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ENGINEERING DATA TRANSMITTAL

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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-2461	-	0	Project W-320, 241-C-106 Sluicing, Civil/Structural Calculations, Vol. 1	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		7/20/98	S2-48						
		Design Agent M.C. DAVENPORT		7/19/98							
2	1	Cog.Eng. ~~CE Graves~~			S2-48						
2	1	Cog. Mgr JW Bailey		7/20/98	S2-48						
		QA									
		Safety									
		Env.									

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

Project W-320, 241-C-106 Sluicing Civil/Structural Calculations, Vol. 1

John W. Bailey
Numatec Hanford Co., Richland, WA 99352
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 civil/structural calculations for Project W-320, readily retrievable.

DATE: JUL 23 1998
STA: 4
HANFORD RELEASE
ID: 58

Release Stamp

Kara A Broz 7/28/98

Release Approval Date

Approved for Public Release

Project W-320, 241-C-106 Sluicing Civil/Structural Calculations, Vol. 1

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W320-21-001

Drainage Runoff - Size Culverts

KAISER ENGINEERS HANFORD	CALCULATION IDENTIFICATION AND INDEX	Page i of iii Date 2/9/94

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

Discipline CIVIL/STRUCTURE WO/Job No. ER 4319 Calculation No. W320-21-001

Project No. & Name W320 TANK 241-C-106 SLUICING

Calculation Item DRAINAGE RUNOFF - SIZE CULVERTS

These calculations apply to:

Dwg. No. H-2-818424 Rev. No. 0

Dwg. No. H-2-818426 (2 SH) Rev. No. 0

Other (Study, CDR) Rev. No.

RONALD W. DAVIDSON
STATE OF WASHINGTON
24180
REGISTERED
PROFESSIONAL ENGINEER
EXPIRES 03/03/96

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	Patrick Finkman 2/9/94		
Checked by	James R Booth 2/10/94		
Approved by	[signature] 4/29/94		
Checked Against Approved Vendor Data	[signature] 8/21/96		

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Design Analysis Page No.	Description
1	OBJECTIVE, DESIGN INPUTS, CONCLUSION
2-10	CALCULATIONS FOR DRAINAGE RUNOFF & SIZING OF CULVERTS
11-15	GRAPHS, CHARTS AND DRAINAGE RUNOFF CRITERA FROM SEELYE'S
Attach A	RAINFALL INPUT FROM BATTELLE
Attach B	DRAINAGE AREA (IES 4319 C.14)

KEH 0378.00 (06/92)

CALCULATION CROSS INDEX (Typical)

Subject Calculation No. W320-21-001

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	
ϕ	–	NA	~	NA	~		✓		✓	[signature] 4/29/94

KEH 1975.00 (12/88)

SFS No. iii of iii

DESIGN VERIFICATION SCREENING CRITERIA

Project/Document No. W320-21-001

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] — Assigned Lead Engineer — Date: 4/29/94

[signature] — Responsible Discipline Manager — Date: 4/29/94

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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HANFORD

DESIGN ANALYSIS

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Client WESTINGHOUSE	WO/Job No. ER 4319		
Subject DRAINAGE RUNOFF - SIZE CULVERTS	Date 1/24/94	By	PB
DWG. NO. ES54319C14	Checked	By	JRB
Location 200E - INTERFARM TRANSF. SYSTEM	Revised	By	

OBJECTIVE: 1) TO CALCULATE THE AMOUNT OF RUNOFF FROM THE DRAINAGE AREAS AJACENT TO THE W320 PROJECT'S SCOPE OF WORK.

2) TO CALCULATE THE SIZE OF DRAINAGE CULVERTS REQUIRED TO DRAIN THE RUNOFF FROM THESE DRAINAGE AREAS.

CRITERIA: DOE 6430.1A

DATA: BATTELLE'S REPORT OF ATMOSPHERIC DATA FOR THE HANFORD SITE.

ASSUMPTIONS: SEE MAIN BODY OF CALCULATIONS

METHOD: RATIONAL METHOD FOR CALCULATION OF RUNOFF FOR DRAINAGE AREAS UNDER 160 ACRES.

REFERENCES: SEELYE'S DESIGN HANDBOOK FOR ENGINEERS
BATTELLE'S ATMOSPHERIC DATA REPORT

CONCLUSIONS: THE DRAINAGE RUNOFF QUANITIES AND SIZES OF CULVERTS ARE BASED UPON CONSERVATIVE FIGURES USING SEELY'S HANDBOOK OF DESIGN. THESE FIGURES WERE COMPARED WITH THE DATA INFORMATION SUPPLIED BY BATTELLE'S RAINFALL DATA REPORT AND WERE FOUND TO BE MORE CONSERVATIVE THAN INITALLY REQUIRED. TWO SIZES OF CULVERTS WERE CHECKED AND BOTH FOUND TO BE ADEQUALLY SIZE TO HANDLE THE AMOUNT OF RAINFALL CALCULATED. FINAL CULVERT SIZE WAS BASED OF SELECTION OF THE MOST ECONOMICAL ONE. USE 2 - 12" Ø CULVERTS TO DRAIN SITE.

