced by a penetration:

$D_p := 8.5\cdot in$ $V_p := \dfrac{\pi\cdot D_p^2}{4}\cdot h$ $V_p = 1.051\cdot ft^3$

Volume of steel penetration asembly: $D_{pi} := 8\cdot in$ $V_{ps} := \dfrac{\pi\cdot(D_p^2 - D_{pi}^2)}{4}\cdot h$ $V_{ps} = 0.120\cdot ft^3$

The density of normal weight reinforced concrete and steel is 150pcf and 490pcf respectively.

$\gamma_{rc} := 150\cdot pcf$ $\gamma_s := 490\cdot pcf$

Total weight of concrete cover block is:

$W_{wcb} := (V_w - V_p)\cdot\gamma_{rc} + V_{ps}\cdot\gamma_s$ $W_{wcb} = 11370\cdot lbf$

In design use:

$W_{wcb} := 11500\cdot lbf$

WEIGHT OF EAST COVER BLOCK

For the reference, see Figures 2 @ 3.

$b_1 := 70.75\cdot in$ $h_1 := 7.5\cdot in$ $l_1 := 102\cdot in$ $b_{2u} := 60.75\cdot in$ $b_{2m} := 60.13\cdot in$ $b_{2l} := 59.5\cdot in$

$h_{12} := 2.5\cdot in$ $l_{2u} := 82\cdot in$ $l_{2m} := 80.75\cdot in$ $l_{2l} := 79.5\cdot in$ $h_2 := 3.75\cdot in$ $h_{23} := 2.5\cdot in$

$b_{3u} := 57\cdot in$ $b_{3m} := 54.75\cdot in$ $b_{3l} := 52.5\cdot in$ $l_{3u} := 79.5\cdot in$ $l_{3m} := 78.25\cdot in$ $l_{3l} := 77\cdot in$

$h_3 := 13.25\cdot in$ $h_{34} := 2.5\cdot in$ $h := h_1 + h_2 + h_3 + h_{12} + h_{23} + h_{34}$ $h = 32.000\cdot in$

Volume of the west cover block is:

$V_1 := b_1\cdot l_1\cdot h_1$ $V_1 = 31.322\cdot ft^3$ $V_{12} := (b_{2u} + 0.25\cdot in)\cdot(l_{2u} + 0.5\cdot in)\cdot h_{12}$ $V_{12} = 7.281\cdot ft^3$

$A_{2u} := b_{2u}\cdot l_{2u}$ $A_{2u} = 4981.500\cdot in^2$ $A_{2m} := b_{2m}\cdot l_{2m}$ $A_{2m} = 4855.498\cdot in^2$

$A_{2l} := b_{2l}\cdot l_{2l}$ $A_{2l} = 4730.250\cdot in^2$

$V_2 := \dfrac{h_2\cdot(A_{2u} + 4\cdot A_{2m} + A_{2l})}{6}$ $V_2 = 10.537\cdot ft^3$ $V_{23} := b_{2l}\cdot l_{2l}\cdot h_{23}$ $V_{23} = 6.844\cdot ft^3$

$A_{3u} := b_{3u}\cdot l_{3u}$ $A_{3u} = 4531.500\cdot in^2$ $A_{3m} := b_{3m}\cdot l_{3m}$ $A_{3m} = 4284.188\cdot in^2$

$A_{3l} := b_{3l}\cdot l_{3l}$ $A_{3l} = 4042.500\cdot in^2$

$V_3 := \dfrac{h_3\cdot(A_{3u} + 4\cdot A_{3m} + A_{3l})}{6}$ $V_3 = 32.858\cdot ft^3$ $V_{34} := b_{3l}\cdot l_{3l}\cdot h_{34}$ $V_{34} = 5.849\cdot ft^3$

Volume of concrete missing due to penetrations

$OD_{1u} := 38.5\cdot in$ $A_{p1u} := \dfrac{\pi\cdot OD_{1u}^2}{4}$ $h_{1u} := 14\cdot in$ $OD_{1l} := 36\cdot in$ $A_{p1l} := \dfrac{\pi\cdot OD_{1l}^2}{4}$

$V_{p1} := A_{p1l}\cdot(h - h_{1u}) + A_{p1u}\cdot h_{1u}$ $V_{p1} = 20.035\cdot ft^3$

$OD_{2u} := 14.00\cdot in$ $A_{p2u} := \dfrac{\pi\cdot OD_{2u}^2}{4}$ $h_{2u} := 4\cdot in$ $OD_{2l} := 12.75\cdot in$ $A_{p2l} := \dfrac{\pi\cdot OD_{2l}^2}{4}$

$V_{p2} := A_{p2l}\cdot(h - h_{2u}) + A_{p2u}\cdot h_{2u}$ $V_{p2} = 2.425\cdot ft^3$

$OD_{3u} := 10.75\cdot in$ $A_{p3u} := \dfrac{\pi\cdot OD_{3u}^2}{4}$ $h_{3u} := 4\cdot in$ $OD_{3l} := 8.625\cdot in$ $A_{p3l} := \dfrac{\pi\cdot OD_{3l}^2}{4}$

$V_{p3} := A_{p3l}\cdot(h - h_{3u}) + A_{p3u}\cdot h_{3u}$ $V_{p3} = 1.157\cdot ft^3$

$V_e := V_1 + V_2 + V_3 + V_{12} + V_{23} + V_{34} - V_{p1} - V_{p2} - V_{p3}$ $V_e = 71.073\cdot ft^3$

Volume of three penetrations steel assemblies is:

$OD_{1u} := 38.5\cdot in$ $ID_{1u} := 36\cdot in$ $A_{p1u} := \dfrac{\pi\cdot\left(OD_{1u}^{2} - ID_{1u}^{2}\right)}{4}$ $h_{1u} := 14\cdot in$ $OD_{1l} := 36\cdot in$

$ID_{1l} := 34.5\cdot in$ $A_{p1l} := \dfrac{\pi\cdot\left(OD_{1l}^{2} - ID_{1l}^{2}\right)}{4}$ $h_{1l} := 19.5\cdot in$ $V_{s1} := A_{p1l}\cdot h_{1l} + A_{p1u}\cdot h_{1u}$

$V_{s1} = 2.122\cdot ft^3$

$OD_{2u} := 14.00\cdot in$ $ID_{2u} := 13.124\cdot in$ $A_{p2u} := \dfrac{\pi\cdot\left(OD_{2u}^{2} - ID_{2u}^{2}\right)}{4}$ $h_{2u} := 6.5\cdot in$ $OD_{2l} := 12.75\cdot in$

$ID_{2l} := 11.938\cdot in$ $A_{p2l} := \dfrac{\pi\cdot\left(OD_{2l}^{2} - ID_{2l}^{2}\right)}{4}$ $h_{2l} := 27.5\cdot in$ $V_{s2} := A_{p2l}\cdot h_{2l} + A_{p2u}\cdot h_{2u}$

$V_{s2} = 0.321\cdot ft^3$

$OD_{3u} := 10.75\cdot in$ $ID_{3u} := 10.02\cdot in$ $A_{p3u} := \dfrac{\pi\cdot\left(OD_{3u}^{2} - ID_{3u}^{2}\right)}{4}$ $h_{3u} := 6.5\cdot in$ $OD_{3l} := 8.625\cdot in$

$ID_{3l} := 7.981\cdot in$ $A_{p3l} := \dfrac{\pi\cdot\left(OD_{3l}^{2} - ID_{3l}^{2}\right)}{4}$ $h_{3l} := 27.5\cdot in$ $V_{s3} := A_{p3l}\cdot h_{3l} + A_{p3u}\cdot h_{3u}$

$V_{s3} = 0.178\cdot ft^3$

Recall the volume of the concrete: $V_e = 71.073\cdot ft^3$

Total weight of concrete cover block. Not including penetration plugs is:

$W_{ecb} := V_e\cdot\gamma_{rc} + \left(V_{s1} + V_{s2} + V_{s3}\right)\cdot\gamma_s$ $W_{ecb} = 11946\cdot lbf$

For design use:

$W_{ecb} := 12000\cdot lbf$

Weight of the plug for the pump penetration.

$r_i := 5\cdot in$ $r_o := 6.5\cdot in$ $t_{bl} := 1.5\cdot in$ $t_t := 2\cdot in$ $d_t := 42\cdot in$ $t_m := 5\cdot in$ $d_m := 35.5\cdot in$ $t_b := 6.5\cdot in$

$d_{bi} := 29.5\cdot in$ $h_{bl} := 6\cdot in$

$V_{plg} := \dfrac{\pi}{4}\cdot\left[\left(r_o^{2} - r_i^{2}\right)\cdot t_{bl}\cdot 2 + d_t^{2}\cdot t_t + d_m^{2}\cdot\left(t_m + t_b\right) - d_{bi}^{2}\cdot t_b\right] + 2\cdot h_{bl}\cdot t_{bl}^{2}$ $V_{plg} = 5.659\cdot ft^3$

$W_{plg} := V_{plg}\cdot\gamma_s$ $W_{plg} = 2772.840\cdot lbf$

In further design use:

$W_{plg} := 2780\cdot lbf$

Cover Block Design Objective: The cover block design will consist of two parts. First, the east cover block will be designed as a system of beams spaning between penetrations. Second, a cover block design will be performed on the west cover block.

PART 1 Design of the East Cover Block.

Dead Load:

$W_{ecb} = 12.000 \cdot kips$ $w := 57 \cdot in$ $l := 79.5 \cdot in$

$w_{d1} := \frac{W_{ecb}}{w \cdot l}$ $w_{d1} = 381.331 \cdot psf$ Maximum weight per square foot of cover block.

$W_{plg1} := 2780 \cdot lbf$ Weight of steel plug for pump penetration.

$W_{plg2} := 350 \cdot lbf$ Weight of the plug for 12" penetration. See H-2-818454, sh. 3

$W_{plg3} := 190 \cdot lbf$ Weight of the plug for 8" penetration. See H-2-818454, sh. 3

$W_{d2} := \frac{W_{plg1}}{2}$ $W_{d2} = 1.390 \cdot kips$

$W_{d3} := \frac{W_{plg2}}{2}$ $W_{d3} = 0.175 \cdot kips$

$W_{d4} := \frac{W_{plg3}}{2}$ $W_{d4} = 0.095 \cdot kips$

Live Load: $q_{ll} := 50 \cdot psf$ $w_1 := 70.75 \cdot in$ $l_1 := 102 \cdot in$

$w_l := q_{ll} \cdot \frac{w_1 \cdot l_1}{w \cdot l}$ $w_l = 79.6 \cdot psf$ Floor load is conservative since access on top of pit is restricted.

Seismic Load:

An equivalent static evaluation will be used in lieu of a dynamic analysis for a simplified and conservative approach. The lateral cover block load must be multiplied by 1.5 per reference 9. In the equivalent static evaluation the fundamental frequency is not calculated but is assumed to be such that response acceleration is the peak of the response spectrum.

$z := 0.47$ Response Spectrum Acceleration (Ref 1, pg 24, Table 6) @ 7% of Critical Damping (Conservative)

$F_{H1} := 1.5 \cdot z \cdot w_{d1}$ $F_{H2} := 1.5 \cdot z \cdot W_{d2}$ $F_{H3} := 1.5 \cdot z \cdot W_{d3}$ $F_{H4} := 1.5 \cdot z \cdot W_{d4}$

$F_{H1} = 268.8 \cdot psf$ $F_{H2} = 0.980 \cdot kips$ $F_{H3} = 0.123 \cdot kips$ $F_{H4} = 0.067 \cdot kips$

The vertical seismic load is 2/3 of the horizontal load(REF 1).

$w_{e1} := \frac{2}{3} \cdot F_{H1}$ $w_{e2} := \frac{2}{3} \cdot F_{H2}$ $w_{e3} := \frac{2}{3} \cdot F_{H3}$ $w_{e4} := \frac{2}{3} \cdot F_{H4}$

$w_{e1} = 179.2 \cdot psf$ $w_{e2} = 0.653 \cdot kips$ $w_{e3} = 0.082 \cdot kips$ $w_{e4} = 0.045 \cdot kips$

Environmental Loads:

Ashfall and snow loading will be combined as stated in SDC 4.1, Rev. 11, page 8 and substituted for tornado loads as stated in the SDC and ACI 349, sec. 9.2.1, load case 5. By inspection, a wind blown object as described in SDC 4.1 will not penetrate the cover blocks.

Ashfall loading: $w_{ash} := 24 \cdot psf$

Snow loading: $w_{sn} := 20 \cdot psf$

$w_a := (w_{ash} + w_{sn}) \cdot \frac{w_1 \cdot l_1}{w \cdot l}$ $\quad w_a = 70.071 \cdot psf$ Combined distributed load from snow and ashfall.

Combined Loading: The following load cases were determined to be valid load combinations from ACI 349, sec 9.2.1 which will be compared to determine the Ultimate Moment.

$w_1 := 1.4 \cdot w_{d1} + 1.7 \cdot w_l$	$w_1 = 669.2 \cdot psf$	$w_7 := w_{d1} + w_l$	$w_7 = 461.0 \cdot psf$
$w_2 := 1.4 \cdot w_{d1} + 1.7 \cdot w_l$	$w_2 = 669.2 \cdot psf$	$w_8 := w_{d1} + w_l + w_{e1}$	$w_8 = 640.2 \cdot psf$
$w_3 := 1.4 \cdot w_{d1} + 1.7 \cdot w_l + 1.7 \cdot w_a$	$w_3 = 788.3 \cdot psf$	$w_9 := 1.05 \cdot w_{d1} + 1.3 \cdot w_l$	$w_9 = 503.9 \cdot psf$
$w_4 := w_{d1} + w_l + w_{e1}$	$w_4 = 640.2 \cdot psf$	$w_{10} := 1.05 \cdot w_{d1} + 1.3 \cdot w_l$	$w_{10} = 503.9 \cdot psf$
$w_5 := w_{d1} + w_l + w_a$	$w_5 = 531.0 \cdot psf$	$w_{11} := 1.05 \cdot w_{d1} + 1.3 \cdot w_l + 1.3 \cdot w_a$	$w_{11} = 595.0 \cdot psf$
$w_6 := w_{d1} + w_l$	$w_6 = 461.0 \cdot psf$		

Load combination 3 is a controling combination, hence ultimate moment can be computed using the following loads:

$w_{31} := w_3$ $\quad w_{31} = 788.3 \cdot psf$ and $\quad W_{32} := 1.4 \cdot W_{d2}$ $\quad W_{32} = 1.946 \cdot kips$

$W_{33} := 1.4 \cdot W_{d3}$ $\quad W_{33} = 0.245 \cdot kips$

$W_{34} := 1.4 \cdot W_{d4}$ $\quad W_{34} = 0.133 \cdot kips$

Cross beam 1: $b_1 := \frac{38.5 \cdot in}{2} + 3.94 \cdot in + \frac{8.625 \cdot in}{2}$ $\quad b_1 = 2.292 \cdot ft$

$L := 38.5 \cdot in$ $\quad L = 3.208 \cdot ft$ See figure 1.

$a := \frac{L}{2}$ Distance from support to the critical section.

$$M_{umax} := \frac{w_{31} \cdot L^2 \cdot b_1}{8} + \frac{W_{32} \cdot L}{4} + \frac{W_{34} \cdot L}{4}$$

$M_{umax} = 3.992 \cdot kips \cdot ft$ maximum moment in the beam 1.

$M_u := M_{umax}$

$M_u = 3.992 \cdot ft \cdot kips$

Determine required flexural reinforcement:

$f_c := 4000 \cdot psi$ $f_y := 60000 \cdot psi$

$h := 27 \cdot in$ $d := h - (1.5 \cdot in + 0.375 \cdot in)$ Assume #6 bars.

$d = 25.125 \cdot in$

$b := 2.875 \cdot in$ Approximate width of beam

$F := \frac{b \cdot d^2}{12000} \cdot in^{-3}$ $F = 0.151$

$K_n := \frac{M_u}{F} \cdot (ft \cdot kips)^{-1}$ $K_n = 26.397$ Use $K_n := 175$ Ref. FLEXURE 2.2. ACI-340.1R-91

$a_n := 4.37$

$A_s := \frac{M_u}{d \cdot a_n} \cdot \frac{in^3}{ft \cdot kips}$ $A_s = 0.036 \cdot in^2$

Check minimum steel required ref ACI 10.5

$A_{smin} := 0.0033 \cdot b \cdot d$ $A_{smin} = 0.238 \cdot in^2$ controls.

Use 1-#6 bar for a steel area of 0.44 sq. inches at the top and bottom of the beam 1 (north of the pump penetration).

Determine shear reinforcement requirements due to shear at the critical section at the pump penetration.

Determine shear and reinforcement requirements due to shear at a distance from the support equal to the depth of the beam.

$V_{ud1} := \frac{w_3 \cdot L \cdot b_1}{2} + \frac{W_{32}}{2} + \frac{W_{34}}{2}$ $V_{ud1} = 3.938 \cdot kips$

Allowable Shear (use width of the section just below the plug crown): $b := 3.94 \cdot in$

$V_c := 2 \cdot \sqrt{f_c \cdot psi} \cdot b \cdot d$ $V_c = 12.522 \cdot kips$ $\phi := 0.85$ $V_n := \phi \cdot V_c$ $V_n = 10.643 \cdot kips$

$0.5 \cdot V_n = 5.322 \cdot kips$

Since $V_{ud1} < 0.5 \cdot V_n$. Design for shear reinforcement not required per ACI 349, Sec. 11.5.5.1.

Development Length: Development length for number 6 bars is 17 inches. Bars will be extended well past the pump penetration opening.

Client: WHC
Subject: Sluice Pit AY-02E Analysis and Design of Cover Block.
Location: Tank 241-AY-102, Sluice Pit.

WO/Job No.: W320/ER4319
Date: 03/08/1996 By: M.B. Lasota
Checked: 4/16/96 By: W.J. Magruder
Revised: By:

Cross beam 2: $b_1 := \frac{38.5 \cdot in}{2} + 5.13 \cdot in + \frac{12.75 \cdot in}{2}$ $b_1 = 2.563 \cdot ft$

$L := 38.5 \cdot in$ $L = 3.208 \cdot ft$ See figure 1.

$a := \frac{L}{2}$ Distance from support to the critical section.

$$M_{umax} := \frac{w_{31} \cdot L^2 \cdot b_1}{8} + \frac{W_{32} \cdot L}{4} + \frac{W_{33} \cdot L}{4}$$

$M_{umax} = 4.357 \cdot kips \cdot ft$ maximum moment in the beam 2.

$M_u := M_{umax}$

$M_u = 4.357 \cdot ft \cdot kips$

Determine required flexural reinforcement:

$f_c := 4000 \cdot psi$ $f_y := 60000 \cdot psi$

$h := 27 \cdot in$ $d := h - (1.5 \cdot in + 0.375 \cdot in)$ Assume #6 bars.

$d = 25.125 \cdot in$

$b := 4.5 \cdot in$ Approximate width of beam

$F := \frac{b \cdot d^2}{12000} \cdot in^{-3}$ $F = 0.237$

$K_n := \frac{M_u}{F} \cdot (ft \cdot kips)^{-1}$ $K_n = 18.406$ Use $K_n := 175$ Ref. FLEXURE 2.2. ACI-340.1R-91

$a_n := 4.37$

$A_s := \frac{M_u}{d \cdot a_n} \cdot \frac{in^3}{ft \cdot kips}$ $A_s = 0.040 \cdot in^2$

Check minimum steel required ref ACI 10.5

$A_{smin} := 0.0033 \cdot b \cdot d$ $A_{smin} = 0.373 \cdot in^2$ controls.

Use 1-#6 bar for a steel area of 0.44 sq. inches at the top and bottom of the beam 1 (south of the pump penetration).

Determine shear reinforcement requirements due to shear at the critical section at the pump penetration.

Determine shear and reinforcement requirements due to shear at a distance from the support equal to the depth of the beam.

$V_{ud2} := \frac{w_3 \cdot L \cdot b_1}{2} + \frac{W_{32}}{2} + \frac{W_{33}}{2}$ $V_{ud2} = 4.337 \cdot kips$

Allowable Shear (use width of the section just below the plug crown): $b := 5.13 \cdot in$

$V_c := 2 \cdot \sqrt{f_c \cdot psi} \cdot b \cdot d$ $V_c = 16.304 \cdot kips$ $\phi := 0.85$ $V_n := \phi \cdot V_c$ $V_n = 13.858 \cdot kips$

$0.5 \cdot V_n = 6.929 \cdot kips$

Since $V_{ud2} < 0.5 \cdot V_n$ Design for shear reinforcement not required per ACI 349, Sec. 11.5.5.1.

Development Length: Development length for number 6 bars is 17 inches. Bars will be extended well past the pump penetration opening.

Primary beam 1 west side of the cover block: $b_1 := \frac{57 \cdot in}{2}$ $b_1 = 2.375 \cdot ft$

$L := 79.5 \cdot in$ $L = 6.625 \cdot ft$ See figure 1.

The contributing width of the beam will result in an overlap of the tributary areas for beam 1 & 2 and primary beam1. Also reactions from beam 1 and 2 are lumped in the center of the primary beam 1, all preceding actions will result in a conservative value of M_u.

$$M_{umax} := \frac{w_{31} \cdot L^2 \cdot b_1}{8} + \frac{V_{ud1} \cdot L}{4} + \frac{V_{ud2} \cdot L}{4}$$

$M_{umax} = 23.977 \cdot kips \cdot ft$ maximum moment in the primary beam 1.

$M_u := M_{umax}$ $M_u = 23.977 \cdot ft \cdot kips$

Determine required flexural reinforcement:

$f_c := 4000 \cdot psi$ $f_y := 60000 \cdot psi$

$h := 27 \cdot in$ $d := h - (1.5 \cdot in + 0.375 \cdot in)$

$d = 25.125 \cdot in$ Assume #6 bars.

$b := 10 \cdot in$ Approximate width of beam

$F := \frac{b \cdot d^2}{12000} \cdot in^{-3}$ $F = 0.526$

$K_n := \frac{M_u}{F} \cdot (ft \cdot kips)^{-1}$ $K_n = 45.579$ Use $K_n := 175$ Ref. FLEXURE 2.2. ACI-340.1R-91

$a_n := 4.37$

$A_s := \frac{M_u}{d \cdot a_n} \cdot \frac{in^3}{ft \cdot kips}$ $A_s = 0.218 \cdot in^2$

Check minimum steel required ref ACI 10.5 .

$A_{smin} := 0.0033 \cdot b \cdot d$ $A_{smin} = 0.829 \cdot in^2$ controls.

<u>Use 2-#6 bars for a steel area of 0.88 sq. inches at the top and bottom of the primary beam 1.</u>

Determine shear reinforcement requirements due to shear at the critical section at the pump penetration.

Determine shear and reinforcement requirements due to shear at a distance from the support equal to the depth of the beam.

$V_{ud} := \frac{w_3 \cdot L \cdot b_1}{2} + \frac{V_{ud1}}{2} + \frac{V_{ud2}}{2}$ $\qquad V_{ud} = 10.339 \cdot kips$

Allowable Shear (use average width of the primary beam 1): $b := 10 \cdot in$

$V_c := 2 \cdot \sqrt{f_c \cdot psi} \cdot b \cdot d$ $\qquad V_c = 31.781 \cdot kips$ $\qquad \phi := 0.85$ $\qquad V_n := \phi \cdot V_c$ $\qquad V_n = 27.014 \cdot kips$

$0.5 \cdot V_n = 13.507 \cdot kips$

Since $V_{ud2} < 0.5 \cdot V_n$ *Design for shear reinforcement not required per ACI 349, Sec. 11.5.5.1.*

Development Length: Development length for number 6 bars is 17 inches. Bars will be extended well past the pump penetration opening.

The primary beam 2, east of penetration is similar to the primary beam 1 with bending moment of the lower magnitude, hence use of the same reinforcement arrangement is justified.

PART 2 *Design of the West Cover Block.*

Dead Load:

For the reference, see Figure 4.

$W_{wcb} = 11.500 \cdot kips$

The width of an equivalent rectangular section is:

$h = 27.000 \cdot in$ $\quad b_{wcb} := 48.25 \cdot in - 3 \cdot in - 2.75 \cdot in$ $\quad b_{wcb} = 42.500 \cdot in$

The following calculations will apply to 1'-0" wide beam strip.

$W_{wcb} = 11.500 \cdot kips$ $\quad b_1 := 12 \cdot in$ $\quad l = 6.625 \cdot ft$

$w_{d1} := \dfrac{W_{wcb}}{l} \cdot \dfrac{b_1}{b_{wcb}}$ $\quad w_{d1} = 0.490 \cdot \dfrac{kips}{ft}$

Live Load:

$q_{ll} := 50 \cdot \dfrac{lbf}{ft^2}$ $\quad b_1 := 12 \cdot in$

$w_l := b_1 \cdot q_{ll}$ $\quad w_l = 0.050 \cdot \dfrac{kips}{ft}$ Floor load is conservative since access on top of pit is restricted.

Seismic Load:

An equivalent static evaluation will be used in lieu of a dynamic analysis for a simplified and conservative approach. The lateral cover block load must be multiplied by 1.5 per reference 9. In the equivalent static evaluation the fundamental frequency is not calculated but is assumed to be such that response acceleration is the peak of the response spectrum.

$z := 0.47$ Response Spectra Acceleration (Ref 1, pg 24, Table 6) @ 7% of Critical Damping (Conservative)

$F_{H1} := 1.5 \cdot z \cdot w_{d1}$ $\quad F_{H1} = 0.346 \cdot \dfrac{kips}{ft}$

The vertical seismic load is 2/3 of the horizontal load(REF 1).

$w_{e1} := \dfrac{2}{3} \cdot F_{H1}$ $\quad w_{e1} = 0.230 \cdot \dfrac{kips}{ft}$

Environmental Loads:

Ashfall and snow loading will be combined as stated in SDC 4.1, Rev. 11, page 8 and substituted for tornado loads as stated in the SDC and ACI 349, sec. 9.2.1, load case 5. By inspection, a wind blown object as described in SDC 4.1 will not penetrate the cover blocks.

Ashfall loading: $w_{ash} := 24 \cdot psf$

Snow loading: $w_{sn} := 20 \cdot psf$

$w_a := (w_{ash} + w_{sn}) \cdot b_1 \quad w_a = 0.044 \cdot \frac{kips}{ft}$ Combined distributed load from snow and ashfall.

Combined Loading: The following load cases were determined to be valid load combinations from ACI 349, sec 9.2.1 which will be compared to determine the Ultimate Moment.

$w_1 := 1.4 \cdot w_{d1} + 1.7 \cdot w_l \quad w_1 = 0.771 \cdot \frac{kips}{ft}$

$w_2 := 1.4 \cdot w_{d1} + 1.7 \cdot w_l \quad w_2 = 0.771 \cdot \frac{kips}{ft}$

$w_3 := 1.4 \cdot w_{d1} + 1.7 \cdot w_l + 1.7 \cdot w_a \quad w_3 = 0.846 \cdot \frac{kips}{ft}$

$w_4 := w_{d1} + w_l + w_{e1} \quad w_4 = 0.770 \cdot \frac{kips}{ft}$

$w_5 := w_{d1} + w_l + w_a \quad w_5 = 0.584 \cdot \frac{kips}{ft}$

$w_6 := w_{d1} + w_l \quad w_6 = 0.540 \cdot \frac{kips}{ft}$

$w_7 := w_{d1} + w_l \quad w_7 = 0.540 \cdot \frac{kips}{ft}$

$w_8 := w_{d1} + w_l + w_{e1} \quad w_8 = 0.770 \cdot \frac{kips}{ft}$

$w_9 := 1.05 \cdot w_{d1} + 1.3 \cdot w_l \quad w_9 = 0.580 \cdot \frac{kips}{ft}$

$w_{10} := 1.05 \cdot w_{d1} + 1.3 \cdot w_l \quad w_{10} = 0.580 \cdot \frac{kips}{ft}$

$w_{11} := 1.05 \cdot w_{d1} + 1.3 \cdot w_l + 1.3 \cdot w_a \quad w_{11} = 0.637 \cdot \frac{kips}{ft}$

Load combination 3 is the controling combination, hence ultimate moment can be computed using the following loads:

$w_3 = 0.846 \cdot \frac{kips}{ft}$

$L := l \quad L = 6.625 \cdot ft$ See figure 1.