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Client WESTINGHOUSE	WO/Job No. ER4319		
Subject DRAINAGE RUNOFF - SIZE CULVERTS	Date 1-24-94	By P. BRINKMAN	
DWG. NO. 1ES4319C14	Checked 2/7/94	By JRBooth	
Location 200E - INTERFARM TRANSF. SYSTEM	Revised	By	

1) CALCULATE DRAINAGE AREAS:

THERE ARE 2 - DRAINAGE AREAS
AREA 1 (W030 JOB & WEST OF TK. FARM 241-AZ)
AREA 2 (NORTH OF W030 SITE AND WEST OF TK. FARM 241-AN)

DRAINAGE AREA 1:
BOUNDARIES -
NORTH - ℄ OF ACCESS RD. TO TK. FARM 241-AZ
EAST - FENCE LINE OF TK. FARM 241-AZ
SOUTH - FENCE LINE BETWEEN TK FARM 241-AY & W030 SITE
WEST - ℄ OF BERM FOR SLUICING LINE

NOTE: SEE DWG. 1ES4319C14 FOR OUTLINE OF DRAINAGE AREAS

DRAINAGE AREA 2:
BOUNDARIES -
NORTH - ℄ OF ACCESS RD. TO TK. FARM 241-AN
EAST - FENCE LINE OF TK. FARM 241-AN
SOUTH - ℄ OF ACCESS RD. TO TK. FARM 241-AZ
WEST - ℄ OF BERM FOR SLUICING LINE

SIZE OF DRAINAGE AREA 1 - $\frac{235' \times 15'}{2} + 30' \times 80' + 205' \times 332' + 20' \times 200'$

$= 1762.5\,FT^2 + 2400\,FT^2 + 68060\,FT^2 + 4000\,FT^2$

$= \frac{76222.5\,FT^2}{43560\,FT^2/ACRE} = \boxed{1.75\ ACRES}$

SIZE OF DRAINAGE AREA 2 - $60' \times 15' + 163' \times 280' + 121' \times 15' + 115' \times 15'$

$+ \frac{235' \times 15'}{2} = 900\,FT^2 + 45640\,FT^2 + 1815\,FT^2$

$+ 1725\,FT^2 + 1762.50\,FT^2 = \frac{51,842.50\,FT^2}{43560\,FT^2/ACRE}$

$= \boxed{1.19\ ACRES}$

2) "C" VALUE:

FROM SEELYES' DESIGN MANUAL, PG. 8-02 "DRAINAGE - RUNOFF - 2" TABLE B - VALUES OF C FOR A EARTH SURFACE CONSISTING OF GRAVEL & SAND MIXTURES, NO SILT OR CLAY TO HIGH CLAY OR SILT CONTENT, USE A "C" VALUE OF 0.65 (MAX. VALUE FOR BARE SOIL) (SEE PG. 11)

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Subject DRAINAGE RUNOFF - SIZE CULVERTS	Date 1-24-94	By	P. BRINKMAN
DWG. NO. 1ES4319C14	Checked 2/7/94	By	JR. Booth
Location 200E - INTERFARM TRANSF. SYSTEM	Revised	By	

3) CALCULATE RAINFALL INTENSITY FOR A CALCULATED TIME OF CONCENTRATION (Tc) (AREA 1 & 2)

RAINFALL INTENSITY (INCHES PER HOUR) FOR A 25YR STORM FOR A 1 HOUR RAINFALL = 0.62 = I DATA IS SUPPLIED FROM BATTELLE - PACIFIC NORTHWEST LABORATORIES. ATTACHED COPY OF INFO FROM BATTELLE IS INCLUDED.

I = 0.62 IS THE ONE HOUR RAINFALL IN INCHES TO BE EXPECTED ONCE IN 25 YEARS. MORE CONSERVATIVE THAN USING 25YR/6 HR. STORM.

CALCULATE TIME OF CONCENTRATION (Tc) AND DETERMINE THE VALUE OF i (RAINFALL INTENSITY - DURATION) FOR THAT TIME OF CONCENTRATION.

TIME OF CONCENTRATION IS THE TIME THAT IT TAKES FOR WATER TO TRAVEL THE LONGEST ROUTE FROM THE HIGH POINT OF THE DRAINAGE AREA TO THE LOW POINT OF THE DRAINAGE AREA WHERE IT WILL BE DISCHARGED THRU A CULVERT.