$M_{umax} := \frac{w_3 \cdot L^2}{8}$

$M_{umax} = 4.641 \cdot kips \cdot ft$ maximum moment in the cover block per one foot of its width.

$M_u := M_{umax} \quad M_u = 4.641 \cdot ft \cdot kips$

Determine required flexural reinforcement:

$f_c := 4000 \cdot psi \quad f_y := 60000 \cdot psi$

$h := 27 \cdot in \quad d := h - (1.5 \cdot in + 0.375 \cdot in)$ Assume #6 bars.

$d = 25.125 \cdot in \quad b := 12 \cdot in$

$F := \frac{b \cdot d^2}{12000} \cdot in^{-3} \quad F = 0.631$

$K_n := \frac{M_u}{F} \cdot (ft \cdot kips)^{-1} \quad K_n = 7.352$ Use $K_n := 175$ Ref. FLEXURE 2.2. ACI-340.1R-91

$a_n := 4.37 \quad A_s := \frac{M_u}{d \cdot a_n} \cdot \frac{in^3}{ft \cdot kips} \quad A_s = 0.042 \cdot in^2$

Check minimum steel required per foot of the width of cover block.

$A_{smin} := \frac{4}{3} \cdot A_s \qquad A_{smin} = 0.056 \cdot in^2$

For the average width of the cover block of 3.542' total reinforcement area is:

$A_s := A_{smin} \cdot \frac{b_{wcb}}{1 \cdot ft} \qquad A_s = 0.200 \cdot in^2$ controls.

$A_{smin} := 0.0033 \cdot b_{wcb} \cdot d \qquad A_{smin} = 3.524 \cdot in^2$

Use 7-#5 bars for a steel area of 2.17 sq. inches.

Determine shear and reinforcing requirements due to shear at the critical section of the pump penetraion.

Factored shear at the controling section is: $w_{d1} = 0.490 \cdot \frac{kips}{ft} \qquad w_l = 0.050 \cdot \frac{kips}{ft}$

$V_u := 1.4 \cdot \left(\frac{w_{d1} \cdot L}{2} \right) + 1.7 \cdot \left(\frac{w_l \cdot L}{2} \right) \qquad V_u = 2.555 \cdot kips$

Allowable Shear:

$V_c := 2 \cdot \sqrt{f_c \cdot psi} \cdot b \cdot d \qquad V_c = 38.137 \cdot kips \qquad \phi := 0.85$

$V_n := \phi \cdot V_c \qquad V_n = 32.417 \cdot kips$

Since $0.5 \cdot V_n = 16.208 \cdot kips$

$V_u < 0.5 \cdot V_n \cdot$ *Design for shear reinforcement not required per ACI 349, Sec. 11.5.5.1.*

ICF KAISER HANFORD COMPANY		Calc. No. W320-24-032
		Revision: 0
DESIGN ANALYSIS		Page No. 22 of 22
Client WHC	WO/Job No. ER 4319/W 320	
Subject Sluice Pit AY-02E Analysis and Design of the Cover Block.	Date 03/21/1996	By M. B. Lasota
	Checked 4/16/96	By W. J. Magruder WJM
Location 241-AY-02E, Sluice Pit	Revised N/A	By N/A

6. CONCLUSIONS.

The Calculation revealed, that the design of the Cover Blocks reflected on ECN W-320-173 and the drawing H-2-818454 meets or exceeds requirements outlined in the Criteria.

W320-24-033

Vehicle Load Over Pipeline

KAISER ENGINEERS HANFORD	CALCULATION IDENTIFICATION AND INDEX	Page i of ii Date 4/9/96

This sheet shows the status and description of the attached Design Analysis sheets.

Discipline CIVIL/STRUCT. WO/Job No. PISHOO Calculation No. W320-24-033

Project No. & Name W-320

Calculation Item VEHICLE LOAD OVER PIPELINE

These calculations apply to:

Dwg. No. H-2-818426 SHTS 1&2 Rev. No. 0

Dwg. No. H-2-818428 Rev. No. 0

Other (Study, CDR) ______ Rev. No. ______

The status of these calculations is:

- ☐ Preliminary Calculations
- ☑ Final Calculations
- ☐ Check Calculations (On Calculation Dated ______)
- ☐ Void Calculation (Reason Voided ______)

Incorporated in Final Drawings? ☐ Yes ☑ No

This calculation verified by independent "check" calculations? ☐ Yes ☑ No

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	R.L. ACKERMAN 4/9/96		
Checked by	W. S. Magnum 4/11/96		
Approved by	[signature] 4/11/96		
Checked Against Approved Vendor Data	[signature] 8/21/96		

INDEX

KEH 0378.00 (06/92)

DESIGN VERIFICATION SCREENING CRITERIA

Project/Document No. W-320/W320-24-033

When the design or design change affects hardware, formal design verification must be performed if one or more of the following questions must be answered affirmatively (YES).

YES	NO	
	✓	1. Does the design or design change involved meet the established criteria to be considered Safety Class 1?
	✓	2. Does this design or design change cause or permit changes to Safety Class 1 instrument or alarm setpoints outside of previously approved operational limits?
	✓	3. Does this design or design change significantly affect the nuclear or environmental safety consequences of a malfunction or failure of the structure, system, or component?
	✓	4. Does this design or design change involve or change design that has previously undergone formal design verification?

[signature] 4/4/96
Assigned Lead Engineer — Date

[signature] 4/4/96
Responsible Discipline Manager — Date

Original Design Package Distribution:

- Project Manager
- Design Verification Officer
- Engineering Document Control

Design Change Distribution:

- Attach to Engineering Change Notice

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HANFORD

DESIGN ANALYSIS

Calc. No. 033
Revision 0
Page No. 1 of 4

Client WHC		WO/Job No.	
Subject VEHICLE LOAD - BERM OVER TRANSFER LINE		Date 4/9/96	By R. ACKERMAN
		Checked 4/11/96	By W.J. Magruder
Location 200 E - BUFFALO & SEVENTH STS.		Revised	By

OBJECTIVE

DETERMINE STRESSES IN ENCASEMENT PIPE FROM VEHICLE LOAD ON BERM. THERE IS PHYSICAL EVIDENCE THAT A VEHICLE DROVE ON BERM OVER PIPE

DESIGN BASIS

ANALYSIS EFFECT OF SUPERIMPOSED LOAD FROM FILL OVER PIPE FROM FILL AND VEHICLE LOAD -

METHOD OF ANALYSIS

HAND CALCULATION

REFERENCES

1. HANDBOOK OF PVC PIPE, UNIBELL PVC PIPE ASSOC, 1991
2. DESIGN AND CONSTRUCTION OF SANITARY AND STORM SEWERS - ASCE M&R ENGR. PRACTICE NO. 37, WPCF NO. 9
3. HIGDON A, MECHANICS OF MATERIAL, JOHN WILE & SONS, NY, 4TH ED. 1985
4. DWGS.
   H-2-818426 REV. 0
   H-2-818428 REV. 0

SPEC W-320-C1, SECTION 02225

KAISER ENGINEERS
HANFORD

DESIGN ANALYSIS

Calc. No.	W 320-24 -033		
Revision	0		
Page No.	2 of 4		
Client		WO/Job No.	
Subject VEHICLE LOAD-BERM OVER TRANSFER LINE		Date 4/5/96	By R. ACKERMAN
		Checked 4/11/96	By W.J. Magruder
Location		Revised	By

CONCLUSION

STRESSES IN 6" ENCASEMENT PIPE FROM FILL AND VEHICLE LOAD IS EXTREMELY LOW.

KAISER ENGINEERS
HANFORD

DESIGN ANALYSIS

Calc. No. W320-24-033
Revision 0
Page No. 3 of 4

Client		WO/Job No.	
Subject VEHICLE LOAD-BEAM OVER TRANSFER LINE		Date 4/9/96	By R. ACKERMAN
		Checked 4/11/96	By WJ Magruder
Location		Revised	By

REFERENCE 2 - PAGE 197

EQUATION 8

WHERE: C_n = LOAD COEFFICIENT
W = UNIT WT. OF SOIL (120 pcf)

$$W_c = C_n \, w \, B_d^2$$ — RIGID PIPE IN NEGATIVE PROJECTING TRENCH

SEE DWG H-2-818428-SHT 1

$$B_d = \frac{7" + 6.625 + 6"}{12} = 1.63'$$

$p' B_d = 0.5$ $p' = 0.31$

$$\frac{H}{B_d} = \frac{3}{1.63} = 1.84$$

PAGE 196, W RIGID CONDUIT NEGATIVE PROJECTING

$$r_{sd} = -0.3 \text{ TO } -0.5$$

USE $R_{sd} = -0.3$, $C_n = 1.8$

$$W_c = 1.8\,(120 \text{ lb/FT}^3)(1.63)^2 = 574 \text{ lb/FT}$$

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DESIGN ANALYSIS

Calc. No. W320-24-053
Revision
Page No. 4 of 4

Client WHC	WO/Job No.
Subject VEHICLE LOAD - BERM OVER TRANSFER LINE	Date 4/9/96 By R. ACKERMAN
	Checked 4/11/96 By WJ Magruder
Location	Revised By

EVEN THOUGH TIRE TRACKS ON BERM LOOKED LIKE A SINGLE PICK-UP HAD DRIVEN OVER THE BERM - WILL USE H-20 TRUCK LOADS TO DETERMINE PRESSURE ON PIPE

REF, 1, P183 FIG 6.7 - H-20 HIGHWAY LOAD

VERT SOIL PRESS. - 3 FT. OF COVER = 650 #/FT^2

PER LINEAR FT PIPE = (650)(1.63) = 1060 #/LINEAR FT.

$$\text{TOTAL} = \begin{array}{r} 574 \\ \underline{1060} \\ 1634 \end{array} \text{ \#/ LINEAL FT}$$

IGNORING SUPPORT FROM SOIL COMPACTED AROUND PIPE, CONSERVATIVE CALCULATION OF STRESS :

REF 3, P160

$$\sigma = \frac{1634(3.125)}{12\,(.28)} = 1520 \text{ psi} - \text{OK} < 35{,}000 \text{ psi}$$

YIELD FOR SCH 40 A-106 B PIPE

6" SCH 40 PIPE

W320-24-034

Process Building Lower Lifting Frame

ICF KAISER HANFORD COMPANY	CALCULATION IDENTIFICATION AND INDEX	Page I of iii Date 05/21/96

This sheet shows the status and description of the attached Design Analysis sheets.

Discipline Civil/Structural WO/Job No. W-320/ER6159 Calculation No. W320-24-034

Project No. & Name PROJECT W-320, TANK 241-C-106 WASTE RETRIEVAL

Calculation Item Process Building Lower Lifting Frame

These calculations apply to:

Dwg. No. ES-W-320-C1 Rev. No. 0

Dwg. No. Rev. No.

Other (Study, CDR) Rev. No.

The status of these calculations is:

[] Preliminary Calculations

[X] Final Calculations

[] Check Calculations (On Calculation Dated)

[] Void Calculation (Reason Voided)

Incorporated in Final Drawings? [X] Yes [] No

This calculation verified by independent "check" calculations? [] Yes [X] No

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	Michael R Curtis 5/23/96		
Checked by	[signature] 6/14/96		
Approved by	[signature] 6/14/96		
Checked Against Approved Vendor Data	[signature] 4/7/98		

INDEX

Design Analysis Page No.	Description
I	Calculation Identification and Index
ii	Calculation Cross Index
iii	Design Verification Screening Criteria
1,2	OBJECTIVES; CRITERIA; DATA; ASSUMPTIONS; METHODS; REFERENCES; CALCULATIONS; CONCLUSIONS
3-6	DESIGN/ANALYSIS
APPENDIX A	Drawing ES-W- 320-C1 (3 Sheets)

CALCULATION CROSS INDEX . /pical)

Subject Calculation No. W320-24-034, Rev. 0

Subject Calculation Revision No.	Superceded by Calculation No.	These interfacing calculation/documents provide input to the subject calculation, and if revised may require revision of the subject calculation.		Results and conclusions of the subject calculation are used in these interfacing calculations and/or documents.		Does the output interface calculation/documents require revision?		Has the output interface calculation/documents been revised?		Discipline manager's signature and date indicating evaluation complete.
		Calculation/Document No.	Revision No.	Calculation/Document No.	Revision No.	Yes	No	Yes	No	
0	—	—	—	ES-W-320-C1	0		✓		✓	[signature] 6/14/96

KEH 1975.00 (12/88)

DESIGN VERIFICATION SCREENING CRITERIA

Project/Document No. CALC. W320-24-034, REV. 0

When the design or design change affects hardware, formal design verification must be performed if one or more of the following questions must be answered affirmatively (YES).

YES	NO		
	✓	1.	Does the design or design change involved meet the established criteria to be considered Safety Class 1 or 2?
	✓	2.	Does this design or design change cause or permit changes to Safety Class 1 or 2 instrument or alarm setpoints outside of previously approved operational limits?
	✓	3.	Does this design or design change significantly affect the nuclear safety consequences of a malfunction or failure of the structure, system, or component?
	✓	4.	Does this design or design change involve or change design that has previously undergone formal design verification?

[signature] 6/14/96
Assigned Lead Engineer — Date

[signature] 6/14/96
Responsible Discipline Manager — Date

Original Design Package Distribution:

- Project Engineer
- Chief Design Engineer
- Engineering Document Control

Design Change Distribution:

- Attach to Engineering Change Notice

DESIGN ANALYSIS	Calc. No. W320-24-034 Revision 0 Page No. 1 of 6
Client WHC	WO/Job No. ER-6159/W-320
Subject Process Building Lower Lifting Frame	Date 05/21/96 By M.R Custer MRC
	Checked 6/14/96 By [signature]
Location TANK 241-C-106	Revised By

OBJECTIVE:

The objective of this calculation is to provide a design for a lifting frame to be used in the placement of the Process Building onto the foundation in the C-Tank Farm.

CRITERIA:

1. DOE ORDER 6430.1A (04/06/89)

2. DOE-RL-92-36, Hanford Rigging and Hoisting Manual, January 15, 1993

DATA:

1. The data consists of the information provided on sketches prepared by field construction a shown in Appendix. A.

ASSUMPTIONS:

1. None

METHODS:

Hand calculations

REFERENCES:

1. AISC Manual of Steel Construction, Ninth Edition

2. DOE-RL-92-36, Hanford Rigging and Hoisting Manual, January 15, 1993

3. AISC Manual of Steel Construction, 9th Edition

4. ES drawing per Appendix A.

	Calc. No. W320-24-034
	Revision 0
DESIGN ANALYSIS	Page No. 2 of 6
Client WHC	WO/Job No. ER-6159/W-320
Subject Process Building Lower Lifting Frame	Date 05/21/96 By M.R Custer MRC
	Checked 6/14/96 By Dew
Location TANK 241-C-106	Revised By

CALCULATIONS:

Refer to DESIGN/ ANALYSIS section.

CONCLUSIONS:

Based on the evaluation performed, the design of the Safety Class 3, Process Building Lifting Frame is structural adequate.

Calc. No. W320-24-034

Revision 0

DESIGN ANALYSIS

Client WHC

WO/Job No. ER-6159/W- 320

Subject Process Building Lower Lifting Frame

Date 05/21/96 By M.R Custer MRC

Checked 6/14/96 By RP

Location TANK 241-C-106

Revised By

DESIGN/ ANALYSIS:

The design and analysis of the lower lifting frame involves determining the applied load(s) on the frame, evaluating the available framing members, design of the member connections and design of a typical lifting lug. The frame will be utilized as a temporary lifting device to place the pre-constructed Process Building into the C-Tank Farm onto the existing foundation. The loads applied to the frame consists of the dead load of the building. The design of the frame will consider only the dead loads of the building and frame , since the frame is temporary.

DETERMINE FRAME MEMBER FORCES:

- Weight of the Process Building, 5000 lb (6000 lb is used in the evaluation)
- Dimensions of the lower lifting frame, 15' - 0" x 25' - 0"
- Vertical angle of the slings which provide a 20-30 degree (max.) offset
- Weight of the Lifting Frame, Wf = 17.0' x 2 x 35 lb/ft + 24.3' x 2 x 33 lb/ft = 2794 lb, Use 3000 lb

DETERMINE FRAME MEMBER FORCES:

The weight of the building is distributed at the four corners of the lifting frame = 6000 lb/ 4 = 1500 lb

The building is supported at the corners and the weight is distributed to each the W10 X 33 and the W12 x 35 beams with a maximum moment in the beam is as follows:

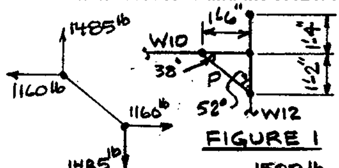

FIGURE 1

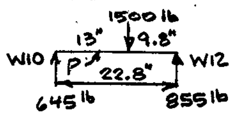

FIGURE 2

- W10 X 33 :

  - Maximum vertical reaction, 645 lb
  - Maximum horizontal reaction, 1160 lb
  - Maximum vertical moment , Mx max :

    Mx max = 18" (645 lb) = 11610 in-lb

  - Maximum horizontal moment, My max:

    My max = 18" (1160 lb) = 20880 in-lb

- W12 X 35:

  - Maximum vertical reaction, 855 lb + 645 lb + 415 = 1915 lb
  - Maximum horizontal reaction, 1299 lb

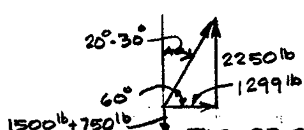

FIGURE 3

	Calc. No. W320-24-034
	Revision 0
DESIGN ANALYSIS	Page No. 4 of 6
Client WHC	WO/Job No. ER-6159/W- 320
Subject Process Building Lower Lifting Frame	Date 05/21/96 By M.R Custer MRC
	Checked 6/14/96 By RD
Location TANK 241-C-106	Revised By

- Maximum vertical moment, Mx max:

- Mx max = 16" (1915 lb) + 14" (855 lb) = 42610 in-lb

- Maximum horizontal moment, My max:

My max = 16" (1299 lb) = 20784 in-lb

- Check combined stresses in the W10 x 33 and W12 x 35:

W10 X33: fbx/ Fbx + fby/Fby </= 1.0

fbx = 11610 in-lb/ 35 in3 = 332 psi < 11200 psi (Lb =22.0 ft, Lc = 8.4 ft, Lu = 16.5 ft, l/rT = 123 , so use Fbx = 11200 psi)

fby = 20880 in-lb/ 9.2 in3 = 2270 psi < 27000 psi (Fby = .75 Fy = 27000 psi)

332/ 11200 + 2270/ 27000 = 0.03 + 0.08 = 0.11 < 1.0 ... OK

W12 x 35: fbx/ Fbx + fby/Fby </= 1.0

fbx = 42610 in-lb/ 45.6 in3 = 934 psi < 18300 psi (Lb = 12.0 ft, Lc = 6.9 ft, Lu = 12.6, l/ rT = 82.8, so use Fb = 18300 psi)

fby = 20784 in-lb/ 7.47 in3 = 2782 psi (Fby = .75 Fy = 27000 psi)

934/ 18300 + 2782/ 27000 = 0.05 + 0.10 = 0.15 < 1.0 ... OK

Try (2)- 3/4" DIA. A-325 bolts for all framing connections (typ., unless noted)
(bearing type connection with threads included in the shear plane)

Single shear capacity of 3/4" dia bolt = (2) 9.3 kips = 18.6 k > 6.0 k (AISC min.) >> 1.06 k .... OK

CHECK SHEAR STRESS IN THE BEAM WEB: (worst case W10 to W10, apply max. Shear = 1.06 kips):

fv = 1.06 k/ (5/16) (4" + 1.5") = 0.62 ksi <<< Fv = 0.40 Fy = 14.4 ksi

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DESIGN ANALYSIS	Page No. 5 of 6
Client WHC	WO/Job No. ER-6159/W- 320
Subject Process Building Lower Lifting Frame	Date 05/21/96 By M.R Custer MRC
	Checked 6/14/96 By RD
Location TANK 241-C-106	Revised By

CHECK COLUMN ATTACHMENT FOR JACK MECHANISM:

- Maximum moment on the W4 X 13 member = Mmax = 6" (6.0 k/ 4) = 9.0 k-in

  Sx = 5.46 in3, fb = M max/ Sx = 9.0 k- in / 5.46 in3 = 1.65 ksi <<< Fb = 22 ksi .... OK

- Check plate bending:

  Sx (pl) = bd3/6 = 5(0.5)3/ 6 = 0.10 in3

  Mmax = [(7" - 4.12")/ 2] [(6" x 1.5 k)/ 7"] = 1.9 k-in

  fb = Mmax/ Sx (pl) = 1.9 k-in / 0.10 in3 = 19.0 ksi <<< 22 ksi .... OK

- Maximum shear on the W4 X 13 member = 1.5 k

  V = 1. 5 kips, A (w4) = [4.16" - 2(0.345)] (0.28") = 0.97 in2

  fv = 1.5 k / 0.97 in2 = 1.55 ksi <<< Fv = 14.4 ksi .... OK

- Check the ½" dia. A-325 bolts :

  T = (Mmax / d)/ 2 = [(1.5 k x 6" / 5.5")/ 2] = 0.82 k << 22 ksi (.393 in2) = 8.6 k .... OK

- Check weld between the W14 X 13 and the ½" baseplate:

  - Tension force on the weld, T = (6" x 1.5 k)/ 4.13" = 2.18 k
  - Weld capacity = (3/16") (4.06")(15800 lb/in2) = 12.0 k >> 2.18 k .... OK

CHECK LIFTING LUG CAPACITY: (The load on the lug is 6000 lb/4 + 3000/4 = 2250 lb = 2.3 k in the vertical direction and 1.3 k in the horizontal direction:

- Check shear on capacity of the lug:

  - Av = [4"/2 - 1.125/2] 0.5" = 0.72 in2
  - fv = P/ Av = 2.6 k / 0.72 in2 = 3.7 ksi <<< Fv = 0.4 (36 ksi) = 14.4 ksi .... OK
  - Factor of Safety = 36/ 3.7 = 9.7 > 3.0 .... O.K

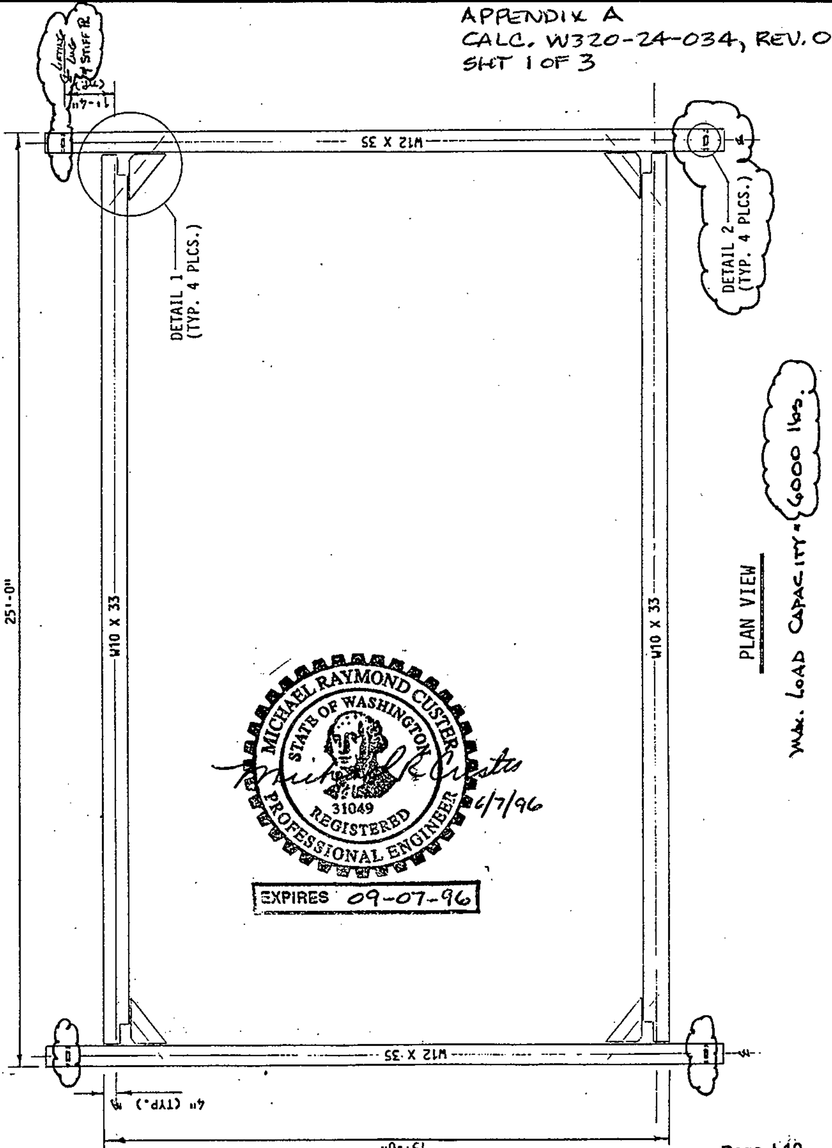
	Calc. No. W320-24-034
	Revision 0
DESIGN ANALYSIS	Page No. 6 of 6
Client WHC	WO/Job No. ER-6159/W- 320
Subject Process Building Lower Lifting Frame	Date 05/21/96 By M.R Custer MRC
	Checked 6/14/96 By RD
Location TANK 241-C-106	Revised By

- **Check weld capacity:**
  - fw = 2.3 k/ .707 (.25") (4" + 4" + .5" + .5") + 1.3/ .707(.25) (4 + 4) = 2.4 ksi << Fw = 15.8 ksi .... OK
  - Factor of Safety = 70/ 2.4 = 29.1 > 3.0 .... OK
- **Check local flange bending of the Process Building Column:**
  - tf > 0.4 (Pbf/Fyc) ½ (no stiffeners required): tf = 3/16" = 0.188"

  0.4 [(2.18 k/2)(5/3) / (36 ksi)] ½ = 0.09" < 0.188" .... O.K , no stiffeners required

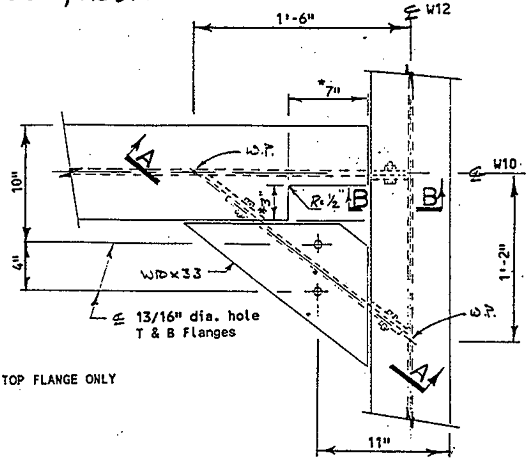
ICF KAISER HANFORD	ENGINEERING SKETCH W320 TANK 241-C-106 SLUICING			
Title: STRUCTURAL - PROCESS BUILDING ERECTION AND LIFTING FRAME	Prepared by: MD AXUP; Checked by: Michael R. Custer 6/7/96	Sh 1 of 3; Cadfile NA	Sketch no. ES-W-320-C1	Rev 2

APPENDIX A
CALC. W320-24-034, REV. 0
SHT 1 OF 3



ICF KAISER HANFORD	ENGINEERING SKETCH HNF-2468, Rev.0 W320 TANK 241-C-106 SLUICING			
Title: STRUCTURAL - PROCESS BUILDING ERECTION AND LIFTING FRAME	Prepared by: MD AXUP / Checked by: Michael R Custer 5/23/96	Sh 2 of 3 / Cadfile NA	Sketch no. ES-W-320-C1	Rev 0