SINCE VISUAL INSPECTION OF THE SITE DOES NOT AGREE WITH THE CONSTRUCTION DWGS., SOME ASSUMPTIONS WILL HAVE TO BE MADE CONCERNING HOW DRAINAGE AREA NO 1 WILL DRAIN AND THE FACTORS THAT WILL BE USED TO CALCULATE THE RUNOFF QUANTITIES FOR THAT AREA. CONSTRUCTION DWGS. SHOW DRAINAGE AREA 1 TO BE FLAT, GRADED TO A CONSTANT ELEV. OF 672.0'. HOWEVER, VISUAL INSPECTION OF THE AREA SHOWS THE AREA DRAINING FROM THE EAST-NORTHEAST TO THE SOUTHWEST CORNER OF THE SITE.

BY ADDING A BERM FROM PROJECT W-320 TO THE WEST SIDE OF DRAINAGE AREA 1, WE HAVE CUT OFF THE FLOW OF RAINWATER TO THE SOUTHWEST CORNER OF AREA 1. THE RAINWATER WILL NOW FLOW TO THE EAST SIDE OF THE BERM AND WILL POND NEXT TO THE BERM. TO AVOID THIS HAPPENING, THE GRADE NEXT TO THE BERM WILL HAVE TO BE BUILT UP HIGHER THUS ROUTING THE WATER AWAY FROM THE BERM. A SMALL SWALE OR DITCH WILL NEED TO BE ADDED TO DRAINAGE AREA 1. THIS DITCH OR SWALE WILL RUN PARALLEL TO THE BERM AND WILL HAVE A HIGH POINT @ THE SOUTH END AND A LOW POINT @ THE NORTH END. A DRAINAGE CULVERT WILL BE ADDED AT THE NORTH END TO CARRY THE RUNOFF FROM DRAINAGE AREA 1 INTO DRAINAGE AREA 2. THIS CULVERT WILL BE DESIGNED FOR A 25YR STORM AND SIZED TO CARRY THE TOTAL RUNOFF FROM DRAINAGE AREA 1.

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Client WESTINGHOUSE   WO/Job No. ER4319
Subject DRAINAGE RUNOFF - SIZE CULVERTS   Date 1-26-94   By P. BRINKMAN
DWG. NO. 1ES4319C14   Checked 2/7/94   By JR Booth
Location 200 E - INTERFARM TRANSF. SYSTEM   Revised   By

CALCULATE TOTAL TIME OF CONCENTRATION (T_C):
(FOR AREA 1)

IN DRAINAGE AREA 1, THERE ARE THREE (3) TIMES OF CONCENTRATION T_{C_1}, T_{C_2} & T_{C_3} TO BE CONSIDERED IN DETERMINING THE TOTAL

TIME OF CONCENTRATION. T_{C_1} IS THE TIME THAT WATER FLOWS OVERLAND FROM THE HIGH POINT OF THE AREA TO THE H.P. OF THE GRADED AREA (EL. 672.00'). T_{C_2} IS THE TIME THAT WATER FLOWS OVERLAND FROM EL. 672.00 TO H.P. SWALE EL. 671.50'. T_{C_3} IS THE TIME THAT WATER FLOWS ALONG A SWALE OR DITCH LOCATED ON THE WEST SIDE OF DRAINAGE AREA 1 AND ON THE EAST SIDE OF THE BERM. THESE THREE (3) TIMES OF CONCENTRATION WILL DETERMINE THE TOTAL TIME THAT IT TAKES FOR WATER TO FLOW FROM THE H.P. OF DRAINAGE AREA 1 TO THE L.P. OF DRAINAGE 1 LOCATED AT A NEW C.B.

TO CALCULATE THE INLET TIME OF CONCENTRATION USE SEELYE'S OVERLAND FLOW TIME CHART (FIG. H)
KNOW FACTORS:

1) CHARACTER OF GROUND = BARE SOIL
2) PERCENT OF SLOPE: USE A CALCULATED VALUE OR A MIN OF 0.50%
3) LENGTH OF FLOW - CALCULATED FROM DWG.

T_{C_1}: OVERLAND FLOW

L = 40' (DISTANCE GRAPHICALLY FROM H.P. EL OF 679.00 TO EL. 672.00')

$$S = \frac{H}{L} = \frac{679.00' - 672.00'}{40'} = \frac{7.0'}{40'} = 17.50\%$$

FOR A GROUND CHARACTER OF BARE SOIL AND A SLOPE OF 17.50%, INLET TIME OF CONC. WAS CALCULATE TO BE 2.0 MIN ± = T_{C_1}

T_{C_2}: OVERLAND FLOW

L = 170' (DISTANCE GRAPHICALLY FROM EL. 672.00' TO H.P. OF SWALE EL 671.50')

$$S = \frac{H}{L} = \frac{672.00' - 671.50'}{170'} = \frac{.50'}{170'} = .29\% \quad \text{USE } 0.50\% \text{ (MIN.)}$$