APPENDIX A
CALC. W320-24-034, REV.0
SHT. 2 OF 3



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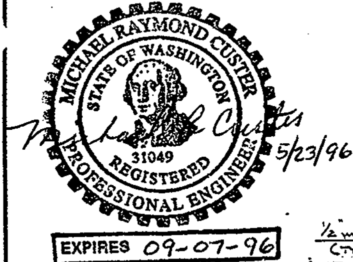
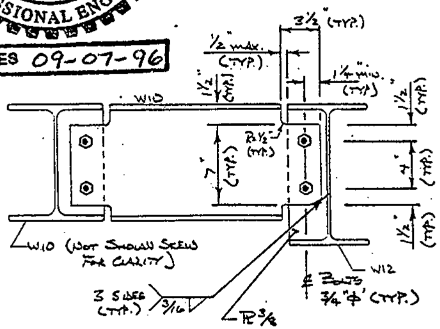
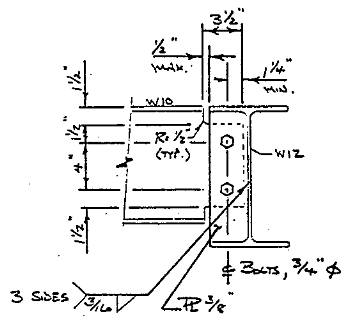
DETAIL 1





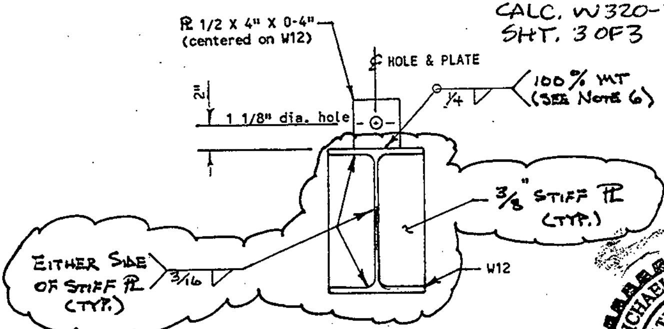
SECTION A-A



SECTION B-B

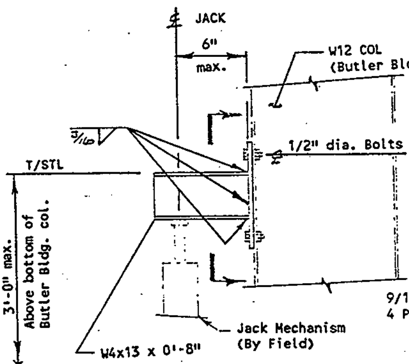
ICF KAISER HANFORD	ENGINEERING SKETCH HNF-2468, Rev.0 W320 TANK 241-C-106 SLUICING			
Title: STRUCTURAL - PROCESS BUILDING ERECTION AND LIFTING FRAME	Prepared by: MD AXUP Checked by: Michael R Custer 6/7/96	Sh 3 of 3 Cadfile NA	Sketch no. ES-W-320-C1	Rev 2

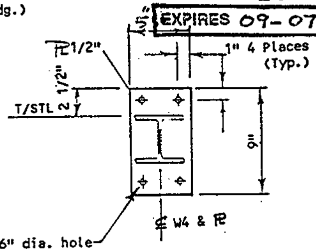
APPENDIX A
CALC. W320-24-034, REV. 0
SHT. 3 OF 3



LIFTING LUG DETAIL

MICHAEL RAYMOND CUSTER
STATE OF WASHINGTON
31049
REGISTERED
PROFESSIONAL ENGINEER
Michael R Custer 6/7/96
EXPIRES 09-07-96





SECTION C-C

COL ATTACH FOR JACK MECHANISM (4 PLACES)

NOTES:

1. Structural steel shapes and plates shall be A 36 material.
2. Bolting material shall be A 325 high strength bolts used with A 194 2H hex nuts. Tightening of bolts shall be by the "turn of the nut" method.
3. Welds shall be made using E70XX electrode.
4. Structural welding and weld inspection shall be performed in accordance with AWS D1.1 criteria.
5. Lifting frame shall be load tested at 125% of rated load capacity of frame in accordance with Hanford Hoisting and Rigging Manual, DOE RL-92-36 (DATED JAN. 15, 1993)
6. MT SHALL BE PERFORMED PRIOR TO AND AFTER LOAD TEST.
7. ANGLE OF SLINGS USED FOR LIFTING SHALL BE A MINIMUM OF 60 DEGREES MEASURED FROM HORIZONTAL.

W320-24-035

Recirculation/Exhaust Skid
Structural Evaluations

FLUOR DANIEL NORTHWEST, INC.	CALCULATION IDENTIFICATION AND INDEX	Page i of i Date March 28, 1997

This sheet shows the status and description of the attached Design Analysis sheets.

Discipline 24 STRUCTURAL WO/Job W-320 Calculation No. W-320-24-035

Project No. & Name W-320 Tank 240-C-106 Sluicing

Calculation Item Recirculation / Exhaust Skid Structural Evaluations

These calculations apply to:

Dwg. No. ______ Rev. No. ___

Dwg. No. ______ Rev. No. ___

Other (Study, CDR) ______ Rev. No. ___

The status of these calculations is:

[] Preliminary Calculations

[X] Final Calculations

[] Check Calculations (On Calculation Dated)

[] Void Calculation (Reason Voided)

Incorporated in Final Drawings? [X] Yes [] No

This calculation verified by independent "check" calculations? []Yes[X]No

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	N. D. Ha [signature] 3/28/97		
Checked by	R. A. Giller [signature] 3-31-97		
Approved by	[signature] 4/1/97		
Checked Against Approved Vendor Data	[signature] 4/1/97		

INDEX

Design Analysis Page No.	Description
1	OBJECTIVE, CRITERIA, REFERENCES, ASSUMPTIONS, CONCLUSIONS
2-14	HANGER EVALUATIONS

Fluor Daniel Northwest

Calc # W-320-24-035
Revision 0
Page 1 of 14

DESIGN CALCULATION

Client :	Project W-320	WO/Job No		
Subject :	Recirculation/Exhaust skid evaluation	Date 3/28/97	By	N. D. Ha *[signature]*
		Checked 3-31-97	By	R. A. Giller *[signature]*
Location :	200 East Area	Revised	By	

Objective:

The Recirculation / Exhaust support skid is a portion of W-320 project. The HVAC skid consists of the steel frame which supports the HVAC equipment and the concrete slab that supports the frame.

Design criteria:

Operation : Deadweight and wind loading are considered.

Seismic :
The HVAC skid structure is designed in accordance with UBC 1994 seismic requirements for low hazard facility (UCRL 15910 safety class 3 structure).

Assumptions:

Assume the Recirculation and the Exhaust skid structures are similar in design

References :

1. Flour Daniel North-West A/E Standard GC-Load-01
2. Manual of Steel Construction (AISC), 9th Edition
3. Designing Floor Slab On Grade, 1992. Boyd C. Ringo and Robert B. Anderson
4. Concrete Floors on Ground, 2th Edition. Porland Cement Association.
5. Uniform Building Code (UBC), 1994
6. Design and Evaluation Guidelines for DOE Facilities Subjected to Natural Phenomina Hazards (UCRL 15910)
7. ASCE Standard 7-88

Conclusions : The HVAC Skid structure is designed to meet the Hanford standard requirements.

Fluor Daniel Northwest

Calc # W-320-24-035
Revision 0
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DESIGN CALCULATION

Client : Project W-320	WO/Job No			
Subject : Recirculation/Exhaust skid evaluation	Date 3/28/97	By	N. D. Ha	*Nha*
	Checked 3-31-97	By	R. A. Giller	*RAGiller*
Location : 200 East Area	Revised	By		

Concrete weight $w_{concrete} := 145\cdot\frac{lbf}{ft^3}$

Concrete compression $f_c := 3000\cdot\frac{lbf}{in^2}$

Concrete tension allowable $f_t := 300\cdot\frac{lbf}{in^2}$

Reinforced steel strength $f_{y.rebar} := 60000\cdot\frac{lbf}{in^2}$

Soil modulus subgrade reaction k
(Sand-gravel)
k= load (psi)/deflection (.05in) $k := 300\cdot\frac{lbf}{in^3}$

Poisson ratio for concrete $v := .15$

Steel properties

Bending allowable $F_{y.bending.allow} := .6\cdot 36000\cdot\frac{lbf}{in^2}$

L3x3x1/4

$A_{L3x3} := 1.44\cdot in^2$ $w_{L3x3} := 4.9\cdot\frac{lbf}{ft}$

$S_{L3x3} := .577\cdot in^3$ $r_{L3x3.} := .592\cdot in$

TS3x3x1/4

$A_{T3x3} := 2.59\cdot in^2$ $r_{T3x3.} := 1.1\cdot in$

$S_{T3x3} := 2.1\cdot in^3$ $w_{T3x3} := 8.81\cdot\frac{lbf}{ft}$

$W_{TS.vert} := w_{T3x3}\cdot 88\cdot in$

$W_{TS.horz} := w_{T3x3}\cdot 45\cdot in$

Weld electrode 70 $f_{y.weld.allow} := 70000\cdot\frac{lbf}{in^2}$

Safety class 3 horizontal acceleration
(UBC 1994)

$Z := .2$ $I := 1.5$ $C_p := .75$

$a_{horz.ubc} := I\cdot Z\cdot C_p$

$a_{horz.ubc} = 0.225$

Fluor Daniel Northwest

Calc # W-320-24-035
Revision 0
Page 3 of 14

DESIGN CALCULATION

Client : Project W-320
Subject : Recirculation/Exhaust skid evaluation
Location : 200 East Area

WO/Job No
Date 3/24/97 By N. D. Ha
Checked 3-31-97 By R. A. Giller
Revised By

Equipments properties

Circulation Heater $W_{recir} := (183 + 40)\cdot lbf$

Exhaust $W_{exhaust} := (73 + 7)\cdot lbf$

11/4" Pump Series 60 $W_{pump} := 55\cdot lbf$

Circulating Pump $W_{circulator} := 7\cdot lbf$

Other pump $W_{small.pump} := 5\cdot lbf$

Circulation Expansion tank $W_{tank.recir} := (14 + 20)\cdot lbf$

Exhaust Expansion tank $W_{tank.exhaust} := (9 + 6)\cdot lbf$

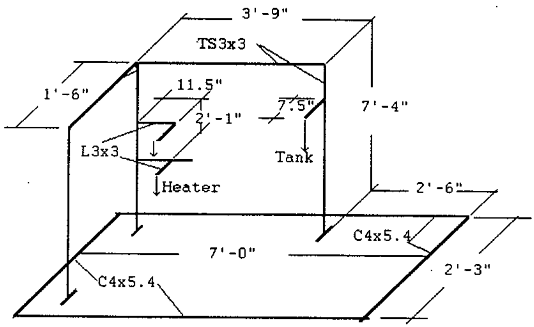
11/4" pipe (11 ft long) $W_{pipe} := 2.82\cdot 11\cdot lbf$

$W_{misc.pumps} := 5\cdot lbf\cdot 4$

$W_{misc.pumps} = 20\cdot lbf$

Weight of 4.25 ft X 9 ft x 6 in. concrete slab $W_{slab} := w_{concrete}\cdot(4.5\cdot 9\cdot .5)\cdot ft^3$

$W_{slab} = 2.936\cdot 10^3 \cdot lbf$



Calc # W-320-24-035
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Fluor Daniel Northwest

DESIGN CALCULATION

Client : Project W-320	WO/Job No		
Subject : Recirculation/Exhaust skid evaluation	Date 3/28/97	By	N. D. Ha *N.Ha*
Location : 200 East Area	Checked 3-31-97	By	R. A. Giller *RA Giller*
	Revised	By	

Recirculation skid

Projected areas of all components

$A_{T3x3} := 3 \cdot in \cdot (3 \cdot 88 + 45) \cdot in$

$A_{recirculator} := 8.5 \cdot 74 \cdot in^2$

$A_{tank.recir} := 11 \cdot in \cdot 23 \cdot in$

$A_{tank.recir} = 253 \cdot in^2$

$A_{elec.box} := 4 \cdot in \cdot 4 \cdot in$

$A_{elec.box} = 16 \cdot in^2$

$A_{pipe} := 1.66 \cdot in \cdot (11 \cdot 12) \cdot in$

$A_f := A_{recirculator} + A_{T3x3} + A_{tank.recir} + A_{elec.box} + A_{pipe}$

$A_f = 2.044 \cdot 10^3 \cdot in^2$

Explosure coefficient $K_z := .8$

Wind speed $V := 70$

Importance factor(Safety class 3) $I := 1.07$

Velocity pressure q_z (Evaluate at z height)

$q_z := .00256 \cdot K_z \cdot (I \cdot V)^2 \cdot \frac{lbf}{ft^2}$

$q_z = 11.489 \cdot \frac{lbf}{ft^2}$

Explosure C $G_z := 1.32$

$C_f := 2.0$

Wind Force on structure (ASCE 1988)

$F_{wind.recir} := q_z \cdot G_z \cdot C_f \cdot A_f$

$F_{wind.recir} = 430.568 \cdot lbf$

Use $F_{wind.recir} := 431 \cdot lbf$

Fluor Daniel Northwest

DESIGN CALCULATION

Client : Project W-320	WO/Job No			
Subject : Recirculation/Exhaust skid evaluation	Date 3/28/97	By	N. D. Ha	*[signature]*
	Checked 3-31-97	By	R. A. Giller	*[signature]*
Location : 200 East Area	Revised	By		

Area of the Tube steel

$$A_{TS.vert} := 3 \cdot in \cdot 88 \cdot in$$

$$A_{TS.horz} := 3 \cdot in \cdot 45 \cdot in$$

Distance from CG of components to the base

$$y_{TS.vert} := \frac{88 \cdot in}{2}$$

$$y_{TS.horz} := 88 \cdot in$$

$$y_{recir} := 43 \cdot in$$

$$y_{tank.recir} := 62 \cdot in$$

$$y_{pipe} := 37 \cdot in$$

$$L_{recir.arm} := 7.5 \cdot in$$

$$L_{TS} := 18 \cdot in$$

$$y_{recirculator} := \frac{2 \cdot A_{TS.vert} \cdot y_{TS.vert} + A_{TS.horz} \cdot y_{TS.horz} + A_{recirculator} \cdot y_{recir} + A_{tank.recir} \cdot y_{tank.recir} + A_{pipe} \cdot y_{pipe}}{2 \cdot A_{TS.vert} + A_{TS.horz} + A_{recirculator} + A_{tank.recir} + A_{pipe}}$$

$$y_{recirculator} = 48.723 \cdot in$$

Moment due to Deadweight

$$M_{dw.recir} := \left(W_{recir} + W_{tank.recir} + W_{pipe} + W_{pump} + W_{misc.pumps}\right) \cdot L_{recir.arm} + \left(W_{TS.vert} \cdot 3 + W_{TS.horz}\right) \cdot \frac{15}{3} \cdot in$$

$$M_{dw.recir} = 3.857 \cdot 10^{3} \cdot in \cdot lbf$$

Tipping about Steel frame

$$M_{tipping.recir} := F_{wind.recir} \cdot y_{recirculator}$$

$$M_{tipping.recir} = 2.1 \cdot 10^{4} \cdot in \cdot lbf$$

Fluor Daniel Northwest

Calc # W-320-24-035
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DESIGN CALCULATION

Client : Project W-320
Subject : Recirculation/Exhaust skid evaluation
Location : 200 East Area

WO/Job No
Date 3/28/97 By N. D. Ha
Checked 3-31-97 By R. A. Giller
Revised By

Exhaust skid

$A_{exhaust} = 6.125 \cdot 32 \cdot in^2$

$A_{T3x3} := 3 \cdot in \cdot (3 \cdot 88 + 45) \cdot in$

$A_{tank.exhaust} := 11 \cdot in \cdot 15.5 \cdot in$

$A_{tank.exhaust} = 170.5 \cdot in^2$

$A_{pipe} := 1.66 \cdot in \cdot (11 \cdot 12) \cdot in$

$A_{f.exhaust} = A_{exhaust} + A_{T3x3} + A_{tank.exhaust} + A_{elec.box} + A_{pipe}$

$A_{f.exhaust} = 1.529 \cdot 10^3 \cdot in^2$

$A_{exhaust} := (6.125 \cdot 32.5) \cdot in^2$

$A_{tank.exhaust} := (11 \cdot 15.5) \cdot in^2$

$L_{exhaust.arm} := 6.5 \cdot in$

$y_{exhaust} := 43 \cdot in$

$y_{tank.exhaust} := 67 \cdot in$

$y_{pipe} := 37 \cdot in$

$$y_{exhaust} := \frac{2 \cdot A_{TS.vert} \cdot y_{TS.vert} + A_{TS.horz} \cdot y_{TS.horz} + A_{exhaust} \cdot y_{exhaust} + A_{tank.exhaust} \cdot y_{tank.exhaust} + A_{pipe} \cdot y_{pipe}}{2 \cdot A_{TS.vert} + A_{TS.horz} + A_{exhaust} + A_{tank.exhaust} + A_{pipe}}$$

$y_{exhaust} = 50.494 \cdot in$

Moment due to Deadweight

$M_{dw.exhaust} := (W_{exhaust} + W_{tank.exhaust} + W_{pipe} + W_{pump} + W_{misc.pumps}) \cdot L_{exhaust.arm} + (W_{TS.vert} \cdot 3 + W_{TS.hor}$

$M_{dw.exhaust} = 2.441 \cdot 10^3 \cdot in \cdot lbf$

$M_{dw.total} := M_{dw.exhaust} + W_{slab} \cdot L_{exhaust.arm}$

$M_{dw.total} = 2.153 \cdot 10^4 \cdot in \cdot lbf$

$F_{wind} := q_z \cdot G_z \cdot C_f \cdot A_{f.exhaust}$

$F_{wind} = 321.984 \cdot lbf$

$F_{wind.exhaust} := 322 \cdot lbf$

Tipping about Steel frame

$M_{tipping.exhaust} := F_{wind.exhaust} \cdot y_{exhaust}$

$M_{tipping.exhaust} = 1.626 \cdot 10^4 \cdot in \cdot lbf$

Check steel frame

Seismic loading

$W_{total.recir} := \left[W_{recir} + W_{tank.recir} + W_{pipe} + W_{pump} + W_{misc.pumps} + \left(W_{TS.vert} \cdot 3\right) + W_{TS.horz}\right]$

$W_{total.recir} = 589.878 \cdot lbf$

$W_{total.exhaust} := \left[W_{exhaust} + W_{tank.exhaust} + W_{pipe} + W_{pump} + W_{misc.pumps} + \left(W_{TS.vert} \cdot 3\right) + W_{TS.horz}\right]$

$W_{total.exhaust} = 427.878 \cdot lbf$

$F_{x.seis} := W_{total.recir} \cdot a_{horz.ubc}$

$F_{x.seis} = 132.722 \cdot lbf$

$F_{z.seis} := F_{x.seis}$

$F_{y.seis} := W_{total.recir} \cdot \frac{2}{3} \cdot a_{horz.ubc}$

$F_{y.seis} = 88.482 \cdot lbf$

Since the seismic load is much less than wind load, wind loading will be a critical load case for this structure.

Fluor Daniel Northwest

Calc # W-320-24-035
Revision 0
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DESIGN CALCULATION

Client : Project W-320	**WO/Job No**		
Subject : Recirculation/Exhaust skid evaluation	**Date** 3/28/97	**By**	**N. D. Ha**
	Checked 3-31-97	**By**	**R. A. Giller** RA Giller
Location : 200 East Area	**Revised**	**By**	

Deadweight and wind loading

L3x3x1/4

$$F_{wind.recirculator} := q_z \cdot G_z \cdot C_f \cdot A_{recirculator}$$

$$F_{wind.recirculator} = 132.491 \cdot lbf$$

$$\sigma_{L3x3} := \frac{(W_{recir} + F_{wind.recirculator}) \cdot 11.5 \cdot in}{S_{L3x3} \cdot 2}$$

$$\sigma_{L3x3} = 3.543 \cdot 10^3 \cdot \frac{lbf}{in^2}$$

Vertical TS3x3

$$\sigma_{T3x3.recir} := \frac{M_{tipping.recir}}{2 \cdot S_{T3x3}}$$

$$\sigma_{T3x3.recir} = 5 \cdot 10^3 \cdot \frac{lbf}{in^2}$$

3/8" Plate (7ft x 2.25ft)

$$t_{plate} := .375 \cdot in$$

$$b_{plate} := 7 \cdot ft$$

$$S_{plate} := \frac{b_{plate} \cdot t_{plate}^2}{6}$$

$$S_{plate} = 1.969 \cdot in^3$$

$$P_{frame} := (W_{recir} + W_{tank.recir} + W_{pipe} + W_{pump} + W_{misc.pumps})$$

$$L_{short} := 2.25 \cdot ft$$

$$M_{plate} := (M_{tipping.recir}) + \frac{P_{frame} \cdot L_{short}}{8}$$

$$\sigma_{plate} := \frac{M_{plate}}{S_{plate}}$$

$$\sigma_{plate} = 1.129 \cdot 10^4 \cdot \frac{lbf}{in^2}$$ $< F_{y.bending.allow}$ ==>OK

Fluor Daniel Northwest

Calc # W-320-24-035
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DESIGN CALCULATION

Client : Project W-320
Subject : Recirculation/Exhaust skid evaluation
Location : 200 East Area

WO/Job No
Date 3/28/97 By N. D. Ha NDHa
Checked 3-31-97 By R. A. Giller RA Giller
Revised By

Lifting bail (5/8" dia)

$D_{rod} := \frac{5}{8} \cdot in$ $\quad A_{rod} := \pi \cdot \frac{D_{rod}^2}{4}$

$f_{shear.allow} := .4 \cdot 36000 \cdot \frac{lbf}{in^2}$

$w_{steel} := 490 \cdot \frac{lbf}{ft^3}$ $\quad w_{chanel} := 5.4 \cdot \frac{lbf}{ft}$

$w_{L1.5x1.5} := 1.8 \cdot \frac{lbf}{ft}$

$W_{plate} := \left(2.25 \cdot ft \cdot 7.33 \cdot ft \cdot \frac{3}{8} \cdot in\right) \cdot w_{steel}$

$W_{chanel} := (2 \cdot 7.33 \cdot ft + 2 \cdot 2.25 \cdot ft) \cdot w_{chanel}$

$W_{L1.5x1.5} := (2 \cdot 7.33 \cdot ft + 2 \cdot 2.25 \cdot ft) \cdot w_{L1.5x1.5}$

$P_{lift} := W_{total.recir} + W_{plate} + W_{chanel} + W_{L1.5x1.5}$

$P_{lift} = 980.371 \cdot lbf$

$\tau_{rod} := \frac{P_{lift}}{4 \cdot A_{rod}}$

$\tau_{rod} = 798.878 \cdot \frac{lbf}{in^2}$ $\quad < f_{shear.allow}$ ==> OK

Roark, Table 17, case 1 (circular ring)

$I_{rod} := \frac{\pi \cdot D_{rod}^4}{64}$ $\quad Radius_{hook.bend} := 1.75 \cdot in$

$\alpha := \frac{I_{rod}}{A_{rod} \cdot Radius_{hook.bend}^2}$

$\alpha = 0.008$ $\quad k_2 := 1 - \alpha$

$M_{hook.bending} := .32 \cdot Radius_{hook.bend} \cdot k_2 \cdot \frac{P_{lift}}{4}$

$f_{b.hook} := \frac{M_{hook.bending} \cdot D_{rod}}{I_{rod} \cdot 2}$

$f_{b.hook} = 5.681 \cdot 10^3 \cdot \frac{lbf}{in^2}$ $\quad < F_{bending.allow}$ ==> OK

DESIGN CALCULATION

Client :	Project W-320	WO/Job No			
Subject :	Recirculator skid evaluation	Date 3/28/97	By	N. D. Ha	Nha
		Checked 3-31-97	By	R. A. Giller	RAGiller
Location :	200 East Area	Revised	By		

Weld checks

Between L3x3 and TS3x3

$$d_{weld} := 3 \cdot in$$

$$b_{weld} := 3 \cdot in$$

$$A_{weld} := b_{weld} + d_{weld}$$

$$S_{weld} := \frac{d_{weld}^{2} \cdot (4 \cdot b_{weld} + d_{weld})}{6 \cdot (2 \cdot b_{weld} + d_{weld})}$$

$$S_{weld} = 2.5 \cdot in^{2}$$

$$P_{y.weld} := \frac{W_{recir}}{2}$$

$$M_{x.weld} := W_{recir} \cdot 11.5 \cdot in$$

$$f_{weld} := \sqrt{\left(\frac{P_{y.weld}}{A_{weld}}\right)^{2} + \left(\frac{M_{x.weld}}{S_{weld}} + \frac{F_{wind.recir}}{2 \cdot A_{weld}}\right)^{2}}$$

$$f_{weld} = 1.062 \cdot 10^{3} \cdot \frac{lbf}{in}$$

$$f_{electrode.allow} := 70000 \cdot \frac{lbf}{in^{2}} \cdot .3$$

$$Weld_{size} := \frac{f_{weld}}{.707 \cdot f_{electrode.allow}}$$

$Weld_{size} = 0.072 \cdot in$ < 3/16" ==> OK

Fluor Daniel Northwest

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DESIGN CALCULATION

Client	: Project W-320	WO/Job No			
Subject	: Recirculator skid evaluation	Date 3/28/97	By	N. D. Ha	NDH
Location	: 200 East Area	Checked 3-31-97	By	R. A. Giller	RAGiller
		Revised	By		

Weld between TS3x3 and 9"x9" plate

$$d_{weld} := 3\cdot in$$

$$b_{weld} := 3\cdot in$$

$$A_{weld} := \left(b_{weld} + d_{weld}\right)\cdot 2$$

$$S_{weld} = b_{weld}\cdot d_{weld} + \frac{d_{weld}^{\ 2}}{3}$$

$$S_{weld} = 12\cdot in^2$$

$$P_{y.weld} := \frac{W_{total.recir}}{3} + \frac{M_{tipping.recir}}{18\cdot in}$$

$$P_{x.weld} := \frac{F_{wind.recir}}{3}$$

$$f_{weld} := \sqrt{\left(\frac{P_{y.weld}}{A_{weld}}\right)^2 + \left(\frac{P_{x.weld}}{A_{weld}}\right)^2}$$

$$f_{weld} = 114.234\cdot\frac{lbf}{in}$$

$$Weld_{size} := \frac{f_{weld}}{.707\cdot f_{electrode.allow}}$$

$Weld_{size} = 0.008\cdot in$ < 3/16" ==> OK

Weld between platform and 9"x9" plate is adequate by comparison

Concrete slab 4.25ftx9ftx6in

The steel frame skid is supported by the concrete slab, assuming the loads are distrubuted uniformly on the skid rectangular frame. Therefore, we can use the wall loading on slab method to find the slab thickness.

$$ksi := 1000 \cdot \frac{lbf}{in^2}$$

Concrete slab thickness $t_{slab} := 6 \cdot in$

Section modulus of 12" strip concrete $SM := \frac{12 \cdot t_{slab}^{\ 2}}{6}$

Modulus of subgrade reaction $k := 300 \cdot \frac{lbf}{in^3}$

Modulus of elasticity of the concrete $E_c := 57000 \cdot \sqrt{f_c \cdot \left(\frac{lbf}{in^2}\right)^{.5}}$

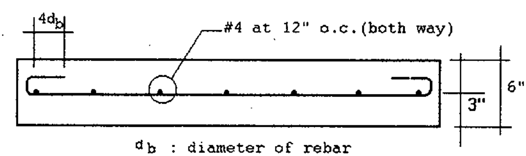
$$E_c = 3.122 \cdot 10^3 \cdot ksi$$

Slab stiffness $Stiffness := \frac{E_c \cdot t_{slab}^{\ 3}}{12 \cdot \left(1 - v^2\right)}$

Radius of relative stiffness $L := \left[\frac{E_c \cdot t_{slab}^{\ 3}}{12 \cdot \left(1 - v^2\right) \cdot k}\right]^{\frac{1}{4}}$ $L = 20.923 \cdot in$

With concrete compressive strength of 3000 psi, Subgrade modulus of 300 pci

Per table 5 reference 3 the wall loading allowable for 6" thick slab **is 1497 lbf/ft**



d_b : diameter of rebar

Hook bend radius is $4d_b$

Concrete slab

Fluor Daniel Northwest

DESIGN CALCULATION

Client	**: Project W-320**	**WO/Job No**			
Subject	**: Recirculator skid evaluation**	**Date** 3/28/97	**By**	**N. D. Ha**	NDHa
		Checked 3-31-97	**By**	**R. A. Giller**	RAGiller
Location	**: 200 East Area**	**Revised**	**By**		

Dimension of steel frame $L_{long} := 7 \cdot ft$

$L_{short} := 2.25 \cdot ft$

Load on frame $Wall_{load} := \dfrac{\dfrac{M_{tipping.recir}}{18 \cdot in} + P_{lift}}{2 \cdot L_{long} + 2 \cdot L_{short}}$

$Wall_{load} = 116.054 \cdot \dfrac{lbf}{ft}$ < Wall load allowable 1497 lbf/ft ==> OK

Shrinkage and temperature

Friction between slab and subgrade use 1.5 per AASHTO guide $\mu := 1.5$

Concrete self weight $W_{concrete} := \dfrac{w_{concrete} \cdot (1 \cdot 1 \cdot .5) \cdot ft^3}{ft^2}$

$W_{concrete} = 72.5 \cdot \dfrac{lbf}{ft^2}$

$L_{slab.long} := 7 \cdot ft$

Tensile force in lbf/ft width of slab $T := \dfrac{W_{concrete} \cdot \mu \cdot L_{slab.long}}{2}$

$T = 380.625 \cdot \dfrac{lbf}{ft}$

$A_s := \dfrac{T \cdot in}{f_{y.rebar}}$

$A_s = 5.286 \cdot 10^{-4} \cdot in^2$

$A_{s.min} := \dfrac{200 \cdot 12 \cdot in \cdot 6 \cdot in}{f_{y.rebar}}$ $A_s = 5.286 \cdot 10^{-4} \cdot in^2$

Use #4 at 12" o.c. each way or W4 wire mesh with 4" wire spacing. Places bars/wire mesh near top face of slab, minimum cover is 1 1/2" or at least 3" from the bottom of slab (minimum cover for concrete exposes to earth ACI 7.7)

FINAL:

Provide 4' x 8' x 6" thk slab (soil supported, non-structural)

As (provided) w/ due consideration to design forces > 1.33 As (req'd by analysis)
WWF 6x6 - W 2.9 x W 2.9 is adequate.