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Location 200E - INTERFARM TRANSF. SYSTEM	Revised	By	

FOR A GROUND CHARACTER OF BARE SOIL AND A SLOPE OF 0.50%, INLET TIME OF CONC. WAS CALCULATED TO BE 12.0 MINUTES = T_{C_2}

T_{C_3}: DITCH OR SWALE FLOW

L = 275.00' (DISTANCE GRAPHICALLY FROM H.P. SWALE EL. OF 671.50' TO L.P. SWALE EL. OF 670.00')

FROM SEELYE'S PAGE 18-05 "DRAINAGE-DITCHES-COMMON SECTIONS 1" USE D-1 "SEGMENTAL" FOR TYPE OF SWALE FOR DRAINAGE AREA 1. FROM SEELYES PAGE 18-06 "DRAINAGE-DITCHES-COMMON SECTIONS-2" FOR A DITCH SLOPE OF 0.0054 AND DITCH TYPE D_1, V = 1.89 FT/SEC.

$S_{DITCH} = \frac{H}{L} = \frac{671.50' - 670.00'}{275'} = \frac{1.50'}{275'}$

DITCH TIME = $\frac{275'}{1.89 \times 60}$ = 2.42 MIN. S = .0054

TOTAL TIME OF CONC. ($T_{C_{TOTAL}}$) = $T_{C_1} + T_{C_2} + T_{C_3}$ = 2.0 + 12.0 + 2.42

$T_{C_{TOTAL}}$ = 16.42 MINUTES USE 16.50 MIN. FROM CHART

4) CALCULATE RAINFALL INTENSITY (i) FOR A Tc OF 16.50 MINUTES

USE SEELYE'S RAINFALL INTENSITY-DURATION CHART (FIG. J "VALUES OF i") TO CALCULATE THE i VALUE

I = 0.62 INCHES PER HOUR (25 YR STORM FOR A 1 HOUR RAINFALL) USE THE 0.60 LINE OF FIG. J

FOR A I VALUE OF 0.60 & A Tc OF 16.50 MINUTES, i = 1.65

5) CALCULATE TOTAL FLOW (Q_T) FROM DRAINAGE AREA 1:

Q = A C i A = 1.75 ACRES
C = 0.65
= 1.75 × 0.65 × 1.65 i = 1.65 IN/HR.
= 1.88 CFS = 843.74 gal./MIN.

DESIGN CULVERT USING A Q OF 2.0 C.F.S.
VELOCITY IN CULVERT SHOULD BE A MIN. OF 2.50-3.0 FT/SEC. FOR CLEANOUT PURPOSES.

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Subject DRAINAGE RUNOFF - SIZE CULVERT | Date 1-27-94 | By P. BRINKMAN
DWG. NO. 1ES4319C14 | Checked 2/8/94 | By JR Booth
Location 200 E - INTERFARM TRANS. SYSTEM | Revised | By

6) DESIGN CULVERT (ASSUME CULVERT WILL BE FLOWING FULL)

CULVERT MATERIAL = CMP
"n" VALUE = UNPAVED ASPHALT COATED OR NON-COATED = 0.024

$Q = AV$ $\quad V = \frac{1.486}{n} \times R^{2/3} \times S^{1/2}$ $\quad Q = 2.0$ C.F.S.
$V = 2.5$ FT/SEC

$Q = A \times \frac{1.486}{n} \times R^{2/3} \times S^{1/2}$

CALCULATE AREA OF PIPE NEEDED FOR A FLOW OF 2.00 C.F.S. AND A VELOCITY OF 2.5 FT/SEC.

$A = \frac{Q}{V} = \frac{Q}{\frac{1.486}{n} \times R^{2/3} \times S^{1/2}}$

$A = \frac{2.00}{2.5} = 0.80\ FT^2$

A 12"ϕ CMP HAS AN AREA OF .785 FT^2

TO BE CONSERVATIVE USE A 15"ϕ CMP
CALCULATE SLOPE FOR A V = 2.50 FT/SEC

A 15"ϕ CMP HAS AN AREA OF 1.23 FT^2

$V = \frac{1.486}{n} R^{2/3} S^{1/2}$

$2.50 = \frac{1.486}{0.024} \times (.31)^{2/3} \times S^{1/2}$

$P = \pi d = \pi \times 1.25 = 3.93$

$R = \frac{A}{P} = \frac{1.23}{3.93} = .31$

$2.50 = 61.92 \times .458 \times S^{1/2}$

$\frac{2.50}{61.92 \times .458} = S^{1/2}$

USE A 15"ϕ CMP @ S = .0078

$\frac{2.50}{28.35936} = S^{1/2}$

CAPACITY OF CULVERT = Q = AV
$= 1.23 \times 2.50$
$= 3.075$ CFS.
> 2.0 CFS OK

$.088154 = S^{1/2}$

$S = .0078 = S$

NOTE:
15"ϕ CMP IS MORE CONSERVATIVE, WHILE A 12"ϕ CMP IS MORE ECONOMICAL

COULD ALSO USE A 12"ϕ CMP @ S = .010 V = 2.5 FT/SEC.

CAPACITY = Q = AV
$= .785 \times 2.50$
$= 1.962$ CFS > 1.92 CFS OK

7) CALCULATE TOTAL TIME OF CONCENTRATION (Tc):
(FOR DRAINAGE AREA 2)

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Client WESTINGHOUSE — WO/Job No. ER4319
Subject DRAINAGE RUNOFF - SIZE CULVERT — Date 1-27-94 By P. BRINKMAN
DWG. NO. IES4319C14 — Checked 2/7/94 By JR Booth
Location 200 E - INTERFARM TRANSF. SYSTEM — Revised By

IN DRAINAGE AREA 2, THER ARE FOUR (4) TIMES OF CONCENTRATION TC_1, TC_2, TC_3 & TC_4 TO BE CONSIDERED IN DETERMINING THE TOTAL

TIME OF CONCENTRATION. TC_1 IS THE TIME THAT WATER FLOWS OVERLAND FROM THE HIGH POINT OF THE AREA (EL. 673.22 ℄ ROAD) TO THE H.P. EL. OF THE GRADED AREA (EL. 670.00). TC_2 IS THE TIME THAT WATER FLOWS FROM EL 670.00 TO THE H.P. OF THE GRADED AREA (EL. 665). TC_3 IS THE TIME THAT WATER FLOWS OVERLAND FROM EL. 665.00 TO EL. 660.00'. TC_4 IS THE TIME THAT WATER FLOWS OVERLAND FROM EL. 660.00 TO THE L.P. OF DRAINAGE AREA 2 (EL. 658.00). THESE FOUR (4) TIMES OF CONCEN.. WILL DETERMINE THE TOTAL TIME THAT IT TAKES FOR WATER TO FLOW FROM THE H.P. OF DRAINAGE AREA 2 TO THE L.P. OF DRAINAGE 2 LOCATED AT A NEW CULVERT.

TC_1 = OVERLAND FLOW

L = 115.00' (DISTANCE GRAPHICALLY FROM H.P. EL. OF 673.22 TO EL. 670.00)

$$S = \frac{H}{L} = \frac{673.22 - 670.00}{115.00'} = \frac{3.22}{115} = .028 \times 100 = 2.8\%$$

FOR A GROUND CHARACTER OF BARE SOIL AND A SLOPE OF 2.8%, INLET TIME OF CONC. WAS CALCULATED TO BE 7.40 MIN = TC_1

TC_2 = OVERLAND FLOW

L = 20' (DISTANCE GRAPHICALLY FROM H.P. EL. OF 670.00 TO EL. 665.00)

$$S = \frac{H}{L} = \frac{670.00 - 665.00}{20'} = \frac{5.0}{20'} = 25\% \quad \text{(USE 20\% MAX)}$$

FROM FIG. H - OVERLAND FLOW TIME, BARE SOIL & A GROUND SLOPE OF 20%, TC_2 = 1.0 MIN (ESTIMATED)

TC_3 = OVERLAND FLOW

L = 145' (DISTANCE GRAPHICALLY FROM EL. 665.00 TO EL. 660.00)

$$S = \frac{H}{L} = \frac{665.00' - 660.00'}{145.0'} = \frac{5'}{145'} = 3.45\% \quad \text{USE 3.50\% SLOPE}$$

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DWG. NO. ES4319C14	Checked 2/8/94	By	JR Booth
Location 200E - INTERFARM TRANSF. SYSTEM	Revised	By	

FROM FIG. H - OVERLAND FLOW TIME, BARE SOIL & A GROUND SLOPE OF 3.50%, TC_3 = 7.78 MINUTES

TC_4 = OVERLAND FLOW

L = 125.0' (DISTANCE GRAPHICALLY FROM EL. 660.00 TO L.P. EL. 658.00)

$$S = \frac{H}{L} = \frac{660.00' - 658.00'}{125.00'} = \frac{2.0}{125.00'} = 1.60\%$$

FROM OVERLAND FLOW TIME CHART, FIG. H, FOR BARE SOIL, & A GROUND SLOPE OF 0.80%, TC_4 = 8.30 MINUTES

TOTAL TIME OF CONC. (TC_{TOTAL}) = $TC_1 + TC_2 + TC_3 + TC_4$ = 7.40 + 1.0 + 7.78 + 8.30 = 24.48 MINUTES USE 24.50 FROM CHART

8) CALCULATE RAINFALL INTENSIDE (i) FOR A TC OF 24.48 MINUTES

USE SEELYE'S RAINFALL INTENSITY - DURATION CHART (FIG. J - "VALUES OF i") TO CALCULATE THE i VALUE.