Calc # W-320-24-035
Revision 0
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Fluor Daniel Northwest

DESIGN CALCULATION

Client : Project W-320	WO/Job No			
Subject : Recirculator skid evaluation	Date 3/28/97	By	N. D. Ha	*NDHa*
	Checked 3-31-97	By	R. A. Giller	*RA Giller*
Location : 200 East Area	Revised	By		

Bearing pressure

$$L_{slab.short} := 4.25 \cdot ft$$

$$L_{slab.long} := 9 \cdot ft$$

$$A_{concrete} := L_{slab.short} \cdot L_{slab.long}$$

$$P_{bearing} := \frac{W_{total.recir}}{A_{concrete}} + \frac{M_{tipping.recir} \cdot \frac{L_{slab.short}}{2}}{L_{slab.short} \cdot ft^3}$$

$P_{bearing} = 890.398 \cdot \frac{lbf}{ft^2}$ < UBC (Table 18-I-A allowable pressure :1500 lbf/ft^2 ==>OK

Check anchor bolts (4 of 1/2" anchor bolt)

Because the tipping moment is greater than the deadweight moment, the steel frame need to be anchored to the concrete slab.

$$M_{dw.total.recir} := M_{dw.recir} + W_{slab} \cdot L_{recir.arm}$$

$M_{dw.total.recir} = 2.588 \cdot 10^4 \cdot in \cdot lbf$ > $M_{tipping.recir}$ ==> Bolts are needed

Force on Bolts

$$F_{bolt.tension} := \frac{M_{tipping.recir}}{18 \cdot in \cdot 2}$$

$$F_{bolt.tension} = 583.317 \cdot lbf$$

$$F_{bolt.shear} := \frac{F_{wind.recir}}{4}$$

$$F_{bolt.shear} = 107.75 \cdot lbf$$

1/2" Carbon Steel Kwik Bolt II allowable working load (3.5" embeded)

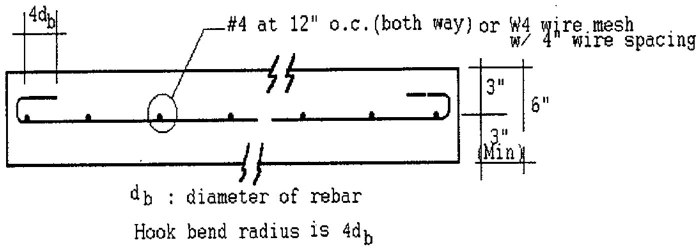
$$Bolt_{tension} := 2130 \cdot lbf$$

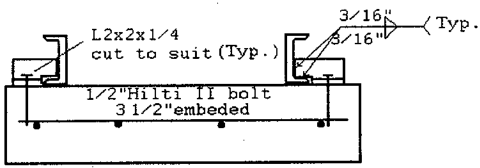
$$Bolt_{shear} := 1600 \cdot lbf$$

$$I := \frac{F_{bolt.shear}}{Bolt_{tension}} + \frac{F_{bolt.shear}}{Bolt_{shear}}$$

$I = 0.118$ < 1 ==> ok

Concrete slab detail





Concrete slab

W320-24-036

Exhaust Skid Platform Modification

Fluor Daniel Northwest	CALCULATION IDENTIFICATION AND INDEX	Page i of iii Date May 8, 1998

This sheet shows the status and description of the attached Design Analysis sheets.

Discipline Structural WO/Job No. ER4319/W-320 Calculation No. W320-24-036

Project No. & Name Project W-320, Tank 241-C-106 Sluicing

Calculation Item Exhaust Skid Platform Modification

These calculations apply to:

Dwg. No. H-2-818470 Rev. No.

Dwg. No. Rev. No.

Other (Study, CDR) Rev. No. N/A

The status of these calculations is:

[] Preliminary Calculations

[X] Final Calculations

[] Check Calculations (On Calculation Dated)

[] Void Calculation (Reason Voided)

Incorporated in Final Drawings? [X] Yes [] No

This calculation verified by independent "check" calculations? [] Yes [X] No

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	Ann S. Langevin 5/8/98 Ann S Langevin		
Checked by	[signature] 5/12/98		
Approved by	Ann S Langevin 5/12/98		
Checked Against Approved Vendor Data	NA		

INDEX

A-6002-143 (01/97) GEF410

CALCULATION CROSS INDEX (Typical)

Subject Calculation No. W320-24-036

Subject Calculation Revision No.	Superceded by Calculation No.	These interfacing calculation/documents provide input to the subject calculation, and if revised may require revision of the subject calculation.		Results and conclusions of the subject calculation are used in these interfacing calculations and/or documents.		Does the output interface calculation/ documents require revision?		Has the output interface calculation/ documents been revised?		Discipline manager's signature and date indicating evaluation complete.
		Calculation/Document No.	Revision No.	Calculation/Document No.	Revision No.	Yes	No	Yes	No	
0	—	—	—	ECN 647838	0	—	—	—	—	ASLangevin 5/12/98

KEH 1975.00 (12/88)

DESIGN VERIFICATION SCREENING CRITERIA

Project/Document No. Calculation W320-24-036

When the design or design change affects hardware, independent design verification must be performed if one or more of the following questions must be answered affirmatively (YES).

YES	NO	
	✓	1. Does the design or design change involved meet the established criteria to be considered Safety Class?
	✓	2. Does this design or design change cause or permit changes to Safety Class instrument or alarm setpoints outside of previously approved operational limits?
	✓	3. Does this design or design change significantly affect the nuclear or environmental safety consequences of a malfunction or failure of the structure, system, or component?
	✓	4. Does this design or design change involve or change design that has previously undergone formal design verification?

Ann S. Langevin — 5/12/98
Assigned Lead Engineer — Date

[illegible signature] — 5/13/98
Engineering Manager — Date

Original Design Package Distribution:

- Project Manager
- Engineering Manager
- Technical Document Control

Design Change Distribution:

- Attach to Design Change Notice

Fluor Daniel Northwest

Calc. No. W320-24-36
Revision 0
Page No. 1 of 15

DESIGN ANALYSIS

Client Numatec
Subject Exhaust Skid Platform Modification
Location 241-C

WO/Job No. W-320
Date 4/14/98
Checked 5/11/98
Revised

By A.S. Langevin ASL
By JGW
By

OBJECTIVE

Design an extension to the existing exterior platform for accessing the sample probe enclosures at the exhaust skid stack.

The original design provided access for the lower enclosure but did not provide access for the upper enclosure. Changes in the access frequency now necessitate the raising of the platform so that both enclosures are accessible.

DESIGN INPUTS

CRITERIA

The platform and the exhaust skid are General Services. Design the platform for the same criteria and referenced codes as given in the exhaust skid procurement spec W-320-P1. (see attachment A):

Snow Load: 20 psf

Wind Loads: per ASCE 7, Section 6, Wind speed = 70mph, I = 1.07, Exp Cat C

$$q_z = 0.00256\ K_z\ (IV)^2$$

$$= 0.00256\ (0.8\ \text{from table 6})\ (1.07\text{x}70)^2$$

$$= 11.49$$

$$p = q_z\ G_h\ C_f$$

$$= (11.49)\ (1.32\ \text{from table 8})\ (1.33\ \text{from table 12 for square with h/D = 3})$$

$$= 20\ \text{psf}$$

Seismic:
for the stack and other equipment as per P1 spec:
Fp = 0.375 Wp

for the platform, a nonbuilding structure, section 1632 of UBC applies:

$$V = Z\ I\ (C/R_w)\ W$$
$$= (0.2)\ (1.25)\ (0.4)\ W$$
$$= 0.1\ W$$

Live Load (includes snow load): 100 psf, (UBC Table 16-A pedestrian walkways)

Fluor Daniel Northwest		Calc. No. W320-24-36
		Revision 0
DESIGN ANALYSIS		Page No. 2 of 15
Client Numatec	WO/Job No. W-320	
Subject Exhaust Skid Platform Modification	Date 4/14/98	By A.S. Langevin ASL
	Checked 5/11/98	By TAW
Location 241-C	Revised	By

REFERENCES

1) W-320-P1 Procurement Specification Exhaust Skid Ventilation Air Cleanup Trains

2) W-320-P41 Procurement Specification Isokinetic Air Sampling System

3) FDNW Practice 134 215 5130 Miscellaneous Typical Steel Ladder and Safety Gate Details

4) Air Monitor Corporation Design Calculation Report for an Air Monitor Supplied Instrument & Isokinetic Control Cabinet and Stack Section (dated 12/20/95)

CODES AND STANDARDS

AISC Manual of Steel Construction, 9th Edition

Uniform Building Code 1994

ASCE 7-88, Minimum Design Loads for buildings and other structures

METHODS OF ANALYSIS

Hand Calculations for platform design. Used standard details of FDNW Practice 134 215 5130 for the design of the ladder and handrails.

ASSUMPTIONS/UNCERTAINTIES

The existing stack and support system, together with the exhaust skid platform, are structurally sound and capable of resisting current design loads in accordance with DOE 6430.1A and UBC requirements. Comprehensive structural analysis of the stack and exhaust skid platform, to ascertain their structural integrity, is not part of the scope of work and therefore not addressed in this ECN. Only cursory review and design check of the pertinent elements as required for interface purposes shall be performed.

The existing skid checkered plate receiving the probe enclosure's access platform support legs is assumed to be adequate requiring no additional reinforcement.

CONCLUSIONS

See ECN 647838 and these calculations.

FLUOR DANIEL NORTHWEST, INC.

DESIGN ANALYSIS

Calc. No. W320-24-036
Revision 0

Client	Numatec	WO/Job No.	W-320
Subject	Exhaust Skid Platform Mod	Date 4/29/98	By AHancour
		Checked 5/11/98	By JaWalle
Location	241-C	Revised	By

Determine Surface Areas and Wind Loads in Worst Case Direction:

WIND LOAD

Railing: $\frac{1.5''}{12}\left[(4' \times 2) + (3.5' \times 2)\right] = 1.88$

C5: $\left(\frac{5''}{12}\right)(4') = 1.67$

TS 3x2: & L3x3 $\left(\frac{3''}{12}\right)(4)(4') = 4.00$ — 2 legs, horiz L & crosspiece

C4: $\left(\frac{4''}{12}\right)(3)(6') = 6.00$

Toeboard: $\left(\frac{4''}{12}\right)(4') = 1.33$

Ladder: $\frac{3/8''}{12}(2)(12') + \frac{3/4''}{12}(1.5')(9) = 1.59$

Tubing Bundle $(1')(4') = 4.00$

Total Surface Area $= 20.47\ ft^2$

Platform Wind Load
$20.47\ ft^2\ (20\ psf) = 410\ lb.$
Wind Load

FLUOR DANIEL NORTHWEST, INC.

DESIGN ANALYSIS

Calc. No. W320-24-036
Revision 0
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Client Numatec
Subject Exhaust Skid Platform Mod
Location 241-C
WO/Job No. W-320
Date 4/29/98 By A. Langevin
Checked 5/11/98 By [signature]
Revised By

Determine Dead Loads and Seismic Loads:

SEISMIC LOAD

Ladder : $(3.19\ lb/ft)(12' \times 2) + (1.5\ lb/ft)(9 \times 1.5') = 98\ lb$

Railing: $(2.27\ lb/ft)[(9' \times 2)+(3.5' \times 6)] = 89\ lb$

Toeboard: $(3.4\ lb/ft)(14') = 47\ lb$

C5×6.7 : $(6.7\ lb/ft)(14') = 94\ lb$

Grating: (1" x 1/8" bearing bars) $(5.5\ psf)(3' \times 4') = 66\ lb$

TS 3×2×1/4 : $(7.11\ lb/ft)[\underbrace{(4' \times 4)}_{legs} + \underbrace{(3' \times 4)}_{cross\ pieces}] = 199\ lb$

C4×5.4 : $(5.4\ lb/ft)(6' \times 8) = 259\ lb$ (legs & crosspieces)

L3×3×1/4 : $(4.9\ lb/ft)(3 \times 4') = 58\ lb$

Conduit - assume $= 50\ lb$

TOTAL DL $= 960\ lb$

Platform Seismic $= (1.30)(0.1)(960) = 125\ lb$ Seismic

(Orthogonal affects see p. A3)

54-4300-037 KEH-0037.00 (06/92)

Client	Numatec	WO/Job No.	W-320
Subject	Exhaust Skid Platform Mod	Date 4/29/98	By AfLangevin
		Checked 5/11/98	By [illegible]
Location	241-C	Revised	By

Top Platform - Determine DL & LL

$$DL = \text{Railing} + \frac{\text{Ladder}}{2} + \text{Toeboard} + C5 + \text{Grating}$$

$$= 89 + \frac{98}{2} + 47 + 94 + 66$$

$$DL = 345 \text{ lb} \longrightarrow \frac{345}{3' \times 4'} = 28 \text{ psf}$$

$$LL = 100 \text{ psf}$$

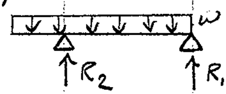
Allowable Uniform LL for 1" x 1/8" Grating = 305 psf (Irving Grating Catalog)

$$DL + LL = 128 \text{ psf}$$

$\boxed{\text{Use } 1" \times 1/8" \text{ Grating}}$

C5x6.7 : $128 \text{ psf} (1.5') \cong 200 \text{ lb/ft} = \omega$

$$M = \frac{\omega}{8l^2}(l+a)^2(l-a)^2 \quad (\text{AISC p. 2-304})$$



$$= \frac{200 \text{ lb/ft}}{8(3)^2}(3+1)^2(3-1)^2$$

$$= 178 \text{ ft-lb}$$

$$f_b = \frac{M}{S} = \frac{178(12)}{3.00 \text{ in}^3} = 712 \text{ psi} = 0.02 F_y$$

bending stresses very small $\therefore$ $\boxed{\text{Use C5} \times 6.7 \text{ to support grating}}$

Reactions at Supports

$$R_1 = \frac{\omega}{2l}(l^2 - a^2) = \frac{200}{6}(3^2 - 1^2) = 267 \text{ lb} \quad \text{Say } 270 \text{ lb}$$

$$R_2 = \frac{\omega}{2l}(l+a)^2 = \frac{200}{6}(3+1)^2 = 533 \text{ lb} \quad \text{Say } 540 \text{ lb.}$$

FLUOR DANIEL NORTHWEST, INC.

DESIGN ANALYSIS

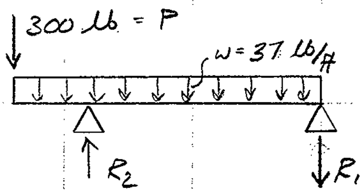
Client	Numatec	WO/Job No.	W-320
Subject	Exhaust Skid Platform Mod	Date 4/29/98	By ASLangevin
		Checked 5/11/98	By [illegible]
Location	241-C	Revised	By

If grating is fully loaded, reactions are both downward, so no uplift.

Check reactions due to concentrated load on cantilevered end - say 300 lb

$DL = (28 psf)(1.5)(0.9) = 37 \text{ lb/ft}$

reduce for conservatism



$$R_1 = \frac{w}{2l}(l^2 - a^2) - \frac{Pa}{l} \quad \text{(AISC p. 2-304, 2-305)}$$

$$= \frac{37}{2(3')}(3^2 - 1^2) - \frac{300(1')}{3'}$$

$$= 49 - 100$$

$$= -51 \text{ lb}$$

Use uplift load in design of connection (see page 15)

Determine R_2 due to DL alone

$$R_2 = \frac{w}{2l}(l+a)^2 = \frac{37}{2(3')}(4')^2 = 99 \text{ lb.}$$

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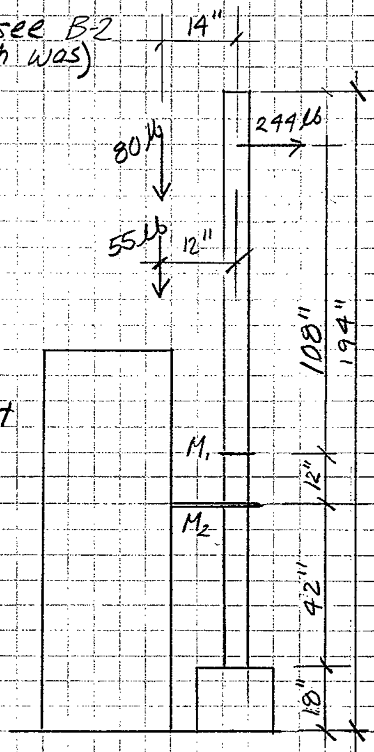
DESIGN ANALYSIS

Client: Numatec — WO/Job No. W-320
Subject: Exhaust Skid Platform Mod — Date 5/7/98 By aAkanaeuvin
Checked 5/11/98 By [signature]
Location: 241-C — Revised — By

Seismic - For stack load see B-2 (conservative - stack length was reduced by ECN 368)



Seismic Left to Rt

Moment @ Int flange

$M_1 = 244 \times 108'' - (80 \times 14 + 55 \times 12)$

$= 26{,}352 - 1780$

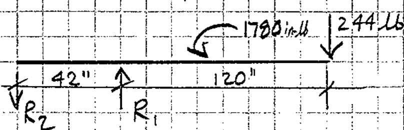
$= 24572$ in-lb

Moment at exst lateral support

$M_2 = 24{,}572 + 244 \times 12$

$= 27500$ in-lb

Assume stack support at top of steel plate box



$R_1 = \dfrac{244 \times 162''}{42''} - \dfrac{1780}{42} = 899$ lb

$R_2 = 655$ lb

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FLUOR DANIEL NORTHWEST, INC.

Calc. No. W320-24-030
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DESIGN ANALYSIS

Client Numatec | WO/Job No. W-320
Subject Exhaust Skid Platform Mod | Date 5/7/98 By [signature]
Checked 5/11/98 By [signature]
Location 241-C | Revised By

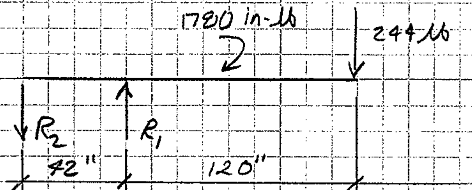
Seismic Right to Left

$M_1 = 244 \times 108 + 80 \times 14 + 55 \times 12$

$= 28132$ in-lb

$M_2 = 28132 + 244 \times 12$

$= 31060$ lb



$R_1 = \dfrac{244 \times 162''}{42''} + \dfrac{1780}{42} = 983$ lb

$R_2 = 739$ lb

CHECK STACK DEFLECTION DUE TO SEISMIC

Stack deflection due to 244 lb alone (deflection due to 1780 in-lb moment will be small)

$\Delta = \dfrac{P \cdot a^2}{3EI}(l + a) = \dfrac{244\text{ lb}\,(120'')^2}{3(29 \times 10^6)(10.18)}(162) = 0.642''$

deflection at top of stack - OK

$I = \pi R^3 t = \pi (3'')^3 (0.12'') = 10.18\ in^3$

assume 11 ga wall

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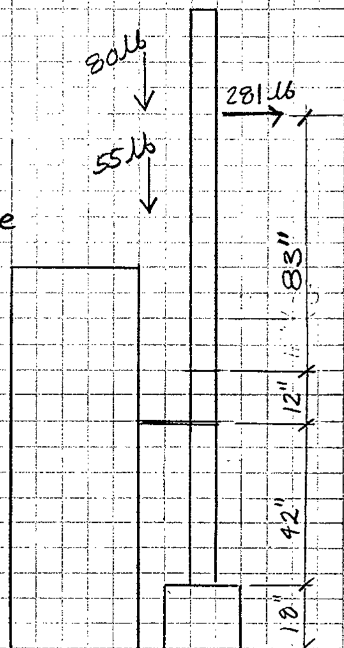
FLUOR DANIEL NORTHWEST, INC.

DESIGN ANALYSIS

Client	Numatec	WO/Job No.	W-320
Subject	Exhaust Skid Platform Mod	Date 5/7/98	By ASLangevin
		Checked 5/11/98	By [illegible]
Location	241-C	Revised	By

Calc. No. W320-24-03
Revision 0

WIND – For stack load see p. B-1



Wind Left to Right

$\Sigma F_w = 281.3$ lb

$\Sigma M = 23{,}386$ in-lb

$\frac{\Sigma M}{\Sigma F_w} = \bar{Y} = \frac{23386}{281.3} = 83$ in above int. flange

$M_1 = 281 \times 83 - (80 \times 14 + 55 \times 12)$

$= 23{,}323 - 1780 = 21{,}543$ in-lb

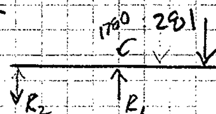
$M_2 = 21{,}543 + 281 \times 12$

$= 24{,}915$ in-lb

$R_1 = \frac{281 \times 137}{42"} - \frac{1780}{42}$

$R_1 = 874$ lb

$R_2 = 593$ lb



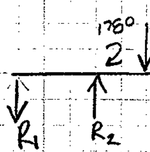
Wind Right to Left

$M_1 = 23{,}323 + 1780 = 25{,}103$ in-lb

$M_2 = 25{,}103 + 281 \times 12 = 28{,}475$ in-lb

$R_1 = \frac{281 \times 137"}{42"} + \frac{1780}{42} = 959$ lb

$R_2 = 678$ lb.



FLUOR DANIEL NORTHWEST, INC.

DESIGN ANALYSIS

Calc. No. W320-24-030
Revision 0
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Client	Numatec	WO/Job No.	W-320		
Subject	Exhaust Skid Platform Mod	Date	5/7/98	By	[illegible]
		Checked	5/11/98	By	[illegible]
Location	241-C	Revised		By	

TOTAL LOADS DUE TO PLATFORM AND STACK REACTION @ R_1

Wind = 410 lb + 959 lb = 1369 lb

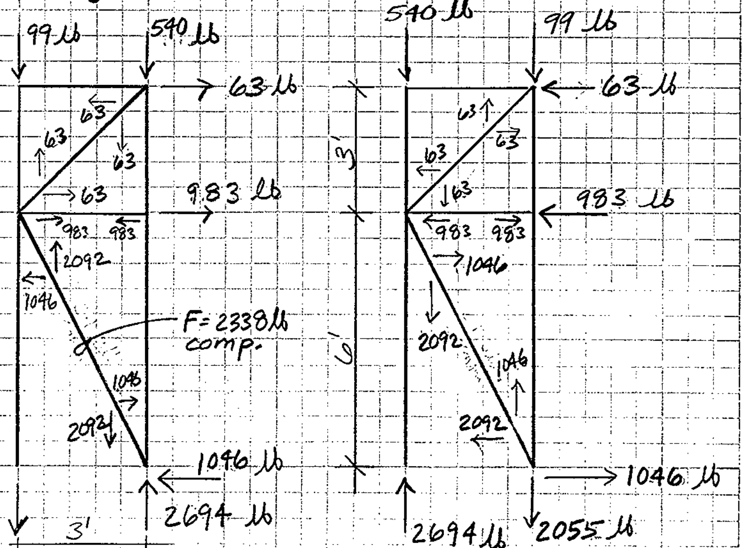
Seismic = 125 lb + 983 lb = 1108 lb

∴ Wind Controls, but look at both.

CASE I SEISMIC

Assume all stack seismic taken by one frame that is at edge of skid and closest to stack

NOTE
99 lb = DL alone
540 lb = full DL+LL
125/2 = full platform seismic conserv to apply at top
= 63



FLUOR DANIEL NORTHWEST, INC.

DESIGN ANALYSIS

Calc. No. W320-24-036
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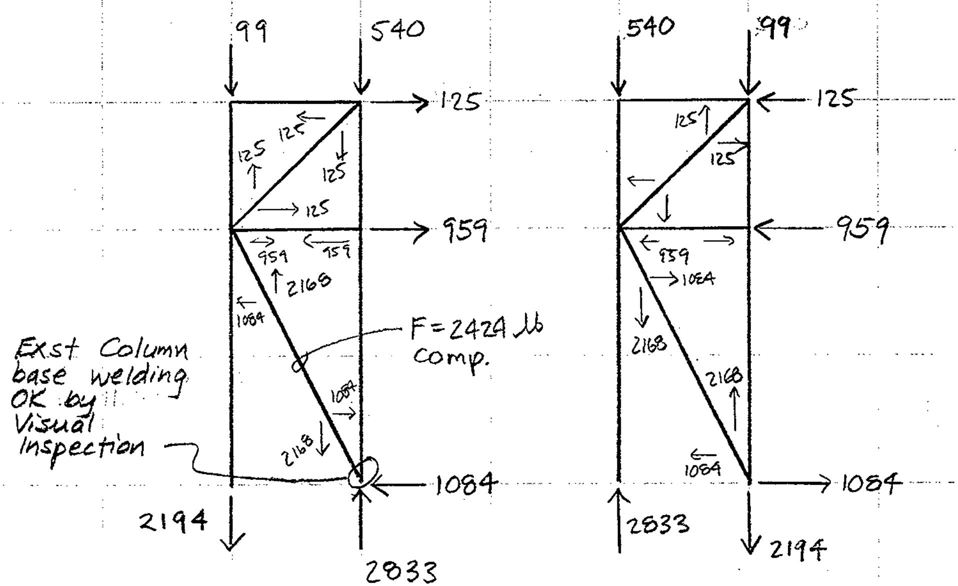
Client	Numatec	WO/Job No.	W-320
Subject	Exhaust Skid Platform Mod	Date 5/8/98	By A. Kangum
		Checked 5/11/98	By [illegible]
Location	241-C	Revised	By

CASE II - WIND

Assume all stack wind load taken by one frame that is at edge of skid and closest to stack.

Apply platform wind load at top of platform. This is conservative, since load would be at mid height so reduce by using factor of 0.6

$$\frac{410\ lb}{2\ frames}(0.6) = 125\ lb$$



FLUOR DANIEL NORTHWEST, INC.

DESIGN ANALYSIS

Calc. No. W320-24-03
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Client Numatec | WO/Job No. W-320
Subject Exhaust Skid Platform Mod | Date 4/29/98 By A Shangerm
Checked 5/11/98 By RJWaller
Location 241-C | Revised By

FRAME MEMBERS

Worst case axial load:

2833 lb compression with $l = 8.25'$

Look at C4×5.4
Existing member

The TS 3×2 is stiffer when comparing the weakest direction.

Add in Dead Load of lower frame and ladder

$$2833 \text{ lb} + \frac{199+259+58}{4 \text{ legs}} = 2962 \text{ — Say } 3010 \text{ lb}$$

$$f_a = \frac{3010 \text{ lb}}{1.59 \text{ in}^2} = 1893 \text{ psi} = 0.05 F_y$$

Determine F_a:

$$\frac{b}{t} = \frac{1.584}{0.296} = 5.35 < \frac{65}{\sqrt{F_y}} = 10.8$$ ∴ Compact Section per AISC Table B5.1

$$\frac{Kl}{r} = \frac{1.0(8.25' \times 12)}{0.449} = 220 > C_c = 126$$ → Exceeds 200 per AISC B7. Use Eq. E2-2

$$F_a = \frac{12\pi^2 E}{23(Kl/r)^2} = \frac{12\pi^2(29\times10^6)}{23(220)^2} = 3085 \text{ psi} > f_a = 1893 \text{ psi}$$

$$\boxed{\text{Frame Members C4×5.4 \& TS 3×2×1/4 OK}}$$

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FLUOR DANIEL NORTHWEST, INC.

DESIGN ANALYSIS

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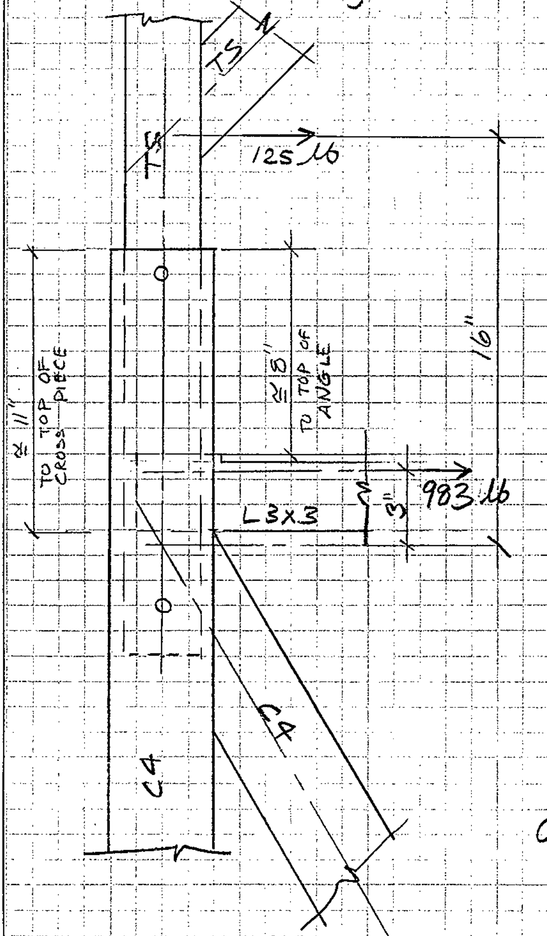
Client Numatec | WO/Job No. W-320
Subject Exhaust Skid Platform Mod. | Date 5/7/98 By JSLangevin
Checked 5/11/98 By [signature]
Location 241-C | Revised By

FRAME MEMBERS NOT COCENTRIC
LOOK at bending of C4x5.4 combined with axial



$M_b = 125\,lb(16) + 983(3)$
$= 4949$ in-lb

$f_b = \frac{M}{S} = \frac{4949}{1.93}$
$= 2564$ psi

$F_b = \frac{12\times10^3 C_b}{ld/A_f} = \frac{12\times10^3}{(8.25\times12)(8.52)}$ (Eq F1-8)

$= 14.2$ ksi

$\frac{f_a}{F_a} + \frac{C_m f_b}{\left(1-\frac{f_a}{F'_e}\right)F_b}$ (Eq H1-1)

$= \frac{1893}{3085} + \frac{2564}{\left(1-\frac{1893}{3085}\right)14{,}200}$

$= 1.08 \cong 1.0$ OK
(conserv — did not include 1/3 increase for EQ)

$\frac{f_a}{0.6F_y} + \frac{f_b}{F_b} = \frac{1893}{0.6(36{,}000)} + \frac{2564}{14{,}200}$
(Eq. H1-2)

$= 0.26 < 1.0$ OK

FLUOR DANIEL NORTHWEST, INC.

Calc. No. W320-24-03[illegible]
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DESIGN ANALYSIS

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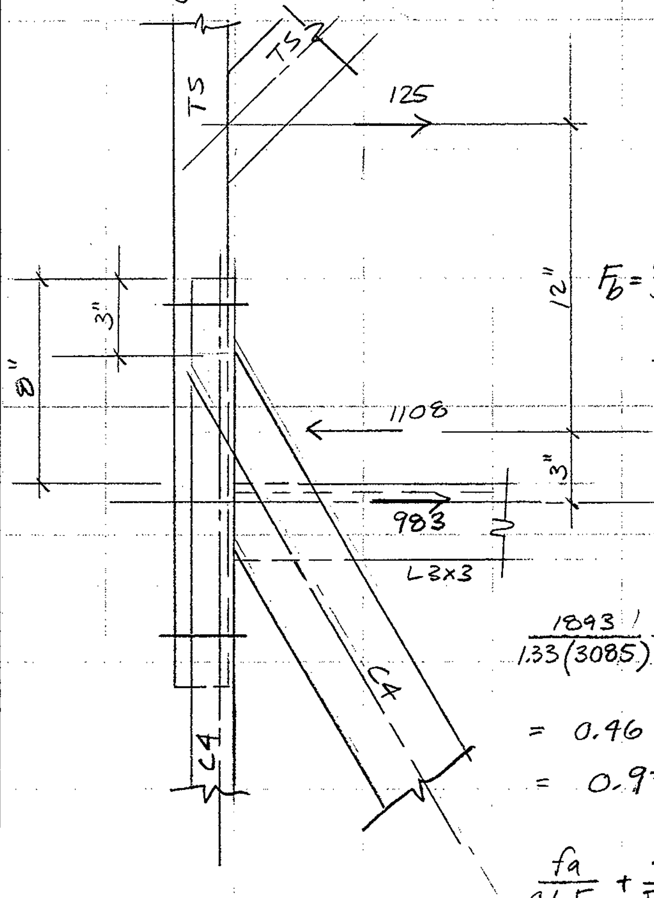
Subject	Exhaust Skid Platform Mod	Date 5/7/98	By [signature]
		Checked 5/11/98	By [signature]
Location	241-C	Revised	By

Look at bending in weak axis direction
Loading in this direction similar to other directio[n]



$$M_b = 125(12) - 983(3)$$
$$= -1449 \text{ in-lb}$$

$$f_b = \frac{M}{S} = \frac{1449}{0.283}$$
$$f_b = 5120 \text{ psi}$$

$$F_b = \frac{12\times10^3 C_b}{ld/A_f} = \frac{1000}{8.5(8.52)} = 13.8$$
(F1-3)

$$\frac{f_a}{F_a} + \frac{C_m f_b}{\left(1-\frac{f_a}{F'_e}\right)F_b}$$

(Include allowable 1/3 increase in stress due to seismic)

$$\frac{1893}{1.33(3085)} + \frac{5120}{\left(1-\frac{1893}{1.33(3085)}\right)(1.33\times 13{,}80\ldots)}$$

$$= 0.46 + 0.518$$

$$= 0.978 < 1.0 \quad \text{OK}$$

$$\frac{f_a}{0.6F_y} + \frac{f_b}{F_b} = \frac{1893}{1.33(36{,}000)(0.6)} + \frac{5120}{1.33(13{,}8\ldots)}$$
$$= 0.34 < 1.0 \text{ OK}$$

$\boxed{\text{C4x5.4 OK for bending due to eccentricity}}$

54-4300-037 KEH-0037.00 (06/92)

FLUOR DANIEL NORTHWEST, INC.

DESIGN ANALYSIS

Calc. No. W320-24-036
Revision 0
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Client	Numatec	WO/Job No.	W-320
Subject	Exhaust Skid Platform Mod	Date 4/29/98	By [signature]
		Checked 5/11/98	By [signature]
Location	241-C	Revised	By

CONNECTIONS

Platform C5x6.7 to TS 3x2x1/4:

Shear (due to wind) $\frac{125 \text{ lb}}{2 \text{ bolts}} = 63 \text{ lb/bolt}$

Tension (due to uplift) $\frac{41 \text{ lb}}{2 \text{ bolts}} = 21 \text{ lb/bolt}$

Loads are very small ∴ Use (2) 1/2"Φ A307 bolts for connection of C5x6.7 to TS 3x2

Platform Leg Splice

TS 3x2x1/4 to exst C4x5.4

Shear due to axial load:

$V_1 = \frac{2833 \text{ lb}}{2 \text{ bolts}} = 1440 \text{ lb/bolt} < V_a = 3.1 \text{ k}$ (AISC Table I-D)

Use (2) 5/8"Φ A307 bolts at connection of TS 3x2x1/4 to C4x5.4

2.3.3 Air Movement and Control Association (AMCA)

99-83 Revised 1986	Standards Handbook
210-85	Laboratory Methods of Testing Fans for Rating Purposes

2.3.4 American National Standards Institute (ANSI)

S2.19-1989	Mechanical Vibration - Balance Quality Requirement of Rigid Motors, Part 1, Determination of Residual Unbalance

2.3.5 American Society of Civil Engineers Standards (ASCE)

ASCE 7-88	Minimum Design Loads For Buildings and Other Structures

2.3.6 American Society of Mechanical Engineers (ASME)

AG-1-1991	Code on Nuclear Air and Gas Treatment
B16.5-1988	Pipe Flanges and Flanged Fittings
N509-1989	Nuclear Power Plant Air-Cleaning Units and Components
N510-1989	Testing of Nuclear Air-Cleaning Systems
NQA-1-1994	Quality Assurance Program Requirements for Nuclear Facilities

2.3.7 American Society for Nondestructive Testing (ASNT)

SNT-TC-1A	Recommended Practice (Dec 1988 Edition)

2.3.8 American Society of Testing and Materials (ASTM)

A 36-91	Structural Steel
A 193-91a	Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service
A 194-91	Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service
A 240-91a	Heat-Resisting Chromium and Chromium-Nickel Stainless Plate, Sheet and Strip for Pressure Vessels
A 325-92a	High-Strength Bolts for Structural Steel Joints
A 563-92a	Carbon and Alloy Steel Nuts

	A 786-89	Rolled Steel Floor Plates
	F 436-92	Hardened Steel Washers
2.3.9	American Welding Society (AWS)	
	D1.1-92	Structural Welding Code-Steel
	D9.1-90	Sheet Metal Welding Code
2.3.10	Federal Specifications (FS)	
	RR-G-661	Grating, Metal, Bar Type (Floor, Except For Naval Vessels)
2.3.11	International Conference of Building Officials (ICBO)	
	UBC	Uniform Building Code (1994)
2.3.12	Institute of Electrical and Electronics Engineers (IEEE)	
	519-1992	Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems
2.3.13	Instrument Society of America (ISA)	
	S5.1-1984 (1992)	Instrumentation Symbols and Identification
2.3.14	National Electrical Manufacturers Association (NEMA)	
	250-1991	Enclosures for Electrical Equipment
	ICS 6-1993	Enclosures for Industrial Controls and Systems
	MG 1-1993	Motors and Generators
2.3.15	National Fire Protection Association (NFPA)	
	70 (1993)	National Electrical Code (NEC)
2.3.16	Underwriters Laboratories (UL)	
	Electrical Appliance and Utilization Equipment Directory	1994
2.3.17	Washington Administrative Code (WAC)	
	Title 29	Department of Labor and Industries
	Chapter 296-24	General Safety and Health Standards

3.2 Environmental Conditions: The Air Cleanup Train will be located outside at an elevation of 700 feet above sea level. Equipment must operate without failure at ambient conditions of -20 to 115°F, and 0 to 100% relative humidity, in rain, sleet, snow, extreme blowing dust, and intense solar radiation.

3.3 Structural Criteria

3.3.1 Structural steel supports and components shall be fabricated in accordance with the AISC ASD, S329 and S335, and the ICBO UBC.

3.3.1.1 The skid shall have a heavy duty, structural steel base that provides structural integrity for the entire ACT system assembly. The arrangement of longitudinal and cross beams shall provide the required strength and stiffness for the base, and support for equipment installed.

3.3.1.2 Deflection of the entire base shall be minimized so as not to cause damage to container elements or equipment installed. Base construction shall take into account loads imposed on the structure during seismic, lifting, shipping, etc. Permanent deformations to the base shall not impair performance of the structure.

3.3.1.3 Lifting attachments for the skid shall be engineered with a safety factor of 5. The manufacturers' name or identification mark shall be forged in raised letters on the lifting attachment. Include any special instructions needed for a safe lift along with manufacturers' data on lifting attachment.

3.3.1.4 The base shall be constructed and detailed for attachment to a concrete pad. Anchorage locations shall be provided.

3.3.1.5 The base and stack support shall be fabricated to handle static and dynamic loads imposed by the Buyer provided 14-foot long upper stack and rain cap assembly. The Buyer provided upper stack section shall be subjected to the loading stated in 3.3.2 and shall transmit those loads to the Seller's lower stack section. Thus, the lower stack section shall be fabricated to support the loads imposed by the upper section. See Sketch ES-1.

3.3.2 Structural Loads: Loads shall include live, dead, wind, snow, sleet, and seismic loads, including normal, operating loads. Other loads, either static or dynamic shall be considered auxiliary loads. Equipment function shall be maintained during load conditions.

3.3.2.1 Wind loads: Loads shall be in accordance with ASCE 7, Section 6, with wind assumed to come from any horizontal direction. Fabrication of the structure and components shall be based on the following:

a. Basic wind speed: 70 mi/h.

b. Importance factor: I = 1.07.

c. Exposure category: C.

3.3.2.2 Snow loads: In accordance with ASCE 7, Section 7. Use 20 lb/ft^2.

3.3.2.3 Seismic loads: Seismic loads shall be in accordance with the ICBO UBC, Sections 2336 and 2337 (Zone 2B), where Fp = 0.375 Wp.

a. The lateral force, Fp shall be distributed in proportion to the mass distribution of the element or component. The distributed forces shall be applied so that the most critical loadings result. These loadings shall be used in the fabrication of the elements or components and anchorages.

b. Orthogonal effects, as described in the ICBO UBC, shall be satisfied by designing such elements for 100% of the seismic forces in one horizontal direction plus 30% of the seismic forces in the perpendicular horizontal direction.

3.4 Material

3.4.1 Materials shall be new, and conform to a national standard such as ASTM or ASME. Pressure boundary material shall be in accordance with ASME N509, Sections 5.6 and 5.10, as applicable.

3.4.1.1 Structural steel shapes, plate, and bars: ASTM A 36.

3.4.1.2 Stainless steel sheet: ASTM A 240.

3.4.1.3 Floor plate for skid base: ASTM A 786, using ASTM A 36 material. Diamond Tread.

3.4.1.4 Bolts: ASTM A 325, Type 1 or 2, plain (noncoated), or ASTM A 193, as applicable.

3.4.1.5 Nuts: ASTM A 563, Grade C, or ASTM A 194, Grade 8F, plain, heavy hex, as applicable.

3.4.1.6 Washers: ASTM F 436, circular.

3.4.1.7 Metal Grating: FS RR-G-661, Type I, Class 1, Material S, hot-dip galvanized. Grating shall be plain surface type with end banding bars. Provide manufacturer's standard clips for attachment to framing.

3.4.2 Pressure boundary materials in contact with the air stream shall be 300 series stainless steel unless noted otherwise in this Specification.

3.4.3 Tape and adhesives leachable chloride content shall not exceed 15 ppm, and leachable fluoride content 10 ppm; 3M Company preservation sealing tape No. 481, 9 mil thick, or Kendall Company Polyken Division No. 226. In addition, materials which contact stainless steel during fabrication and shipping shall not exceed these limits.

3.5 Fabrication and Assembly

3.5.1 Base Construction: The base shall be constructed from fabricated hot or cold rolled or cold formed steel shapes, welded on suitable jigs or alignment beds. Welding shall be in accordance with AWS D1.1.

DESIGN CALCULATION WORKSHEET

Project: WHC W320-P41 W.O. No: 25255

Contract No: P.O. 80166

3.2 CON'T CALCULATE WIND LOADS (STACK SECTION)

WIND LOAD IN "X" DIRECTION

ITEM	$G_H \cdot q_z$ (lbf/ft²)	C_f	A_p (ft²)	F_w (lbf)	$\bar{Y}$ (IN)	M_w (IN-lb)
TOP ENCLOSURE	17.3	1.2	1.67	34.7	112"	3,886
LOWER ENCLOSURE	17.3	1.2	1.39	28.6	80"	2,288
6" STACK W/1" INSULATION	17.3	1.2	5.56	115.4	72"	8,309
			Σ = 8.6	Σ = 178.7		Σ = 14,483

WIND LOAD IN "Z" DIRECTION

ITEM	$G_H \cdot q_z$ (lbf/ft²)	C_f	A_p (ft²)	F_w (lbf)	Y (IN)	M_w (IN-lb)
TOP ENCLOSURE	17.3	1.2	3.33	69.1	112"	7,739
LOWER ENCLOSURE	17.3	1.2	2.22	46.1	80"	3,688
6" STACK W/1" INSULATION	17.3	1.2	8.0	166.1	72"	11,959
			Σ = 13.6	$\boxed{\Sigma = 281.3}$ ←		Σ = 23,386 TOTAL MOMENT AT STACK BASE

FIND VERTICAL CENTROID OF WIND FORCE ACTION

$$\bar{Y}_{x\,TOTAL} = \frac{\Sigma A_i Y_i}{\Sigma A_i} = \frac{(1.67)(122)+(1.39)(80)+(5.56)(72")}{8.6} = \bar{Y}_x = 83 \text{ IN ABOVE FLANGE}$$

$$Y_{z\,TOTAL} = \frac{\Sigma A_{zi} Y_i}{\Sigma A_{zi}} = \frac{(3.33)(112)+(2.22)(80)+(8.0)(72)}{13.6} = \bar{Y}_z = 83 \text{ IN ABOVE FLANGE}$$

THEREFORE USE $\bar{Y} = 83"$

Prepared By: Scott Munidin Title: MECH. ENGR. Date: 11-7-95

Verified By: Paresh Dave Title: Mech. Appl. Engr. Date: 11-18-95

Air Monitor Corporation

DESIGN CALCULATION WORKSHEET

Project: WHC W320-P41 | W.O. No: 25255

Contract No: P.O. 80166

5.0 SEISMIC FORCES ON STACK COMPONENTS

ASSEMBLED STACK WEIGHT ≈ 500 lb = W_p

$F_p = 0.375 W_p$ (FROM SPEC. SECTION 3.3.1.4)

$F_p = 0.375(500\text{ lb}) \Rightarrow F_p = 188\text{ lb}$

SEISMIC FORCE $F_s = 188\text{ lb} + 0.3(188\text{ lb}) \Rightarrow \boxed{F_s = 244\text{ lb}}$

TOTAL FORCE F_T = SEISMIC + DEADWEIGHT $\Rightarrow F_T = 500\text{ lb} + 244\text{ lb}$

$\Rightarrow F_T = 744\text{ lbs}$

THE ENTIRE LOAD WILL BE DISTRIBUTED OVER THE 6" 150 lb FLANGES 8 - 3/4" ASTM A-325 HEX HEAD HIGH STRENGTH CAP SCREWS. SHEAR + TENSILE STRESSES WILL BE CALCULATED BASED ON THE APPLIED LOAD PER BOLT. $F_T = 744\text{ lb}/8\text{ BOLTS} \Rightarrow F = 93\text{ lb/bolt}$

5.1 CALCULATE SHEAR PER BOLT

SHEAR AREA $(A_s) = \frac{\pi(O.D.)^2}{4} = \frac{\pi(.75)^2}{4} \Rightarrow A_s = .4418\text{ in}^2$

YIELD STRENGTH OF BOLT = 92 Kpsi (REF 1 PG 8-30)

SAFETY FACTOR = 3 (FROM SPEC SEC 3.3.1.1)

ALLOWABLE LOAD = $\frac{92\text{ Kpsi}}{3} \Rightarrow \sigma_a = 30.6\text{ Kpsi}$

ALLOWABLE SHEAR = $0.5\,\sigma_a \Rightarrow \tau_a = 15.3\text{ Kpsi}$

$\tau = \frac{F}{A_s} \Rightarrow \frac{93\text{ lb}}{.4418\text{ in}^2} \Rightarrow \tau = 210\text{ lb/in}^2 \ll 15.3\text{ Kpsi} \Rightarrow S.F. = 73$

Prepared By: Scott Minahan | Title: MECH ENGR | Date: 12-20-95

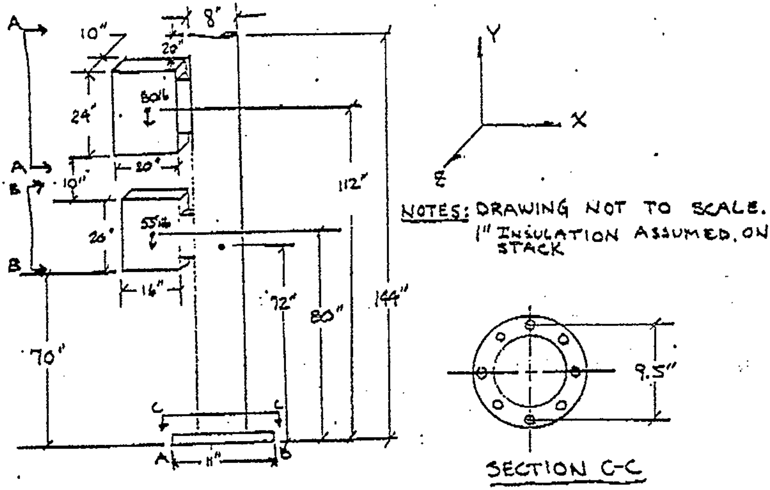
Verified By: Paresh Dave | Title: Mgr. Appl. Engrg | Date: 12-20-95

DESIGN CALCULATION WORKSHEET

Project: WHC W320-P41 W.O. No: 25255

Contract No: P.O. 80166

3.2 CALCULATE WIND LOAD (STACK SECTION)



NOTES: DRAWING NOT TO SCALE.
1" INSULATION ASSUMED ON STACK

PROJECTED AREAS:

$A_{P_X} = 8''(20''+10''+70'') + (24''\times10'') + (20''\times10'') \Rightarrow 1240\,in^2 = 8.6\ FT^2$

$A_{P_Z} = 8''(144'') + (24''\times20'') + (20''\times16'') \Rightarrow 1952\,in^2 = 13.6\ FT^2$

C_f TO BE CALCULATED ON A COMPONENT BASIS

FOR TOP ENCLOSURE $\frac{H}{1X} = \frac{HEIGHT}{WIDTH} = \frac{24''}{10''} = 2.4 < 3 \Rightarrow C_{f_{1X}} = 1.2$

$\frac{H}{1Z} = \frac{24''}{20''} = 1.2 < 3 \Rightarrow C_{f_{1Z}} = 1.2$

Prepared By: Scott Menaker Title: MECH. ENGR. Date: 11/7/95

Verified By: Paresh Dave Title: MGR. APPL. ENGRG. Date: 11-16-95

P.O. BOX 321188
BIRMINGHAM, AL 35232-1188
(205) 592-8981

CERTIFIED TEST REPORT

The following tests conform to the requirements of the specifications listed.

Rec# 172384
Line # 100
Job K0701

WE HEREBY CERTIFY THAT THE FOLLOWING DATA IS A TRUE COPY FROM TESTS PERFORMED IN OUR LABORATORY.

Trish Lauer
TRISH LAUER
QUALITY CONTROL MANAGER

1/ 4

A.H. C

W320-24-036

SHIP NO	S97611
BOL NO	B46915
CUST PO	P51116TL008
INV NO	V126768
INV DATE	01/03/96

S 297750
O RIVERFRONT STEEL
L P.O. BOX 14149A
D CINCINNATI, OH
T USA 452500149
O

S RIVR
H RIVERFRONT STEEL
I 884 MEHRING WAY
P CINCINNATI OH
T USA 45203
O

HEAT NO.	SECTION		SPECIFICATION	T #	YIELD PSI	TENSILE PSI	ELONG %	ELONG IN	R.A. %	BEND TST DIAM	BEND TST RSL	DATE ROLLED
952739	L 3X3X1/4	20	ASTM A36-93a	1	51500	72500	33.0	8				061195
				2	51000	72000	33.0					
953741	C 4X5.4	20	ASTM A36-93a	1	49700	70000	27.0	8				090395
				2	49500	71000	28.0					
953742	C 4X5.4	20	ASTM A36-93a	1	50500	70500	30.0	8				090395
				2	50500	70500	28.0					
956458	W 8X13.0	45	ASTM A36-93/A572-93-50	1	53000	72500	28.0	8				010296
				2	52500	72500	28.0					
956468	W 8X13.0	50	ASTM A36-93/A572-93-50	1	56000	75500	28.0	8				010296
				2	56000	76000	28.0					
956472	W 8X13.0	50	ASTM A36-93/A572-93-50	1	57000	76500	26.0	8				010296
				2	55500	75500	26.0					

C-1

HEAT NO.	C	MN	P	S	SI	CU	CR	NI	MO	CB	V	AL	CE	SN	BHN	CHARPY V-NOTCH IMPACT RESULTS SIZE (MM)	TEMP.	FT.-LBS.	FT.-LBS.	FT.-LBS.
952739	.14	0.74	.012	.039	.20	.39	0.07	0.15	.041	.000	.0000	.000	.32	.016						
953741	.13	0.69	.008	.036	.21	.45	0.09	0.18	.053	.001	.0000	.000	.31	.013						
953742	.13	0.62	.007	.022	.20	.48	0.08	0.15	.046	.000	.0000	.000	.30	.014						
956458	.15	0.81	.007	.026	.15	.21	0.04	0.09	.020	.000	.0200	.001	.32							
956468	.16	0.86	.008	.032	.23	.35	0.06	0.12	.040	.001	.0190	.002	.35							
956472	.15	0.81	.009	.019	.22	.31	0.08	0.12	.040	.000	.0200	.002	.34							

Approved E & W QA
Name 2-19-96 date

REMARKS: 100% MELTED AND MANUFACTURED IN THE USA AND FREE FROM MERCURY CONTAMINATION IN THE PROCESS

7

W320-24-037

Elec. Equip. Rack Check Calculations

FLUOR DANIEL NORTHWEST

CALCULATION SHEET

Calc. No. W-320-24-037
Revision 0
Page No. 1 of 8

Client	Numatec Hanford Corporation	Contract/Job No.	W-320-98-005 (NHC-9853435)
Subject	W-320 Tank 241-C-106 Sluicing	Originated By	L.A. VALLE LAV Date 6/23/98
	Elec. Equip. Rack Check Calculations	Checked By	W.J. MAGRUDER WJM Date 6/23/98
Location	241-AY/200E	Revised By	Date

Executive Summary: The Tank Waste Remediation System (TWRS) Initial Tank Retrieval System (ITRS) will provide feed for processing plants, dispose of processed waste, consolidate solid tank waste, and provide for mixing of waste types. This process will backup space available and support the close down of other facilities and remediation of the Hanford Site.