I = 0.62 INCHES/HOUR (25YR STORM - 1 HOUR RAINFALL)

FOR A I VALUE OF 0.60 & A TC OF 24.50 MINUTES, i = 1.25

9) CALCULATE TOTAL FLOW (Q_T) FROM DRAINAGE AREA 2:

$Q = ACi$ A = 1.19 ACRES
C = 0.65
i = 1.25

= 1.19 × 0.65 × 1.25
= 0.97 CFS.

DESIGN NEW CULVERT TO TAKE FLOW FROM BOTH DRAINAGE AREAS 1 & 2

CHECK TOTAL INLET TIME OF CONC. USE THE LONGEST TIME TO DETERMINE THE TOTAL FLOW OF WATER GOING INTO THE NEW CULVERT.

KAISER ENGINEERS HANFORD

DESIGN ANALYSIS

Calc. No. W320-21-001
Revision 0
Page No. 9 of 15

Client WESTINGHOUSE | WO/Job No. ER 4319
Subject DRAINAGE RUNOFF - SIZE CULVERT | Date 1-27-94 | By P. BRINKMAN
DWG. NO. 1ES4319614 | Checked 2/8/94 | By JR Booth
Location 200 E - INTERFARM TRANSF. SYSTEM | Revised | By

INLET TIME OF CONC. TO FIRST CULVERT = 16.42 MIN. (INTAKE OF PIPE) CALCULATE TIME OF CONC. FROM INLET SIDE OF CULVERT NO. 1 TO THE INLET SIDE OF CULVERT NO. 2

VELOCITY IN CULVERT = 2.50 FT/SEC
LENGTH OF CULVERT = 55.0'

$$Tc_4 = \frac{55.0'}{2.50\ FT/SEC} = \frac{22\ SEC}{60} = .37\ \text{MINUTES}$$

TIME OF CONCENTRATION (TC_5) = TIME IT TAKES FOR WATER TO FLOW FROM DISCHARGE OF CULVERT NO. 1 TO ELEV. 660.00

TC_5 = OVERLAND FLOW

L = 125.0' (DISTANCE GRAPHICALLY FROM CULVERT DISCH. TO EL. 660.00'

$$S = \frac{H}{L} = \frac{665.00 - 660.00'}{125.0'} = \frac{5.0'}{125.0'} = 4.0\%$$

FROM FIG. H - "OVERLAND FLOW TIME CHART", FOR A BARE SOIL & A GROUND SLOPE OF 4.0%, TC_4 = 7.10 MINUTES

INLET TIME OF CONCENTRATION (TC_6) FROM EL. 660.00 TO L.P. EL. 658.00 = INLET TIME OF CONCENTRATION (TC_4) FOR AREA 2

= 8.30 MIN.

TOTAL INLET TIME FROM H.P. DRAINAGE AREA 1 TO INTAKE @ CULVERT NO. 2 = 16.42 + .37 + 7.10 + 8.30 = 32.19 MINUTES (USE 32.0)

THIS TIME IS LONGER THAN THE INLET TIME CALCULATED FOR DRAIN AREA 2, USE TC OF 32.0 MINUTES TO CALCULATE NEW i VALUE.

FOR A I VALUE OF 0.60 & A TC OF 32.0 MINUTES, i = 1.10

TOTAL DRAINAGE AREA DRAINING INTO CULVERT NO. 2 = 1.75 + 1.19 = 2.94 ACRES ≈ 3 ACRES
USE 3.0 ACRES FOR CALCS.

$Q = ACi$
$= 3.0 \times 0.65 \times 1.10$
$= 2.145$ CFS

$A = 3.0$ ACRES
$C = 0.65$
$i = 1.10$

KAISER ENGINEERS HANFORD

Calc. No. W320-21-001
Revision φ
Page No. 10 of 15

DESIGN ANALYSIS

Client WESTINGHOUSE	WO/Job No. ER4319		
Subject DRAINAGE RUNOFF - SIZE CULVERT	Date 1-27-94	By	P. BRINKMAN
DWG. NO. H-2-54319-C1A	Checked 2/8/94	By	J.R. Booth
Location 200 E - INTERFARM TRANSF. SYSTEM	Revised	By	

DESIGN CULVERT № 2 USING A Q OF 2.15 C.F.S. VELOCITY IN CULVERT SHOULD BE A MIN. OF 2.50 - 3.0 FT/SEC. FOR CLEANOUT PURPOSES.

10) DESIGN CULVERT (ASSUME CULVERT WILL BE FLOWING FULL)

SEE PG. № 5 OF 9 FOR CULVERT DESIGN.