Objective: 1) Provide check calculations to verify the structural adequacy of the existing AY-102 Electrical Equipment Rack, FIT-0622 and its foundation.

2) Provide design and sketches to reinforce the rack and/or its foundation, as required to mount - the new electrical equipment FIT-0622.

Design Criteria:

1) DOE Order 6430.1A and UCRL-15910, Design and Evaluation Guidelines for the Design of DOE Facilities
2) Uniform Building Code (ICBO) 1994
3) ASCE 7-95 Minimum Design Loads for Buildings and other Structures
4) Manual of Steel Construction (ASC) 9th Edition
5) GC-LOAD-01, Rev.1, Design Loads for Facilities
6) Safety Class: The support system subject of these calculations is classified as Safety Class 3.

References:

1) EDT 604381 "Structural Evaluation of Electrical Equipment Rack of the Annulus Ventilation System", dated 1/18/96
2) ECN No. 647828 showing additional elec. equip to be supported by the exst. rack AY-102, FIT 0622
3) UNISTRUT and Hilti Kwik Bolt II catalog information

Conclusions:

1) Check calculations indicate that the existing electrical equipment rack system is adequate to support the electrical equipment required to support the replacement of Tank AY-102 Annulus Air Flow monitoring instruments.

2) Analysis also indicates that one of the existing footings requires modification to satisfy Natural phenomena hazards code requirements. See pages 19 & 20 of ECN 647828 for reqiuired modifications.

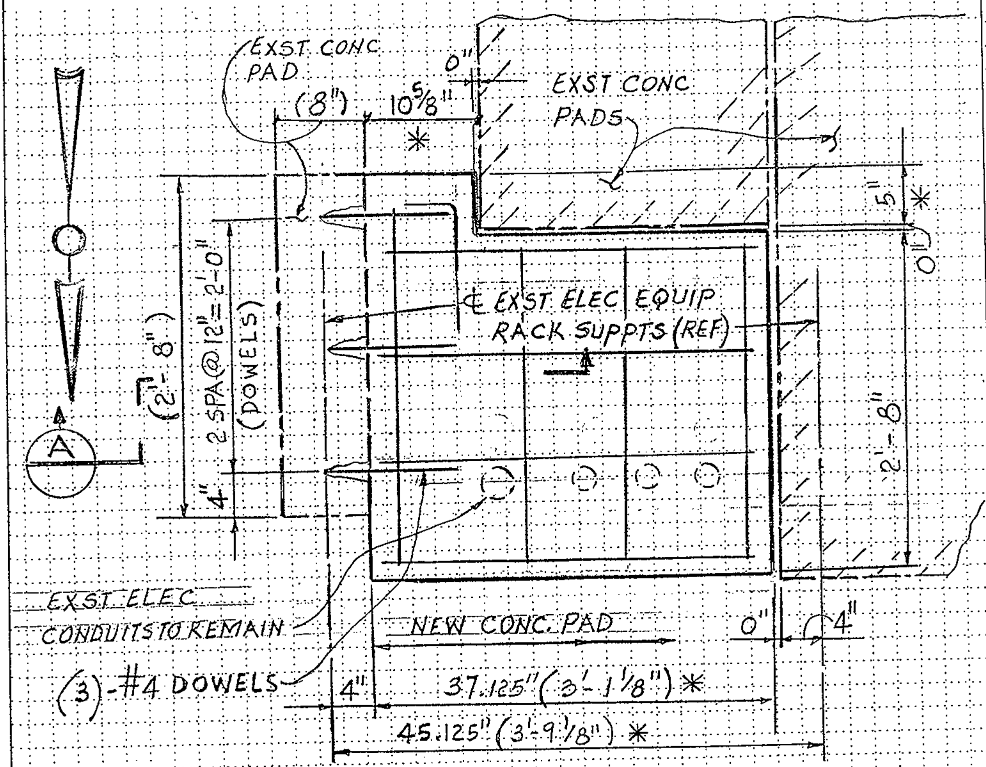
E-NW-123A (5/98)

FLUOR DANIEL NORTHWEST

CALCULATION SHEET

Revision 0

Client	Numatec Hanford Corporation	Contract/Job No.	W-320-98-005 (NHC-9853435)
Subject	W-320, Tank: 241-C-106 Sluicing	Originated By	L.A. VALLE LAV Date 6/23/98
	Elec. Equip. Rack FIT-0622 - Check Calcs.	Checked By	WJ Mayer Date 6/23/98
Location	241-AY/200E	Revised By	Date



ELEC EQUIP SUPPORT PAD

PLAN

1" = 1'-0"

* FIELD FURNISHED DIMENSIONS

E-NW-123A (5/98)

FLUOR DANIEL NORTHWEST

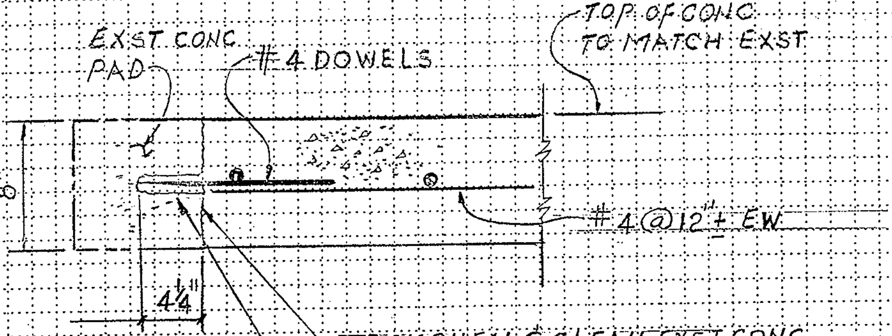
CALCULATION SHEET

Calc. No. W-320-24-037

Revision 0

Page No. 3 of 8

Client	Numatec Hanford Corporation	Contract/Job No.	W-320-98-005 (NHC-9853435)		
Subject	W-320, Tank: 241-C-106 Sluicing	Originated By	L.A. VALLE	Date	6/23/98
	Elec. Equip. Rack FIT-0622 - Check Calcs.	Checked By	WJ Morgan	Date	6/23/98
Location	241-AY/200E	Revised By		Date	



ROUGHEN & CLEAN EXST CONC FACE BEFORE NEW CONC EXTENSION IS POURED

DRILL 1½" ϕ HOLE FOR #4 x 12" LG DOWELS AS SHOWN - FILL POCKETS WITH NONSHRINK EPOXY GROUT OR DRILL FOR HILTI HVU ADHESIVE CAPSULE INSERT FOR #4 REBAR

(A) SECTION

1" = 1'-0"

FLUOR DANIEL NORTHWEST

CALCULATION SHEET

Calc. No. VI-320-24-02
Revision 0
Page No. 1 of

Client NUMATEC HANFORD CORP Contract/Job No. 65100501 ...
Subject VI-320, TANK 241-C-106 Originated By L A VALLE Date 6/22/98
SLUICING - ELEC. EQUIP RACK Checked By WJ McMillan Date 6/23/98
Location FIT-0622 - CHECK CALCS. Revised By Date

ASSUME FULL WIND ON FRAME
(SEISMIC DOES NOT CONTROL)

$p = C_e C_q q_s I$

$C_e = 1.11$

$C_q = 1.3$

$q_s = 14.0$

$I = 1.0$ (HC-LAP-31 SC-3)

$p = 1.11 \cdot 1.3 \cdot 14.0 \cdot 1.0$

$= 20.2$ PSF

$V_W = \left(\frac{47}{12} \times 5.33\right) 20.2$

$= 436^{\#}$

℄ LAT $\simeq 5.33/2 + 10''/12$

(LATERAL) $= 3.5'$ FROM BASE

$M_1 = Pe = 348 \times 8/12 = 232'^{\#}$

M_2 (WIND) $= 436 \times 3.5' = 1526'^{\#}$

MAX TENSION @ BRACE $= (1526 + 232)/2 \times 12/14$

$= 753^{\#}$

$F_{BRACE} = 753 \times 1/\cos 15° = 780^{\#}$ (TENS)

MAX COMP @ EQUIP SUPPT $= 348^{\#} + 753^{\#}$

$= 1100^{\#}$

WIND FROM RIGHT TO LEFT

$R = (1526 - 232)/2 \times 12/14 = 555^{\#}$

$F_{BRACE} = 555 \times 1/\cos 15° = 575^{\#}$ (COMP)

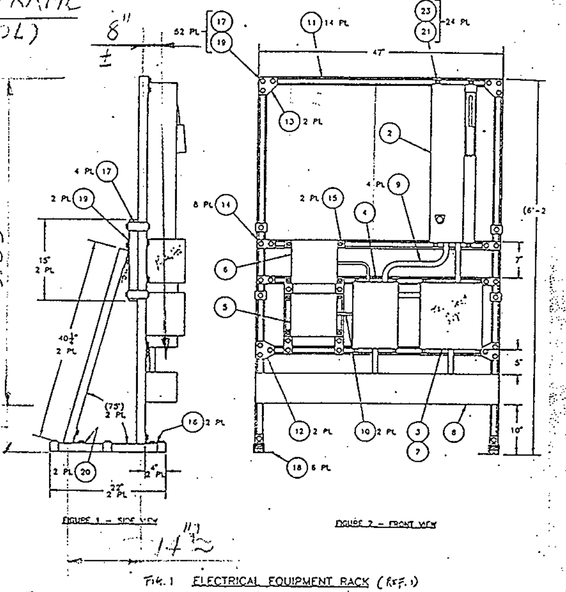
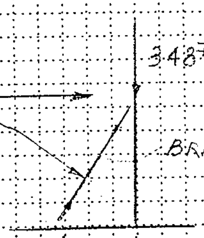


FIG. 1 ELECTRICAL EQUIPMENT RACK (REF. 1)

$\Sigma W = 268^{\#}$ (EXST EQUIP)

$+ 80$ (NEW PANEL)

$348^{\#} = P$



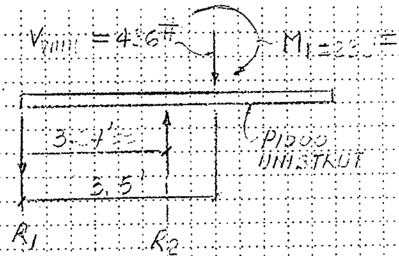
$R = \left\{ \begin{array}{ll} +753^{\#} & 1100^{\#} (-) \\ -555^{\#} & 207^{\#} (+) \end{array} \right.$

FLUOR DANIEL NORTHWEST

CALCULATION SHEET

Calc. No. VI-320-[illegible]
Revision 0
Page No. 5 of 8

Client: NUMATEC HANFORD CORP	Contract/Job No. [illegible]/VI-320		
Subject: W-320, TANK 241-C-106 SLUICING - ELEC. EQUIP RACK	Originated By: LA VALLE	Date: 6/22/[illegible]	
	Checked By: [illegible signature]	Date: 6/23/98	
Location: FIT-0622 - CHECK CALCS	Revised By:	Date:	



$R_1 = [436(3.5-3.24) + [illegible]] / 3.24 \times 2$

$= 53\#$

$R_2 = [illegible] / 3.24$

$= [illegible]\#$

$M_{CANT} = 436(3.5-3.24) + [illegible]$

$= 113 + [illegible] = 345.4'\# = 4144''\#$

P1000 UNISTRUT CAP { $P_{ALLOW} = 3590\#$ (3.25") → UNISTRUT CATALOG #12
{ $M_{ALLOW} = 5080''\#$

COMB.

$\frac{1100}{3590} + \frac{4144}{5080} = 0.58 + 0.516 = 1.2 < 1.33$, OK

CHECK EXP ANCHORS (½" φ KB-II), $F_V = 1840\#$, $F_t = 1220\#$ { HILTI ICBO REPORT 1662, 3000 PSI CONC W/SP INSP, (APPDX B)

$f_V = \frac{315}{2} = 159\#$, $f_t = 755\#$

COMB. $\frac{109}{1840} + \frac{755}{1220} = 0.06 + 0.612 = 0.672 < 1.0$, OK

UNISTRUT P1000 BRG CAP = $\frac{3500}{2.5 \to S.F}$ = 1400# > 1100#, OK
(SEE APPDX B)

ANGULAR FITTING W/½" NUT (P1000) ALLOWABLE PULL-OUT = 2000#
> 780# OK
(SEE APPDX B)

 E-NW-123A (5/98)

Client NUMATEC HANFORD CORP — Contract/Job No. 65100501 (ER4519/W-320)

Subject W-320, TANK 241-C-106 — Originated By LA VALLE — Date 5/28/98

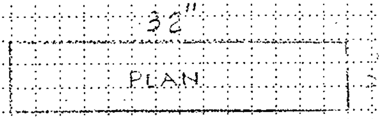
SLUICING - ELEC. EQUIP RACK — Checked By WJ Meyer — Date 6/23/98

Location FIT-08 - CHECK CALC. — Revised By — Date

CHECK EXIST. SUPPORT PAD

$W_{CONC} = \frac{1.5 \times 32 \times 52}{12^3} \times 0.150$

$= .180^K$



CHECK SAFETY FACTOR AGAINST O.T.

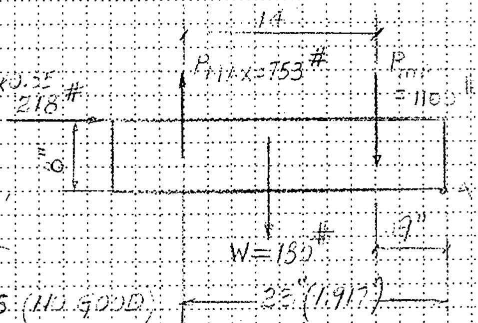
$M_r = \frac{0.180 \times 32}{2 \times 12} + 1100 \times \frac{9}{12} \times 0.85$
@A

$= 0.24 + 0.700 = 0.94^{'K}$

$M_o = 0.218 \times 0.67 + 0.753 \times 1.917'$

$= 0.146 + 1.444 = 1.59^{'K}$

$S.F = \frac{0.940}{1.59} = 0.591 < 1.5$ (NO GOOD)



NEED TO REVISE FTG TO SATISFY SAFETY FACTOR AGAINST O.T.

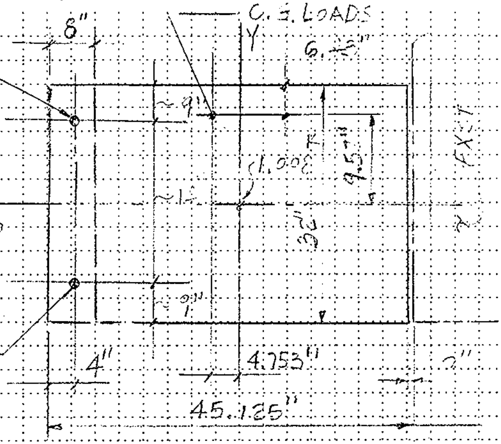
SEE P. 7

Client NUMATEC HANFORD CORP Contract/Job No. 65100501

Subject W-320, TANK 241-C-106 Originated By LA VALLE Date 6/22/98

SLUICING ELE EQUIP RACK Checked By WJ Morgan Date 6/23/98

Location FIT Revised By Date



EXTEND EXST FTG TO 1.1^K

EDGE OF EXST EQUIP PAD

NEW PAD SIZE = 32" x 45.125" x 8" THICK

$$CONC.\ WT = \frac{32}{12} \times \frac{45.125}{12} \times 0.67 \times 0.150$$

$$= 1.008^K$$

EQUIP LOADS

Σ 268 + 85 = 343#

$$M_R = (0.343 \times 0.55 + 1.1 + 0.323)\ 9/12 + 1.008 \times 16/12$$

$$= 0.786 + 1.344 \longrightarrow = 2.13^{'K}$$

$M_O = 1.59^{'K}$ (SEE P. 6), $S.F = \frac{2.13}{1.59}$

= 1.34 (WILL NOT OVERTURN)

SAY OK

C.G. LOADS

$$\bar{Y} = \begin{array}{rcl} +0.753 & \times\ 23 & = (+)17.32 \\ -1.100 & \times\ 9 & = -9.90 \\ -1.008 & \times\ 16 & = -16.13 \\ \hline -1.355 & & -8.71 \end{array}$$

$\bar{Y} = 6.43''$

$$\bar{X} = \begin{array}{rcl} -0.753 \times 4 & = & -3.012 \\ 1.10 \times 4 & = & 4.4 \\ 1.008 \times \frac{45.125}{2} & = & 22.743 \\ \hline 1.355 & & 24.131 \end{array}$$

$\bar{X} = 17.81''$

FLUOR DANIEL NORTHWEST

CALCULATION SHEET

Calc. No.

Revision

Page No. of

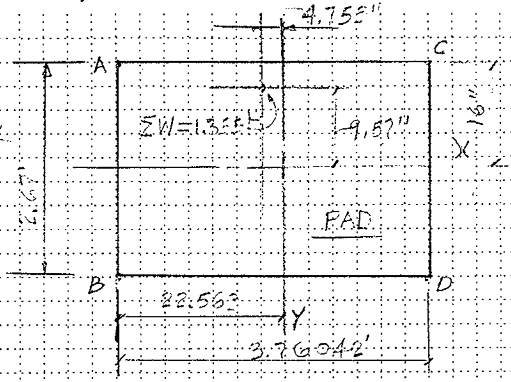
Client Contract/Job No.

Subject Originated By L.A. VALLE Date 6/23/98

Checked By W J Mraz Date 6/23/98

Location Revised By Date

FINAL BEARING PRESSURE:



$M_X = 1.355 \times 9.57 = 12.97''K$

$M_Y = 1.355 \times 4.755 = 6.44''K$

$I_{X-X} = \dfrac{3.76042 \times 2.67^3}{12}$

$= 5.965\ FT^4$

$I_Y = \dfrac{2.67 \times 3.76042^3}{12}$

$= 11.83\ FT^4$

$q_A = \dfrac{\Sigma W}{A} \pm \dfrac{M_X Y}{I_{X-X}} \pm \dfrac{M_Y X}{I_{Y-Y}}$

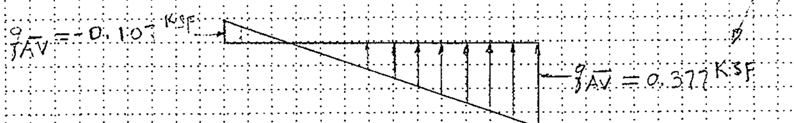
$= \dfrac{1.355}{2.67 \times 3.76042} + \dfrac{12.97 \times 2.67/2}{12 \times 5.965} + \dfrac{6.44 \times 3.76042/2}{12 \times 11.83}$

$= 0.135 + 0.242 + 0.0853 \longrightarrow 0.4623\ KSF$

$q_B = 0.135 - 0.242 + 0.0853 \longrightarrow -0.0217\ KSF$

$q_C = 0.135 + 0.242 - 0.0853 \longrightarrow 0.2917\ KSF$

$q_D = 0.135 - 0.242 - 0.0853 \longrightarrow -0.1923$



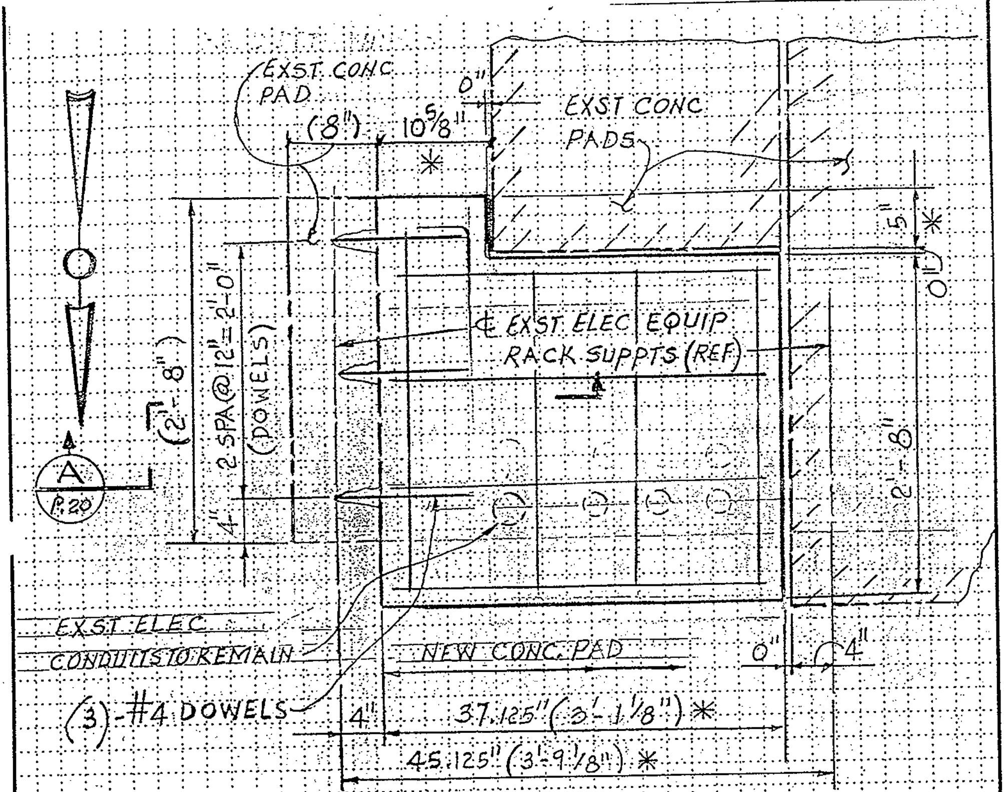
PRESSURE DIAGRAM

MAX. BRG. PRESSURE SHOWN < UBC ALLOWABLE OF 1.5 KSF, OK

CONC. PAD REINF., USE MIN. $A_S = 0.0018 \times 12 \times 8 = 0.173\ in^2/'$, USE #4@12 EW

FLUOR DANIEL NORTHWEST, INC. — ENGINEERING CHANGE NOTICE SKETCH

Ref Dwg	Sh	Rev	Prepared By	Checked By	ECN No	Page
H-2-92970	1	3	[signature]	[signature]	647828	19



ELEC EQUIP SUPPORT PAD

PLAN

1" = 1'-0"

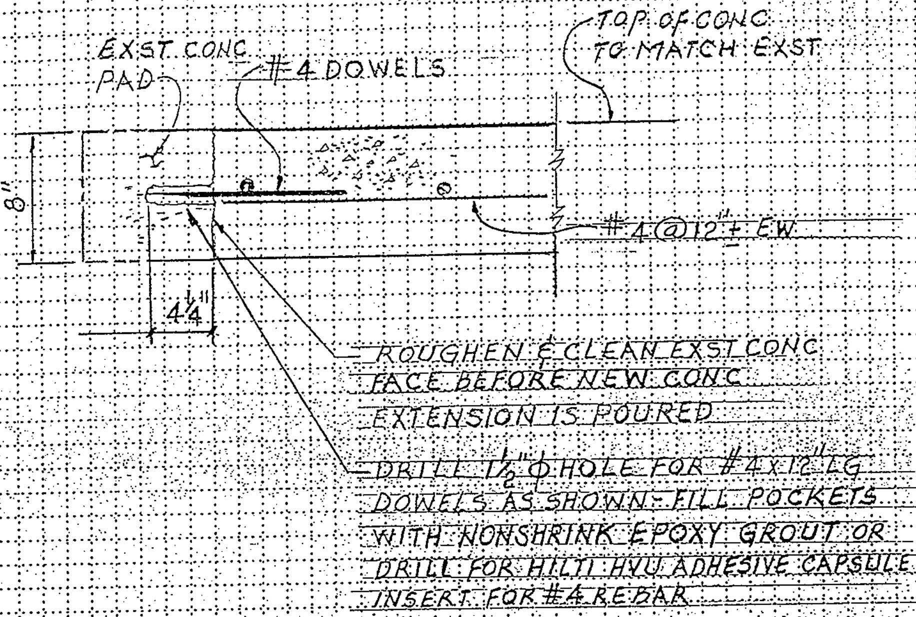
* FIELD FURNISHED DIMENSIONS

PLOT SCALE: 1-1 CAD FILE: FDNW-0159.00 (10/96)

FLUOR DANIEL NORTHWEST, INC.

ENGINEERING CHANGE NOTICE SKETCH

Ref Dwg	Sh	Rev	Prepared By	Checked By	ECN No	Page
H-2-92970	1	3	[signature]	[signature]	647828	20



A
P.19
SECTION
1" = 1'-0"

PLOT SCALE: 1-1 CAD FILE:

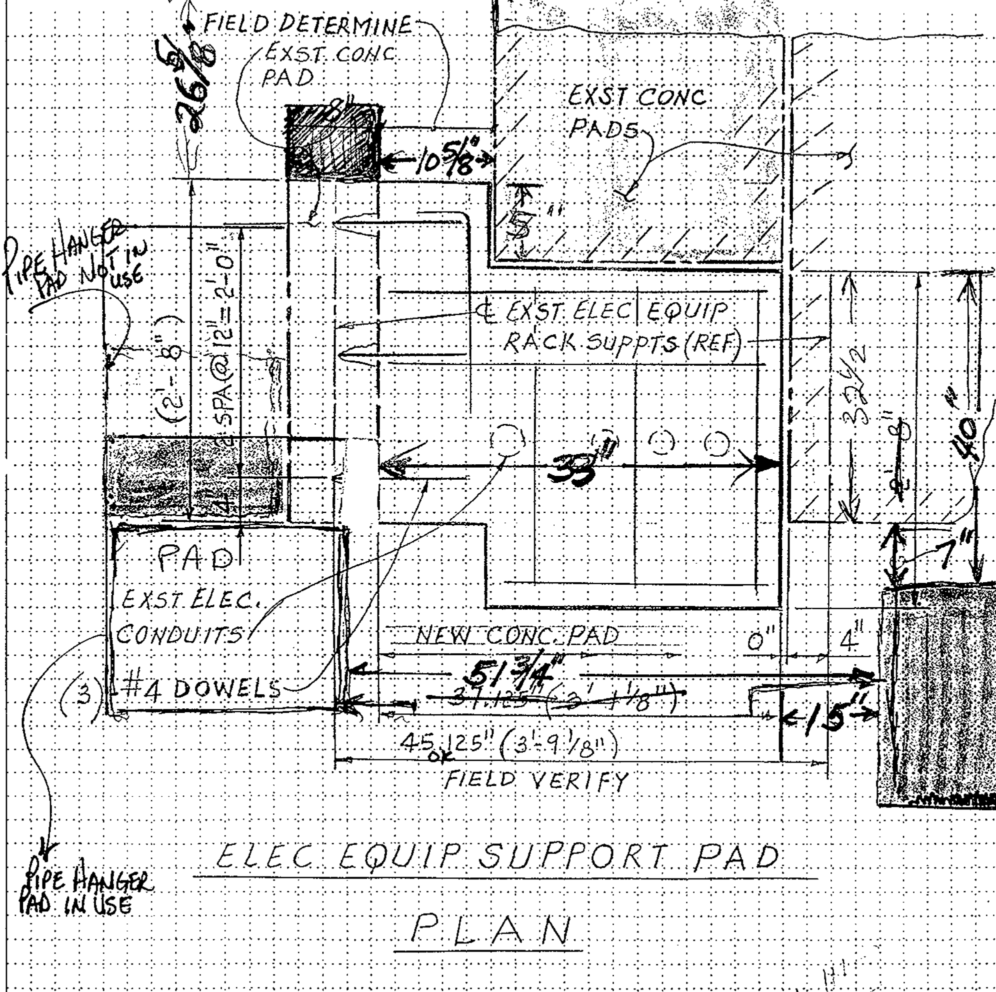
FDNW-0159.00 (10/96)

FLUOR DANIEL NORTHWEST

CALCULATION SHEET

Calc. No.
Revision
Page No. of

Client
Contract/Job No.
Subject
Originated By Date
Checked By Date
Location
Revised By Date



ELEC EQUIP SUPPORT PAD

PLAN

JOHN WRIGHT W-320 SUPT 544-8551

E-NW-123A (5/98)

JAN 18 1996

ENGINEERING DATA TRANSMITTAL

Page 1 of 14

1. EDT 604381

2. To: (Receiving Organization) Controlled Clean and Stable Engineering	3. From: (Originating Organization) TPSECS/Analytical Services (OHJ48)	4. Related EDT No.: N/A
5. Proj./Prog./Dept./Div.: Tank Waste Remediation System	6. Cog. Engr.: M. M. Jennings	7. Purchase Order No.: N/A
8. Originator Remarks: This correspondence contains a structural evaluations of the Electrical Equipment Rack of the Annulus Ventilation System AY-101 and AY-102 under seismic and wind load conditions.		9. Equip./Component No.: N/A
		10. System/Bldg./Facility: AY-101 and AY-102.
11. Receiver Remarks: EDT file (GRS. 23.5a)		12. Major Assm. Dwg. No.: N/A
		13. Permit/Permit Application No.: N/A
		14. Required Response Date: N/A

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Impact Level	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	N/A	~~N/A~~ 14	N/A	STRUCTURAL EVALUATION OF ELECTRIAL EQUIPMENT RACK OF THE ANNULUS VENTILATION SYSTEM	N/A	2	1	

16. KEY

Impact Level (F)	Reason for Transmittal (G)	Disposition (H) & (I)
1, 2, 3, or 4 (see MRP 5.43)	1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION (See Impact Level for required signatures)

(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.
1	1	Cog.Eng.W. W. Chen	[signature]	1/3/96	H5-57					1	
1	1	Cog. Mgr. F. C. Han	[signature]	1/3/96	H5-72						
2	1	M. M. Jennings	[signature]	1/17/96	R2-88						
2	1	S. R. Pierce	[signature]	1/18/96	S5-05						
2	1	G.N. Hanson	[signature]	1/18/96	S5-05						
2	1	J. Wells	[signature]	1/18/96	S5-05						

18.	19.	20.	21. DOE APPROVAL (if required)
W. W. Chen [signature] 1/3/96 Signature of EDT Originator Date	M. M. Jennings [signature] 1/17/96 Authorized Representative Date for Receiving Organization	[signature] 1/18/96 Cognizant Project Engineer's Manager Date	Ltr. No. [] Approved [] Approved w/comments [] Disapproved w/comments

BD-7400-172-2 (07/91) GEF097

BD-7400-172-1 (07/91)

EDT 604381
ITEM #1
13 TOTAL PAGES

Structural Evaluation of Annulus Ventilation System Electrical Equipment Rack

OBJECTIVE

The objective of this analysis is to perform a structural evaluations of the electrical equipment rack of the annulus ventilation system (AY-101 and AY-102) under the seismic and wind load conditions. All the attached components and the system evaluated meet the requirements for dead load and natural phenomena hazard loads (seismic and wind) and are structurally qualified.

This report contains all the calculations to qualify the structure under hazard loads.

INTRODUCTION

The electrical equipment rack system is free-standing and suitable for concrete pad mounting as shown in Figure 1 (Ref 1). The rack is assembled using P1000 unistrut and other assorted hardware as described in Figure 2 (Ref. 1). The component and total system weight of the rack is tabulated in Table 1 (Ref 2). The unistrut channel and combinations are roll formed from 12 gauge (0.105") strip steel.

Under non-reactor Safety Class 3 category, the rack was designated as low hazard/important system or component as described in Ref. 3. This low hazard (safety Class 3) structure or facilities may be evaluated by elastic dynamic analysis. For simple structures with non-uniform mass distributions, the equivalent-static load analysis may be used.

Earthquake input excitation to the elastic dynamic analysis is given site-specific median response spectra anchored to a maximum ground acceleration (Ref. 3). Reference 5 stated that 0.12g site-specific safe shutdown earthquake (SSE) has been maintained for the non-reactor structures. This load may be amplified by multiplying the structure, equipment, or component masses by an acceleration equal to 1.5 times the peak acceleration of the application response spectrum (Ref. 4).

The basic wind speed is 70 mph as determined from regional climate data (Ref. 10). Since the structure height is only slightly over 6', the factors used for velocity pressure calculations are highly conservative.

The structural components connected to the unistrut structure are qualified based on the design data specified in Reference 8. Anchor bolts embedded in the concrete pad are qualified based on the HILTI system technical guide (Ref. 9) and design guide SDC- 4.2 (Ref. 6).

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13 Total Pages

CONCLUSION

A seismic and wind load analyses of the electrical equipment rack system have been completed. The analyses were based on the Standard Design Criteria (Ref. 5 and 6) and ASCE standard reference (Ref. 4 and 10). The Hilti Kwik-Bolt II (Ref. 9) and Unistrut catalogue (Ref. 8) were used to qualify the structural components.

The results indicate that the electrical equipment rack system are qualified to resist the earthquake and wind load requirement. The edge distance and embedment depth for the expansion anchor and the anchor spacing meet the design criteria. Mounting equipments on the rack meet the structural design requirements.

REFERENCES

1. WHC-S-0443, 1995, "Specification for Annulus Ventilation System Electrical Equipment Rack," System No. AY-101 and AY-102.

2. cc\mail from Stenkamp, D. M., dated 12/13/95.

3. UCRL-15910, 1990, "Design and Evaluation Guidelines for Department of Energy Facilities Subjected to Natural Hazard Phenomena Hazards," R.P.Kennedy, et al, June 1990.

4. ASCE Standard Reference 4-86, 1986, "Seismic Analysis of Safety Related Nuclear Structures and Commentary on Standard for Seismic Analysis of Safety Related Nuclear Structures," ASCE, Sept 1986.

5. SDC-4.1, 1989, "Standard Arch-Civil Design Criteria, Design Loads for Facilities," Rev. 11, Sept 1989.

6. SDC-4.2, 1992, "Standard Arch-Civil Design Criteria, Design and Installation of Expansion Anchors" Rev. 0, Sept 1992.

7. UBC, 1994, "Uniform Building Code," Vol. 2, Structural Engineering Design Provisions.

8. UNISTRUT, Unistrut All Purpose Metal Framing Systems, General Engineering Catalogue, Unistrut Corporation, Wayne MI., 1988.

9. HILTI, Fastening Systems, Technical Guide, Tulsa, OK., 1987.

10. ASCE Standard Reference 7-93, "Minimum Design Loads for Buildings and Other Structures," Revision of ANSI/ASCE 7-88, ASCE, December 1993.

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Table 1. Component Weights of the Rack *

ITEM #	DESCRIPTION	WEIGHT	
2	COMBINATION STARTER	50 LBS	
11	P1000 UNISTRUT 465 LINEAR INCHES - AT 190 LBS/C FT =	74 LBS	
12-24	UNISTRUT FITTINGS/HARDWARE	49 LBS	
3	12 X 12 X 6 TERMINAL BOX	15 LBS	
4	12 X 10 X 5 TERMINAL BOX	10 LBS	
8	6 X 6 X 48 WIRE WAY	30 LBS	
5	PRESSURE SWITCH W/ENCLOSURE	20 LBS	
6	PRESSURE SWITCH W/ENCLOSURE	20 LBS	
		268 LBS	TOTAL PER RACK

* Reference 2.

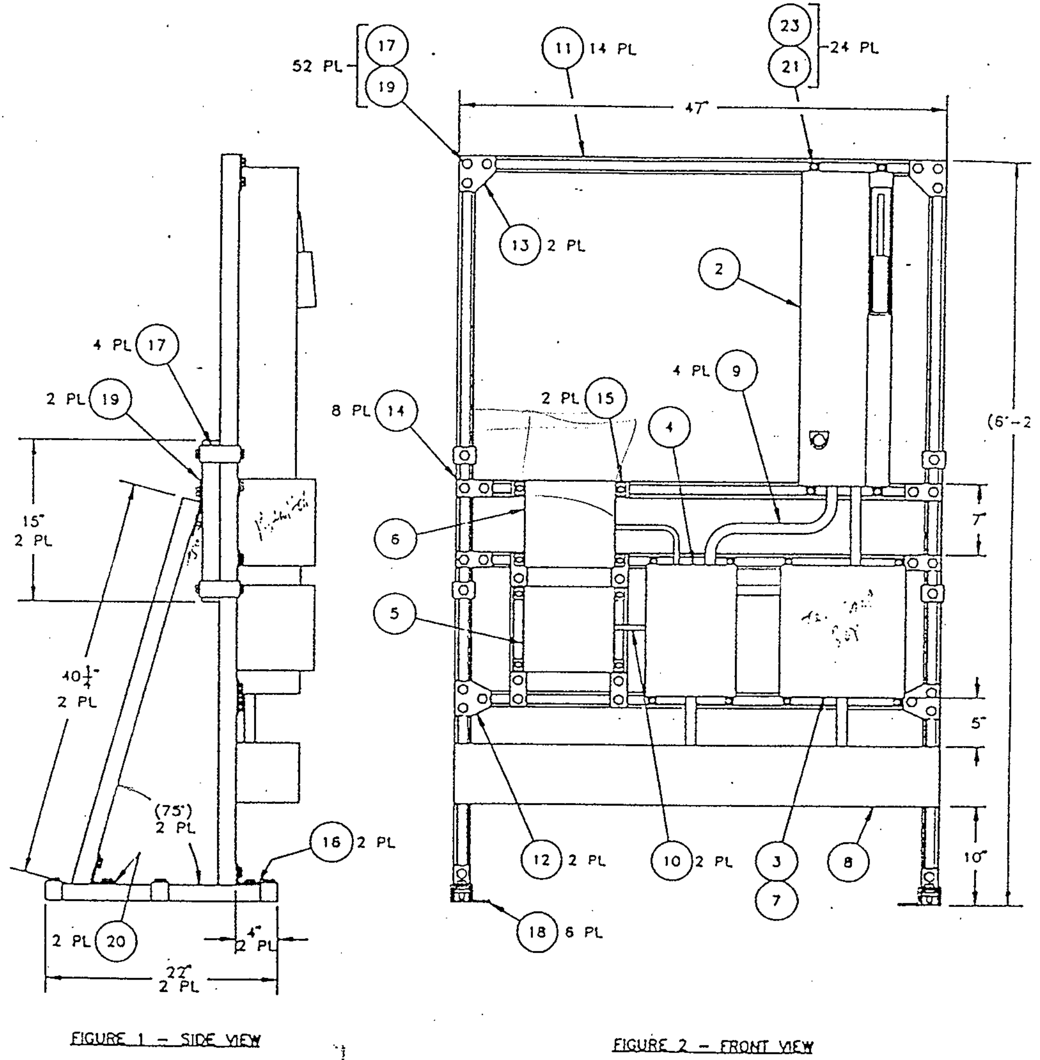


FIG. 1 ELECTRICAL EQUIPMENT RACK (REF. 1)

PARTS LIST

101 QTY	102 QTY	ITEM NO.	DESCRIPTION	MATERIAL/REFERENCE	DWG NO.
1	1	1	ELECTRICAL EQUIPMENT RACK		FIGURE 1 & 2
1	1	2	COMBINATION MOTOR STARTER	PARAGRAPH 3.2.4	
1	1	3	TERMINAL BOX	HOFFMAN, A-1212CHNF W/ A-12P12	
1	1	4	TERMINAL BOX	HOFFMAN, A-1210CHNF W/ A-12P10	
1	1	5	DIAPHRAGM PRESSURE SWITCH W/ WEATHERPROOF HOUSING, OPERATING RANGE, INCHES, .05 TO .25	DWYER, SERIES 1630, MODEL NO. 1638-0WP	
1	1	6	DIAPHRAGM PRESSURE SWITCH W/ WEATHERPROOF HOUSING, OPERATING RANGE, INCHES, 2.0 TO 6.0	DWYER, SERIES 1630, MODEL NO. 1638-5WP	
1	1	7	POWER DISTRIBUTION TERMINAL BLOCK	SQUARE "D", CLASS 9080, / LBA362104	
1	1	8	WIREWAY	HOFFMAN, F-66W48SS	
AR	AR	9	CONDUIT, 1", W/ MISC. FITTINGS	GALVANIZED RIGID STEEL	
AR	AR	10	CONDUIT, 1/2", W/ MISC. FITTINGS	GALVANIZED RIGID STEEL	
AR	AR	11	CHANNEL, 1 5/8	UNISTRUT, P1000	
2	2	12	FLAT PLATE FITTING	UNISTRUT, P1356	
2	2	13	FLAT PLATE FITTING	UNISTRUT, P1334	
8	8	14	FLAT PLATE FITTING	UNISTRUT, P1065	
2	2	15	FLAT PLATE FITTING	UNISTRUT, P1063	
2	2	16	NINETY DEGREE ANGLE FITTING	UNISTRUT, P2626	
4	4	17	U-SHAPE FITTING	UNISTRUT, P1044	
6	6	18	U-SHAPE FITTING	UNISTRUT, P1046 A *	
2	2	19	ANGULAR FITTING	UNISTRUT, P2103	
2	2	20	ANGULAR FITTING	UNISTRUT, P2106	
24	24	21	HEX HEAD CAP SCREW, 3/8-16UNC-2A X 1 1/4 L	UNISTRUT, HHCS037125EG	
52	52	22	HEX HEAD CAP SCREW, 1/2-13UNC-2A X 1 1/2 L	UNISTRUT, HHCS050150EG	
24	24	23	CHANNEL NUT WITH SPRING, 3/8-16UNC-2B	UNISTRUT, P1008	
52	52	24	CHANNEL NUT WITH SPRING, 1/2-13UNC-2B	UNISTRUT, P1010	

* ENLARGE 9/16" DIA HOLE TO 5/8" DIA FOR HILTI BOLT CLEARANCE.

5 FIGURE 2 - PARTS LIST (REF. 1)

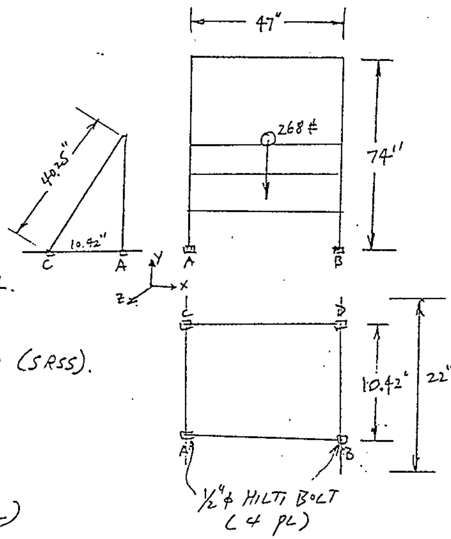
ANALYTICAL CALCULATIONS

Subject: ELECTRICAL EQUIPMENT RACK

Originator: W. Chen Date: 12/14/95

Checker: F H Date: 1/3/96

1. SEISMIC ANALYSIS



LOADINGS:

FOR CLASS 3 STRUCTURE THE HORIZONTAL g-LOAD IS (REF. 5) 0.12 g

WHILE THE VERTICAL g-LOAD IS $\frac{2}{3} \times 0.12 = 0.08\,g$.

LOAD WILL BE COMBINED USING SQUARE ROOT-SUM (SRSS). METHOD.

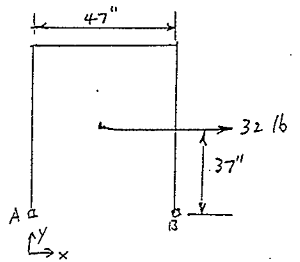
ANALYSIS:

X-Direction (HORIZONTAL)

$1.5 \times 0.12 g = 0.12 \times 268 = 48$ lbs

$SHEAR = \frac{48}{4} = 12$ lb/Bolt

$TENSION = 48 \frac{(37)}{47} \frac{1}{2} = 19$ lb/Bolt

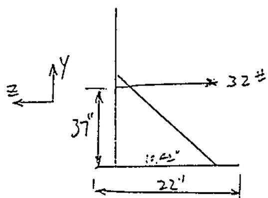


Z-DIRECTION (HORIZONTAL)

$SHEAR = \frac{48}{4} = 12$ lb/Bolt

$TENSION = 48 \frac{(37)}{10.42"} \frac{1}{2}$

$= 85$ #/Bolt



ANALYTICAL CALCULATIONS

Subject ELECTRICAL EQUIPMENT RACK

Originator W. CHEN Date 12/15/95

Checker E. L. Date 1/3/96

Y-DIRECTION (VERTICAL)

$1.5 \times \frac{2}{3} \times HORIZ = \frac{2}{3} \times .12 \times 268 = 21.4$ #

TENSION $= \frac{21.4}{4} = 5.1$ #

USING SRSS FOR DIRECTIONAL LOAD COMBINATIONS PER BOLT,

SHEAR $= \sqrt{12^2 + 12^2} = 17$ #

TENSION $= \sqrt{19^2 + 85^2 + 5.1^2} = 87$ #

CONSIDER CONCRETE MINIMUM STRENGTH OF 2,000 PSI. FOR CARBON STEEL HILTI BOLT II OF ½", THE MAXIMUM ALLOWABLE FOR (REF. 6):

TENSION: 1,100 PSI / BOLT
SHEAR 1,450 PSI / BOLT

ASSUMING MINIMUM EMBEDMENT OF 2¼" FOR EACH BOLT. THE DESIGN SHALL NOT CONSIDER ANCHOR PRETENSION. BASED ON THE INTERACTION REQUIREMENTS:

$$\frac{\text{SHEAR APPLIED}}{\text{SHEAR ALLOWABLE}} + \frac{\text{TENSION APPLIED}}{\text{TENSION ALLOWABLE}} \leq 1.0$$

SO

$$\frac{17}{1,100} + \frac{87}{1,450} = 0.08 < 1.0 \quad \text{OK.}$$

BD-6400-060.1 (07/93)

ANALYTICAL CALCULATIONS

Subject: ELECTRICAL EQUIPMENT RACK
Originator: W. CHEN Date: 12/18/95
Checker: F. [illegible] Date: 1/3/96

2. EDGE DISTANCE

FOR THE CARBON STEEL HILTI KWIK-BOLT AND KWIK-BOLT II, THE MINIMUM DISTANCE FROM THE EXPANSION ANCHOR CENTER LINE TO THE EDGE OF THE CONCRETE NOT LESS THAN 10 NOMINAL DIAMETERS. FOR ½" BOLT, THE EDGE DISTANCE REQUIRED FOR (TABLE 1, REF. 6):

SHEAR = 6¾"
TENSION = 5"

THIS DESIGN IS 5.8", SO LESS THAN 6¾". EVEN IF CONSIDER THE EDGE DISTANCE LOAD REDUCTION EFFECT OF 50%, THE ANCHOR STILL MEETS THE REQUIREMENT OF INTERACTION LOADING FACTOR.

3. ANCHOR SPACING:

ANCHOR SPACE BETWEEN ANCHORS IS 12 NOMINAL DIAMETER, 12 x ½" = 6". FOR ANCHORS BETWEEN A-B AND C-D IS 47", A-C AND B-D IS 10.42". AS SEEN FROM FIGURES IN PAGE 4. IT MEETS THE ANCHOR SPACING REQUIREMENTS

ITEM #1
13 TOTAL PAGES

Subject ELECTRICAL EQUIPMENT RACK

Originator W. CHEN Date 12/20/95

Checker F. Han Date 1/3/96

5. EMBEDMENT DEPTH

FOR 1/2" KWIK BOLT II, THE MINIMUM EMBEDMENT DEPTH IS 2 1/4", THEREFORE THE BASE MATERIAL THICKNESS SHOULD BE AT LEAST GREATER THAN 2 1/4". OR FOR SAFETY, CONCRETE SHOULD BE 4" THICK.

6. MOUNTING EQUIPMENT SEISMIC CHECK.

FOR SEISMIC CLASS-3 EQUIPMENT, USE REF. 7 FOR TOTAL LATERAL SEISMIC DESIGN FORCE, F_p, FOLLOWING FORMULA MAY BE USED (REF. 7)

$$F_p = Z I_p C_p W_p$$

WHERE Z = SEISMIC ZONE FACTOR 2A = 0.15 (TABLE 16-I)
I_p: IMPORTANCE FACTOR = 1.25 (TABLE 16-K)
C_p = HORIZONTAL FORCE FACTOR = 0.75 (TABLE 16-N
W_p = WEIGHT OF EQUIPMENT,

SO

$$F_p = (0.15)(1.25)(0.75) W_p = 0.14 W_p$$

FOR COMBINATION STARTER $W_p = 50$ #, THE DESIGN FORCE IS

$$F_p = 0.14 \times 50 = 7 \text{ \#}$$

THE 3/8-16 UNC HEX CAP SCREW SHOULD HOLD THIS FORCE WITHOUT PROBLEM.

BD-6400-060.1 (07/93)

ANALYTICAL CALCULATIONS

Subject: ELECTRICAL EQUIPMENT RACK

Originator: W. CHEN Date: 12/21/95

Checker: F. K... Date: 1/3/96

SO PRESSURE ON THE TOP IS

$$P_{top} = 11.5(-1.0) - 11.5\,(0.75) = -20.13 \text{ psf}$$
$$= 11.5\,(-1.0) - 11.5\,(-0.25) = -8.63 \text{ psf}$$

WIND LOAD

LATERAL AREA $= 47''[5''+6''+15''+7'']$
$+ 31'' \times 6'' = 1551 + 186$
$= 1737 \text{ in}^2 = 12.1 \text{ ft}^2$

LATERAL LOAD
$= 15(12.1) + 16.2(12.1)$
$= 377.5$ lbs CONTROL OVER SEISMIC

VERTICAL LOAD
$$= 20.13\left(\frac{1.625'' \times 47''}{144}\right)$$
$= 10.7$ lb.

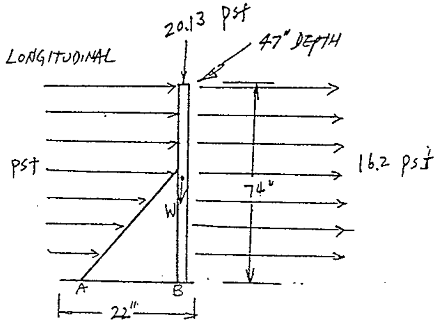


FIG. 1

THE WIND LOAD ON THE LATERAL SURFACE (FIG. 2) IS SMALL DUE TO ITS SURFACE AREA.

SO THE CRITICAL WIND LOAD SHOULD BE ANALYZED FROM THE CONDITION OF FIGURE 1. HOWEVER, THE LATERAL AREA WAS CALCULATED ASSUMING MORE SOLID AREA CONTACTING AGAINST WIND. THEREFORE, THE LATERAL FORCE IS CONSERVATIVE.

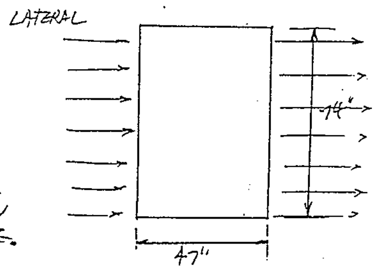


FIG. 2

Subject: ELECTRICAL EQUIPMENT RACK

Originator: W. CHEN Date: 12/21/95

Checker: F. [illegible] Date: 1/3/96

7. WIND LOAD

THE VELOCITY PRESSURE q_z AT HEIGHT z MAY BE CALCULATED BY (REF 10)

$$q_z = 0.00256\, K_z (IV)^2$$

WHERE K_z : Vel. Press Exposure Coeff, 0.80 (EXPOSURE C) (TABLE 6, REF. 10)

I = IMPORTANCE FACTOR: 1.07 (REF. 5, P. 8)

V = BASIC WIND SPEED: 70 mph (REF. 5, P. 8)

SO

$$q_z = 0.00256(0.8)(1.07)^2(70)^2 = 11.5 \text{ lb/ft}^2$$

PRESSURE MAY BE CALCULATED (REF. 11, EQ. 3) BY:

$$p = q_z (G_h C_p) - q_h (GC_{pi})$$

WHERE $G_h = 1.32$; $q_h = q_z$; GUST RESPONSE FACTOR

$C_p = 0.8$ FOR WINDWARD DIRECTION
$= -0.5$ FOR LEEWARD } WALL PRESS. COEFF.

$GC_{pi} = 0.75$ TOWARD SURFACE
$= -0.25$ AWAY FROM SURFACE] INT. PRESS. COEFFICIENTS

WINDWARD

$$P_{WINDW} = 11.5(1.32)(0.8) - 11.5(0.75) = 3.5 \text{ psf}$$
$$= 11.5(1.32)(0.8) - 11.5(-0.25) = 15.0 \text{ psf}$$

LEEWARD

$$P_{LEEWARD} = 11.5(1.32)(-0.5) - 11.5(0.75) = -16.2 \text{ psf}$$
$$= 11.5(1.32)(-0.5) - 11.5(-.25) = -4.7 \text{ psf}$$

TOP OF THE RACK

$G_h C_p = -1.0$ FOR HEIGHT LESS THAN 60'.

ANALYTICAL CALCULATIONS

Subject ELECTRICAL EQUIPMENT RACK
Originator W. CHEN Date 12/21/95
Checker F Hu Date 1/3/96

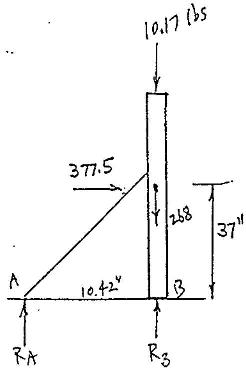
TAKE MOMENT ABOUT B,

$$\circlearrowright M_B = R_A(10.42) + 377.5\,(37)$$

$$R_A = -1{,}341 \text{ lbs COMP}$$

$$R_B = 1341 + 268 + 10.17$$

$$= 1{,}619.17 \text{ lbs TENSION}$$



SINCE THERE ARE 2 ANCHORS, THE ACTUAL REACTION FORCES ARE

$$R_A = \frac{1341}{2} = 671 \text{ lb. COMP}$$

$$R_B = \frac{1{,}619.17}{2} = 809.6 \text{ lb TENSION}$$

THE SHEAR AND TENSION FORCES ON ANCHORS DUE TO WIND LOAD ARE:

$$\text{SHEAR} = \frac{377.5}{4} = 94.4 \text{ lb}$$

$$\text{TENSION} : 809.6 \text{ lb.}$$

CHECK THE INTERACTIVE REQUIREMENTS

$$\frac{94.4}{1{,}100} + \frac{809.6}{1{,}450} = 0.086 + 0.558 = 0.644 < 1.0 \text{ OK.}$$

WHERE 1,100 lbs AND 1450 lbs ARE THE SHEAR AND TENSION ALLOWANCE FOR HILTI KWIK-BOLT II (REF. 6, TABLE 9)

ANALYTICAL CALCULATIONS

Subject: ELECTRICAL EQUIPMENT RACK
Originator: W. CHEN Date: 12/22/95
Checker: [illegible] Date: 1/3/96

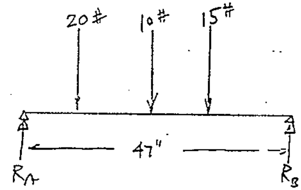
8. QUALIFICATION OF UNISTRUT LOAD:

FOR 12 GAUGE (0.105"), P1000 UNISTRUT CHANNEL, WITH BOTH END SUPPORTED 90° FITTING, CONNECTION, THE DESIGN LOAD IS 5,000 lbs. EVEN WITH CONSERVATIVE CALCULATIONS. REACTION FORCE AT B (FIGURE AT P. 10), IT IS WITHIN THE ALLOWABLE (P.28, REF. 8).