A 15"φ CMP @ S = .0078 WILL CARRY A CAPACITY OF 3.075 CFS. V = 2.50 FT/SEC.

USE A 15"φ C.M.P. FOR CULVERT NO. 2

A 12"φ CMP MAY BE USED WITH A VELOCITY OF 2.5 FT/SEC.

(12") $V = \frac{1.486}{n} R^{2/3} S^{1/2}$

$V = \frac{1.486}{.024} \times (.250)^{2/3} \times (.010)^{1/2}$

$= 61.917 \times .397 \times 0.10$

$= 2.45$ FT/SEC.

<u>NOTE</u>:

USING 2~15"φ CMP IS VERY CONSERVATIVE, 2~12"φ CMP IS MORE ECONOMICAL.

∴ USE 2~12"φ CMP W/ SLOPE S = 0.010

DRAINAGE — RUNOFF — 2

Q=Aci RATIONAL FORMULA (Logical approach).

RUNOFF = Peak discharge of watershed in cubic feet per second (c.f.s.) due to maximum storm assumed. See Figs. A to F, Pg. 18-01 (Usually 10-25 years).
A = Area of watershed in acres.
C = Coefficient of runoff, Table B below (Measure of losses due to infiltration, etc.).
i = Intensity of rainfall in inches per hour based on concentration time. See Pg. 18-01. Concentration time = time required for rain falling at most remote point to reach discharge point. Concentration time may include Overland flow time, Fig. H, Pg. 18-01, and Channel flow time, Pg. 18-05, 18-06, 18-69 and 18-71.

TABLE A-COMPUTATION FORM FOR RATIONAL FORMULA.

LOCATION			A			TIME OF FLOW-MIN.					DESIGN					PROFILE				
STREET	FROM	TO	INCREMENT	TOTAL	C	TO INLET	IN CHANNEL	TIME OF CONC.	i *	Q c.f.s.	CHANNEL OR PIPE SIZE	SLOPE ft. per ft.	n	CAPACITY FULL c.f.s.	V ft. per Sec.	LENGTH ft.	FALL ft.	OTHER LOSSES ft. ✝	INV. ELEV. UPPER END	INV. ELEV. LOWER END
FIRST ST.	A	B	1.8	1.8	.44	16.5	0.3	16.5	3.8	3.0	15"	.008	.015	4.6	3.9	60	0.48	0	82.00	81.52
MAIN RD.	B	C	1.9	3.7	.50		2.5	16.8	3.7	6.8	D-2	.011	.030	12.0	2.8	420	4.62	0	81.52	76.90
" "	C	D	2.0	5.7	.50		1.8	19.3	3.5	10.0	21"	.007	.015	11.1	4.5	480	3.36	2.20	74.70	70.34

*Note that the sequence of design as in example, Fig. J, Pg. 18-01 involves trial assumptions in determining i.
✝Fall in manhole.

TABLE B - VALUES OF $C = \frac{RUNOFF}{RAINFALL}$

SURFACES			VALUE PROPOSED MIN.	VALUE PROPOSED MAX.	VALUE BY OTHER AUTHORITY MIN.	VALUE BY OTHER AUTHORITY MAX.	
ROOFS, slag to metal.			0.90	1.00	0.70	0.95	①
PAVEMENTS	Concrete or Asphalt.		0.90	1.00	0.95	1.00	③
PAVEMENTS	Bituminous Macadam, open and closed type.		0.70	0.90	0.70	0.90	③
PAVEMENTS	Gravel, from clean and loose to clayey and compact.		0.25	0.70	0.15	0.30	①
R.R. YARDS			0.10	0.30	0.10	0.30	①
EARTH SURFACES	SAND, from uniform grain size, no fines, to well graded, some clay or silt.	Bare	0.15	0.50	0.01	0.55	④
		Light Vegetation	0.10	0.40	0.01	0.55	④
		Dense Vegetation	0.05	0.30	0.01	0.55	④
	LOAM, from sandy or gravelly to clayey.	Bare	0.20	0.60			
		Light Vegetation	0.10	0.45			
		Dense Vegetation	0.05	0.35			
	GRAVEL, from clean gravel and gravel sand mixtures, no silt or clay to high clay or silt content.	Bare	0.25	0.65			
		Light Vegetation	0.15	0.50			
		Dense Vegetation	0.10	0.40			
	CLAY, from coarse sandy or silty to pure colloidal clays.	Bare	0.30	0.75	0.10	0.70	④
		Light Vegetation	0.20	0.60	0.10	0.70	④
		Dense Vegetation	0.15	0.50	0.10	0.70	④
COMPOSITE AREAS	City, business areas.		0.60	0.75	0.60	0.95	⑤
	City, dense residential areas, vary as to soil and vegetation.		0.50	0.65	0.30	0.60	⑤
	Suburban residential areas. " " "		0.35	0.55	0.25	0.40	⑤
	Rural Districts, " " "		0.10	0.25	0.10	0.25	②
	Parks, Golf Courses, etc., " " "		0.10	0.35	0.05	0.25	①

NOTE: Values of "C" for earth surfaces are further varied by degree of saturation, compaction, surface irregularity and slope, by character of subsoil, and by presence of frost or glazed snow or ice.