9. BEAM CHECK.

$\curvearrowright + \sum M_A = 20 \times 12 + 10 \times 25 + 15(40) - 47 R_B$

$R_B = 23$ lbs
$R_A = 22$ lbs



FLAT PLATE FITTING (UNISTRUT P 1356) AT R_A, BEAM UNIFORM LOAD ALLOWED IS 680 lbs AT 48" SPAN (REF. 8). FOR EQUIPMENT LOADED ON THE SPAN OF 47" SHOULD HAVE NO PROBLEM.

STRENGTH OF P1010 NUTS USED IN P1000 CHANNEL IS:
RESISTANCE TO SLIP: 1500 LBS PER BOLT.
PULL OUT STRENGTH: 2000 LBS PER BOLT.
(INCLUDES A MINIMUM SAFETY FACTOR OF 3).

BD-6400-060.1 (07/93)

ICBO Evaluation Service, Inc.
5360 WORKMAN MILL ROAD • WHITTIER, CALIFORNIA 90601-2299
A subsidiary corporation of the International Conference of Building Officials

EVALUATION REPORT

ER-4627
Reissued July 1, 1996

Filing Category: FASTENERS—Concrete and Masonry Anchors (066)

KWIK BOLT-II

HILTI, INC.
5400 SOUTH 122ND EAST AVENUE
TULSA, OKLAHOMA 74146

I. **Subject:** Kwik Bolt-II Concrete Anchors.

II. **Description:** A. **General:** Kwik Bolt-II (KB-II) concrete anchors consist of a stud, wedge, nut and washer. The stud is manufactured from a carbon or stainless steel material. The carbon steel Kwik Bolt-II stud is made from AISI 1038 or AISI 1144 materials. The wedges are made of AISI 1010 steel, except that KB-II $^3/_4$-by-12, KB-II 1-by-6, KB-II 1-by-9, and KB-II 1-by-12 have AISI 304 (stainless steel) wedges. All carbon steel components are zinc-plated. Each component of the stainless steel Kwik Bolt-II is made from either AISI 304 or AISI 316 material.

The stud consists of a high-strength steel rod threaded at the upper end. The tapered mandrel has an increasing diameter toward the anchor base and is enclosed by a three-section wedge which freely moves around the mandrel. In the vertical direction, the wedge movement is restrained by the mandrel taper at the bottom and by a collar at the top of the mandrel. When subjected to torque, the wedge is forced against the wall of the predrilled hole to provide the anchorage. Allowable tension and shear values in normal-weight concrete are shown in Tables 3 and 4 for the carbon steel and stainless steel anchors, respectively. Allowable tension and shear values for lightweight concrete are shown in Table 5.

B. **Post Nut Kwik Bolt-II:** Post Nut Kwik Bolt-II concrete anchors consist of a carbon (AISI 1144) or stainless (Type 304) steel stud and post nut. The stud threaded end is fabricated to accept a threaded post nut whose outside diameter is equal to the nominal diameter of the stud. The post nut has a countersunk head configuration. Allowable tension and shear values in 3,000 psi (20.7 MPa) normal-weight concrete for carbon and stainless anchors are shown in Table 7.

C. **Installation:** 1. **Kwik Bolt-II:** The Kwik Bolt-II anchor is installed in concrete with a predrilled hole of approximately the same size as the nominal bolt diameter. The drilled holes must exceed the depth of anchor embedment by at least two anchor diameters to permit overdriving of anchors and to provide a dust-free area. The anchor must be hammered into the predrilled hole until at least six threads are below the surface. The nut must be tightened against the washer until the torque values specified in Table 1 are attained. Minimum embedment depths, and edge and spacing requirements, are set forth in Table 1.

2. **Post Nut Kwik Bolt-II:** The Post Nut Kwik Bolt-II anchor is installed in concrete in a predrilled hole approximately the same size as the nominal bolt diameter. The drilled holes must exceed the depth of anchor embedment by approximately two anchor diameters to permit overdriving and to provide a dust-free area. The anchor is tapped into the hole until the post nut head touches the material to be fastened. The post nut is then loosened by two complete turns and the anchor tapped again until the post nut is again in contact with fastened material. The post nut is then tightened.

D. **Special Inspection:** Where special inspection is required, compliance with Section 1701.5 of the code is necessary. The special inspector must be on the jobsite continuously during anchor installation to verify anchor type, anchor dimensions, concrete type, concrete compressive strength, predrilled hole dimensions, anchor spacing, edge distances, slab thickness, anchor embedment and tightening torque.

E. **Identification:** The anchors are identified in the field by dimensional characteristics and packaging. The packaging label indicates the manufacturer's name and address and the size and type of anchor. A length identification code letter is stamped on the threaded end of the bolt. See the length identification system in Table 6.

III. **Evidence Submitted:** Reports of tests in accordance with the ICBO ES Acceptance Criteria for Expansion Anchors in Concrete and Masonry Elements (AC01), dated January 1993.

Findings

IV. **Findings: That the Kwik Bolt-II concrete anchors described in this report comply with the 1994 *Uniform Building Code*™, subject to the following conditions:**

1. **Installation dimensions and installation torques are as noted in Table 1.**
2. **Allowable tension and shear values are as noted in Tables 2 through 5.**
3. **Calculations justifying that the applied loads comply with this report are submitted to the building official for approval.**
4. **Special inspection is provided as set forth in Section II D of this report.**
5. **Anchors are limited to installation in uncracked concrete, which is concrete subjected to tensile stresses not exceeding 170 psi (483 kPa) as induced by external loads, deformations and interior exposures.**
6. **Use of the anchors in resisting wind and seismic forces is beyond the scope of this report.**
7. **Use of the anchors in resisting vibratory or shock loads, such as those present in supports for reciprocating engines or crane loads, is beyond the scope of this report.**
8. **Anchors are limited to nonfire-resistive construction.**
9. **Anchors are manufactured by Hilti, Inc., at 5400 South 122nd East Avenue, Tulsa, Oklahoma, with quality control inspections by Underwriters Laboratories Inc. (AA-637).**

This report is subject to re-examination in one year.

P1000 & P1001 CHANNELS
FOR 1-5/8" (41 MM) WIDTH SERIES CHANNEL

COLUMN LOADING DATA

Unbraced Height		Channel	Max. Allowable Load at Slot Face		Maximum Column Load Applied at C.G.							
					K = .65		K = .80		K = 1.0		K = 1.2	
In	mm		Lbs	kN	Lbs	kN	Lbs	kN	Lbs	kN	Lbs	kN
24	610	P1000 P1001	3400 6360	15.1 28.3	9600 23820	42.7 106.0	9500 23560	42.3 104.8	9320 23130	41.5 102.9	9100 22610	40.5 100.6
36	914	P1000 P1001	3000 6190	13.3 27.5	7640 23190	34.0 103.2	7400 22610	32.9 100.6	7000 21640	31.1 96.3	6490 20460	28.9 91.0
48	1219	P1000 P1001	2570 5970	11.4 26.6	5910 22310	26.3 99.2	5530 21270	24.6 94.6	4980 19560	22.2 87.0	4430 17460	19.7 77.7
60	1524	P1000 P1001	2230 5690	9.9 25.3	4780 21180	21.3 94.2	4390 19560	19.5 87.0	3850 16870	17.1 75.0	3330 13590	14.8 60.5
72	1829	P1000 P1001	1970 5360	8.8 23.8	4090 19790	18.2 88.0	3680 17460	16.4 77.7	3140 13590	14.0 60.5	2650 9570	11.8 42.6
84	2134	P1000 P1001	1760 4970	7.8 22.1	3600 18150	16.0 80.7	3170 14980	14.1 66.6	2630 10130	11.7 45.1	2160 7030	9.6 31.3
96	2438	P1000 P1001	1580 4510	7.0 20.1	3220 16270	14.3 72.4	2770 12120	12.3 53.9	2240 7750	10.0 34.5	1800 5380	8.0 23.9
108	2743	P1000 P1001	1430 4030	6.4 17.9	2910 14120	12.9 62.8	2450 9570	10.9 42.6	1930 6130	8.6 27.3	** 4250	** 18.9
120	3048	P1000 P1001	1290 3610	5.7 16.1	2640 11750	11.7 52.3	2180 7750	9.7 34.5	** 4960	** 22.1	** **	** **

$^{**}\frac{KL}{r} > 200$

ELEMENTS OF SECTION

Channel	Areas of Section		Axis 1 - 1						Axis 2 - 2					
			I		S		r		I		S		r	
	In²	cm²	In⁴	cm⁴	In³	cm³	In	cm	In⁴	cm⁴	In³	cm³	In	cm
P1000	.556	3.6	.185	7.7	.202	3.3	.577	1.5	.236	9.8	.290	4.7	.651	1.7
P1001	1.112	7.2	.930	38.7	.572	9.4	.915	2.3	.472	19.6	.580	9.5	.651	1.7

I - Moment of Inertia S - Section Modulus r - Radius of Gyration

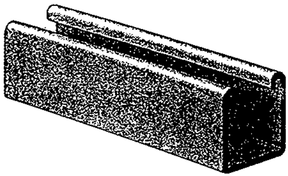
APPD'x 'B'

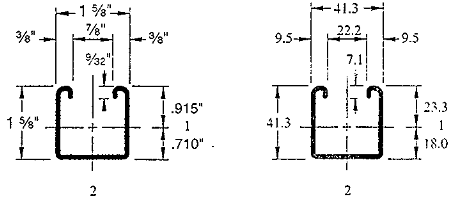
P1000® & P1001 CHANNELS

FOR 1-5/8" (41 MM) WIDTH SERIES CHANNEL

UNISTRUT

P1000

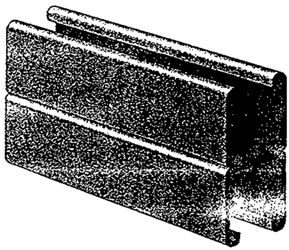


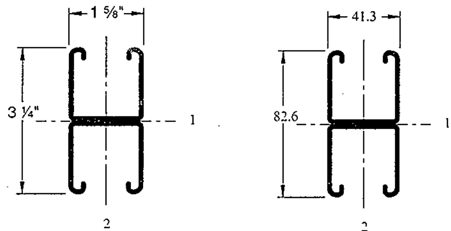


Pierced channels are found on pages 60 and 61.

Weight: 190 Lbs/C Ft (283 kg/100 m)

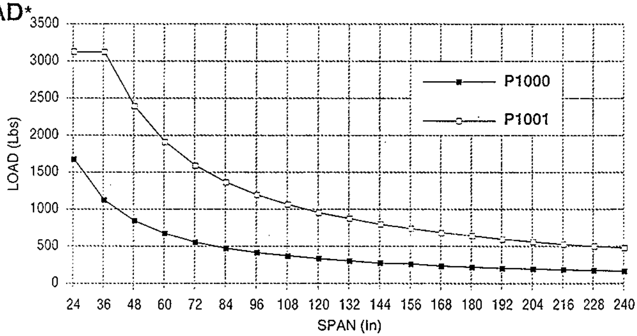
P1001





Weight: 380 Lbs/C Ft (566 kg/100 m)

BEAM LOAD*



*Maximum allowable uniform load.

Channel	Weight		Allowable Moment		Material Thickness		Standard Lengths		Finishes				Other Materials	
	Lbs/Ft	kg/m	In-Lb	N•m	In	mm	10'	20'	PL	GR	HG	PG	SS	EA
P1000	1.90	2.8	5,080	570	.105	2.7	■	■	■	■	■	■	■	■
P1001	3.80	5.7	14,390	1630	.105	2.7	■	■	■	■	■	■	■	■

Nominal thickness of 12 gage strip steel is .105 inches.

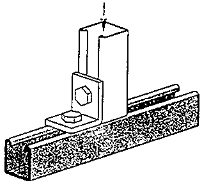
APPDX 'E'

BEARING LOADS FOR CHANNEL & COMBINATIONS
FOR 1-5/8" (41 MM) WIDTH SERIES CHANNEL

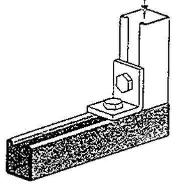
UNISTRUT

BEARING LOADS ON UNISTRUT CHANNELS

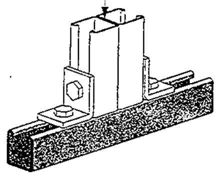
Bearing Length 1-5/8" (41 mm)



Bearing Length 1-5/8" (41 mm)



Bearing Length 3-1/4"(92 mm)



Channel	Bearing Length 1-5/8" (41 mm) Maximum Allowable Loads		Bearing Length 1-5/8" (41 mm) Maximum Allowable Loads		Bearing Length 3-1/4"(92 mm) Maximum Allowable Loads	
	Lbs	kN	Lbs	kN	Lbs	kN
P1000	5000	22.2	3500	15.6	8000	35.6
P1100	3500	15.6	2500	11.1	5500	24.5
P2000	2000	8.9	1500	6.7	3000	13.3
P3000	5000	22.2	3500	15.6	8000	35.6
P3300	6000	26.7	4000	17.8	9000	40.0
P4000	2200	9.8	1700	7.6	3500	15.6
P4100	3400	15.1	2600	11.6	4800	21.4
P5000	4000	17.8	2000	8.9	5500	24.5
P5500	5000	22.2	3500	15.6	8000	35.6
P9000	5000	22.2	3500	15.6	8000	35.6
P9200	5000	22.2	3500	15.6	8000	35.6

Safety Factor — 2-1/2

APPDX '2'

MAXIMUM ALLOWABLE PULL-OUT AND SLIP LOADS

Channel Nut Size/Thread	Gage	Channel	Allowable Pull-Out Strength		Resistance to Slip		Torque	
			Lbs	kN	Lbs	kN	Ft Lbs	N•m
3/4" - 10	12	P1000 P3000 P5000 P5500	2500	11.1	1700	7.6	125*	170
5/8" - 11			2500	11.1	1500	6.7	100*	135
1/2" - 13			2000	8.9	1500	6.7	50	70
7/16"- 14			1400	6.2	1000	4.4	35	50
3/8" - 16			1000	4.4	800	3.6	19	25
5/16"- 18			800	3.6	500	2.2	11	15
1/4" - 20			600	2.7	300	1.3	6	8
1/2" - 13	12	P3300	1500	6.7	1500	6.7	50	70
3/8" - 16			1000	4.4	800	3.6	19	25
5/16"- 18			800	3.6	500	2.2	11	15
1/4" - 20			600	2.7	300	1.3	6	8
1/2" - 13	14	P1100 & P4100	1400	6.2	1000	4.4	50	70
3/8" - 16			1000	4.4	750	3.3	19	25
5/16"- 18			800	3.6	400	1.8	11	15
1/4" - 20			600	2.7	300	1.3	6	8
1/2" - 13	16	P2000 & P4000	1000	4.4	1000	4.4	50	70
3/8" - 16			1000	4.4	750	3.3	19	25
5/16"- 18			800	3.6	400	1.8	11	15
1/4" - 20			600	2.7	300	1.3	6	8

* May require 3/8" or 1/2" thick fitting.
Nut design loads include a minimum safety factor of 3.
Note: Refer to the Channel Nut Selection Chart on the following two pages for the part number.

W320-24-038

DBE Analysis for the 1000 CFM Portable Exhausters (VTP-POR-007 & 008)

Fluor Daniel Northwest	CALCULATION IDENTIFICATION AND INDEX	Page i of Date JULY 1998

This sheet shows the status and description of the attached Design Analysis sheets.

Discipline STRUCTURAL WO/Job No. W-320 Calculation No. W-320-24-038

Project No. & Name W-320, TANK 241-C-106 WASTE RETRIEVAL

Calculation Item DBE ANALYSIS FOR THE 1000 CFM PORTABLE EXHAUSTERS (VTP-POR-007 & 008)

These calculations apply to:

Dwg. No. N/A Rev. No. N/A

Dwg. No. N/A Rev. No. N/A

Other (Study, CDR) CDR Rev. No. 0

The status of these calculations is:

- [] Preliminary Calculations
- [x] Final Calculations
- [] Check Calculations (On Calculation Dated)
- [] Void Calculation (Reason Voided)

Incorporated in Final Drawings? [] Yes [X] No

This calculation verified by independent "check" calculations? [x] Yes [] No

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	SAGuzzo 7/14/98		
Checked by	[signature] 7/14/98		
Approved by	JKoznik 7/16/98		
Checked Against Approved Vendor Data	JKoznik 7/16/98		

INDEX

Design Analysis Page No.	Description
	OBJECTIVE, DESIGN INPUT, ASSUMPTIONS, SUMMARY/CONCLUSIONS
	REFERENCES
1-5	SUPPORTING CALCULATIONS

A-6002-143 (01/97) GEF410

DESIGN VERIFICATION CHECKLIST

Document Reviewed: Project W-320, Tank 241-C-106 Waste Retrieval, DBE analysis for the 1000 CFM Exhausters (VTP-POR-007 & 008) calculation No. W-320-24-038

Author S. A. Fargo

Yes	No	N/A	
[X]	[ ]	[ ]	Problem completely defined.
[X]	[ ]	[ ]	Necessary assumptions explicitly stated and supported.
[ ]	[ ]	[X]	Computer codes and data files documented.
[X]	[ ]	[ ]	Data used in calculations explicitly stated in document.
[X]	[ ]	[ ]	Data checked for consistency with original source information as applicable.
[X]	[ ]	[ ]	Mathematical derivations checked, including dimensional consistency of results.
[ ]	[ ]	[X]	Models appropriate and used within range of validity or use outside range of established validity justified.
[X]	[ ]	[ ]	Hand calculations checked for errors.
[ ]	[ ]	[X]	Code run streams correct and consistent with analysis documentation.
[ ]	[ ]	[X]	Code output consistent with input and with results reported in analysis documentation.
[X]	[ ]	[ ]	Acceptability limits on analytical results applicable and supported. Limits checked against sources.
[X]	[ ]	[ ]	Safety margins consistent with good engineering practices.
[X]	[ ]	[ ]	Conclusions consistent with analytical results and applicable limits.
[X]	[ ]	[ ]	Results and conclusions address all points required in the problem statement.
	[None]		Software QA Log Number.

M. A. Islam (signature) 7/14/98
Reviewer Date

PROJECT W-320

DESIGN BASIS EARTHQUAKE ANALYSIS
FOR THE 1000 CFM PORTABLE EXHAUSTER
(Calculation No. W-320-24-038)

OBJECTIVE

The objective of this engineering evaluation is to analyze the existing 1000 CFM portable exhauster design (VTP-PRO-007 & 008) to determine whether the exhauster will overturn and/or slide during a DBE event for Non-Reactor Safety Class 1, per SDC 4.1 Rev.12.

DESIGN INPUT

This evaluation is based on the following input:

- DBE ground acceleration for Non-Reactor Safety Class facility as specified in SDC 4.1 Rev. 12.
- The exhausters are not restrained and can be resting on sand or concrete floor.
- Exhauster assembly including the skid were designed and qualified by Trentec, Inc. (Ref. 5).
- Weight of the assembly is taken from reference No. 5 and modified to include the new fan shaft mounting base.

ASSUMPTIONS

The coefficient of friction between steel and concrete is normally taken to be 0.70 however, the exhauster jack pads will be resting on smooth concrete surface indoors and loose sand and gravel surface while the unit is outdoors therefore, it is assumed that the coefficient of friction for both surfaces to be 0.50. All other assumptions are identified in the attached calculations.

SUMMARY/CONCLUSIONS

The analysis of the portable exhauster unit concluded that the exhauster will not overturn during a DBE event of 0.20g ZPA horizontal acceleration however, the exhauster assembly unit will slide during the DBE event. The sliding distance of the exhauster unit during the DBE event was calculated by equating the maximum Kinetic Energy to the maximum Potential Energy generated during the seismic event; the maximum distance the unit will travel was found to be 3.92 inches.

Calculation No. W-320-24-038

REFERENCES

1. American Concrete Institute, Building Code Requirements For Reinforced Concrete, ACI 318/318R-160.

2. HNF-SD-W320-FDC-001, Rev. 5, Functional Design Criteria for Tank 241-C-106 Waste Retrieval, Project W-320.

3. JABE-WADCO-02 Rev. 2, Seismic Design Criteria For The Fast Flux Test Facility, July 1975.

4. Mario Paz, "Structural Dynamics Theory And Computation," Chapter 8, 1980.

5. Trentec, Inc., Definitive Design Report 96675.2, Rev. 2, "Portable Exhauster System For Waste Tank Ventilation," October 1997.

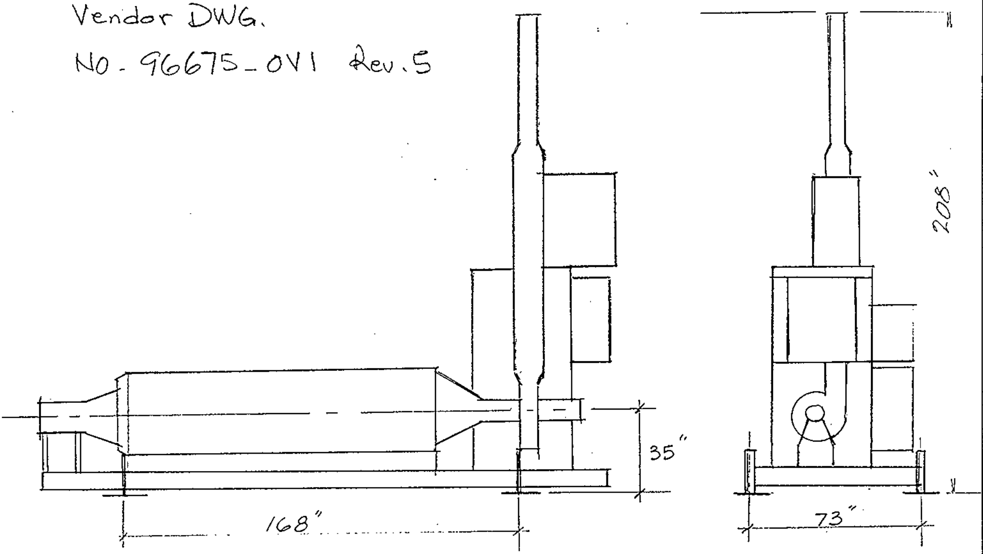
6. Farwell & Hendricks, Inc. Vendor Drawings Numbers 96675-0V1 Rev. 5, 96675-A01 Rev. 1, & 96675-0V2 Rev. 4.

FLUOR DANIEL NORTHWEST

CALCULATION SHEET

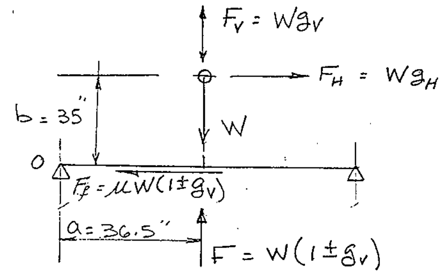
Client LMHC	Contract/Job No. W-320	Calc. No. W-320-24-038	Revision 0
Subject Project W-320	Originated By S. Vargas	Date 6/98	Page No. 1 of
DBE analysis for Portable exhauster	Checked By M. A. Islam	Date 7/14/98	
Location 200 E	Revised By	Date	

Reference:
Vendor DWG.
NO. 96675_0V1 Rev. 5



The C.G. is taken at 35" above the leveling Jack base (the center of the inlet - outlet duct). The C.G. estimate of 35" is based on a survey of the different Exhauster components and their location & weight.
The moment arm is the distance between the center of the Jacks (no credit is taken for the Jack pads as they are considered non-rigid; used for bearing only.)

Client LMHC	Contract/Job No. W-320		
Subject Project W-320	Originated By S. Fargo	Date 6/98	
DBE analysis for Portable Exhauster	Checked By M.A. Islam	Date 7/14/98	
Location 200 E	Revised By	Date	



ΣM_O

$$F_H\,(b) = F\,(a) \qquad \text{-----} \quad (1)$$

ΣF_{Horz}

$$F_H = F_f \qquad \text{-----} \quad (2)$$

Substituting

$$F_f\,(b) = F\,(a)$$
$$\mu W(1 \pm g_v)(b) = W(1 \pm g_v)(a)$$
$$\mu = \frac{a}{b}$$

For the System to overturn, $\mu > \frac{a}{b}$

$\frac{a}{b} = 1.04 > \mu = 0.5$ System Will not Overturn

Note: $\mu = 0.70$ for concrete & Smooth bar (Ref 1)
For this application, Steel on Smooth Concrete Surface or gravel Use $\mu = 0.50$

Check Sliding -

Sliding will take place if $F_H > F_f$

$$W g_H > \mu W (1 \pm g_V)$$

$$\mu < \frac{g_H}{1 - g_V}$$

$$g_H = 1.5 \sqrt{g_{H_x}^2 + g_{H_z}^2}$$

The design basis for W320 is SDC 4.1 Rev. 12 (Ref 2) For Non-Reactor SC-1, the max horizontal acceleration is 0.42 & max vertical is 0.28

$$g_H = 1.5 \sqrt{(0.42)^2 + (0.42)^2} = 0.891$$

$$g_V = 0.28$$

$$\mu = \frac{0.891}{1 - 0.28} = 1.24 > \mu = 0.5$$

The unit will slide; to find the distance the unit will slide set the Kinetic Energy KE_{max} = the Potential Energy PE_{max}

Conservative Assumptions:

- DBE produces 10 cycles of maximum response (Ref 3)
- Horizontal Response, is constant for all 10 cycles.
- Vertical Response, allways acts upward.
- Forcing Function is sinosoidal.

The maximum absolute acceleration – spectral acceleration ($S_a = \ddot{y}_{max}$)

The maximum relative Velocity - Spectral Velocity ($S_v = \dot{y}_{max}$)

The maximum relative displacement - Spectral displacement ($S_D = y_{max}$)

$$S_V = \omega S_D = \frac{S_a}{\omega} = \frac{a\, g_H}{2\pi f} \qquad \text{(Ref 4)}$$

The maximum Kinetic Energy

$$KE_{max} = \frac{1}{2} m v^2 = \frac{1}{2}\left(\frac{W}{a}\right)(S_V)^2$$

$$= \frac{1}{2}\left(\frac{W}{a}\right)\left(\frac{a^2 (g_H)^2}{4\pi^2 f^2}\right) = \frac{W a (g_H)^2}{8\pi^2 f^2}$$

The maximum Potential Energy

$$PE_{max} = F_f * y_{max} = W \mu (1 - g_v)\, y_{max}$$

Client LMHC	Contract/Job No. W-320	
Subject Project W-320	Originated By S-Farzan	Date 6/98
DBE analysis for portable Exhauster	Checked By M.A-Islam	Date 7/14/98
Location	Revised By	Date

$$KE_{max} = PE_{max}$$

$$\frac{Wa(g_H)^2}{8\pi^2 f^2} = W\mu(1-g_v)\, y_{max}$$

$$y_{max} = \frac{a(g_H)^2}{8\pi^2 f^2 \mu(1-g_v)} \qquad (a = 386.4\ in/sec^2)$$

For 10 cycles of maximum response

$$y_{max} = \frac{5a(g_H)^2}{4\pi^2 f^2 \mu(1-g_v)}$$

Considering the first mode natural Frequency
$f = 5.2363$ (Table 5.3 Ref 5)

NOTE: The frequencies of Table 5.3 are based on 0.12g ZPA and total exhauste assembly Weight = 8855 lb (Ref. 5). This evaluation is based on 0.20g ZPA and total weight of 9000 lb (145 lb added for the modified Fan Shaft-estimated per field inspection). This evaluation is concerned with the Skid (more rigid than the rest of the Components) also the first mode of $f = 5.2363$ Hz is used (conservative)

$$y_{max} = \frac{5(386.4)(0.891)^2}{4\pi^2(5.24)^2(0.5)(1-0.28)} = 3.92\ in$$

DISTRIBUTION SHEET

To	From	Page 1 of 1
Distribution	JW Bailey	Date 19 July 1998
Project Title/Work Order		EDT No. 622226
Project W-320 Tank 106-C, HNF-2468, Civil/Structural Calculations, Vol. 8		ECN No. n/a

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
JW Bailey	S2-48				
W-320 Project Files	R1-29				