① ...iant & Kuichling, Report, Back Bay Sewerage District, Boston, 1909.
② Metcalf and Eddy, American Sewerage Practice, 1928. McGraw-Hill.
③ Used by City of Boston, reported by Metcalf & Eddy.
④ Used by City of Detroit, reported by Metcalf & Eddy.
⑤ L.C. Urquhart, Civil Engineering Handbook, 1940. McGraw-Hill.

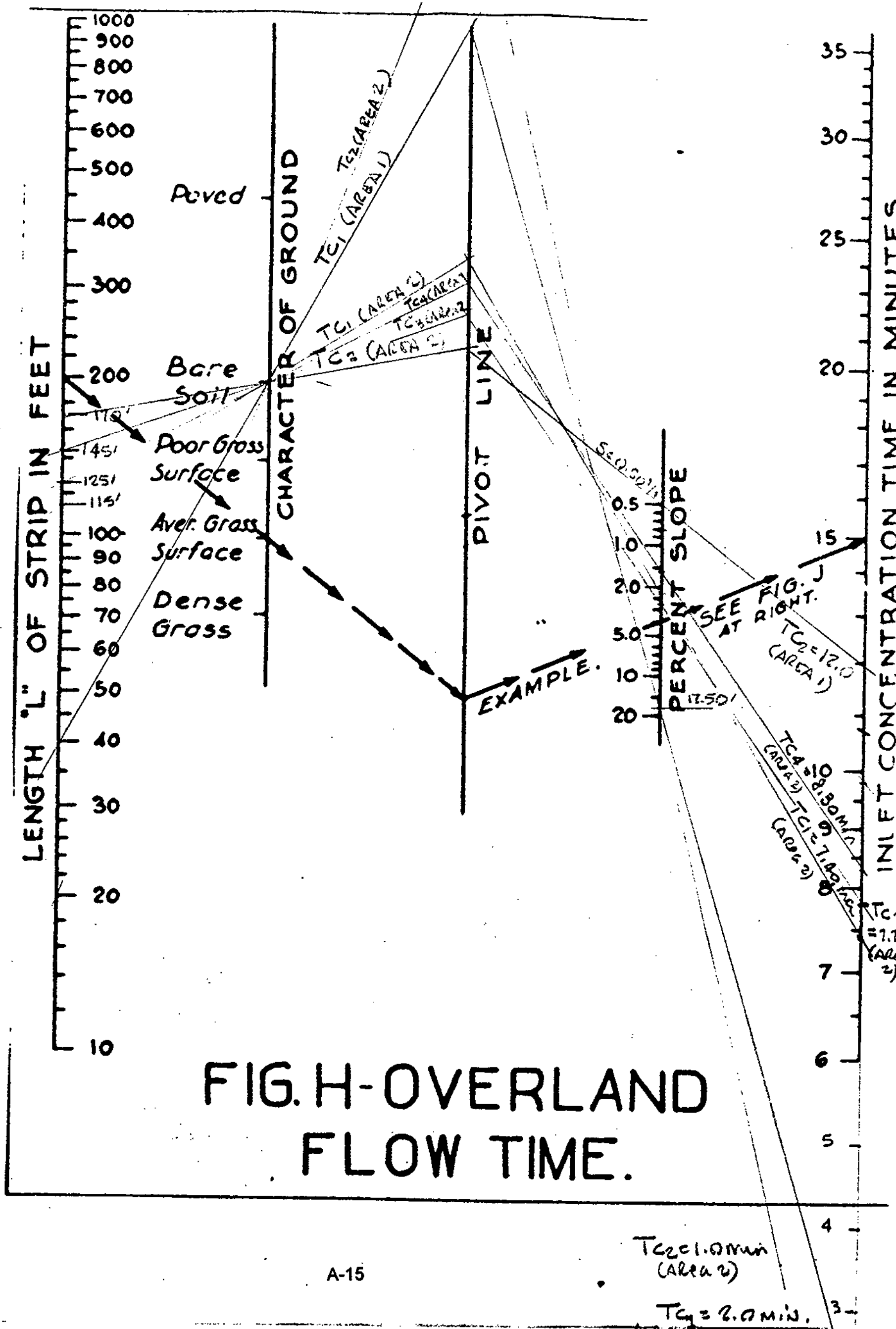
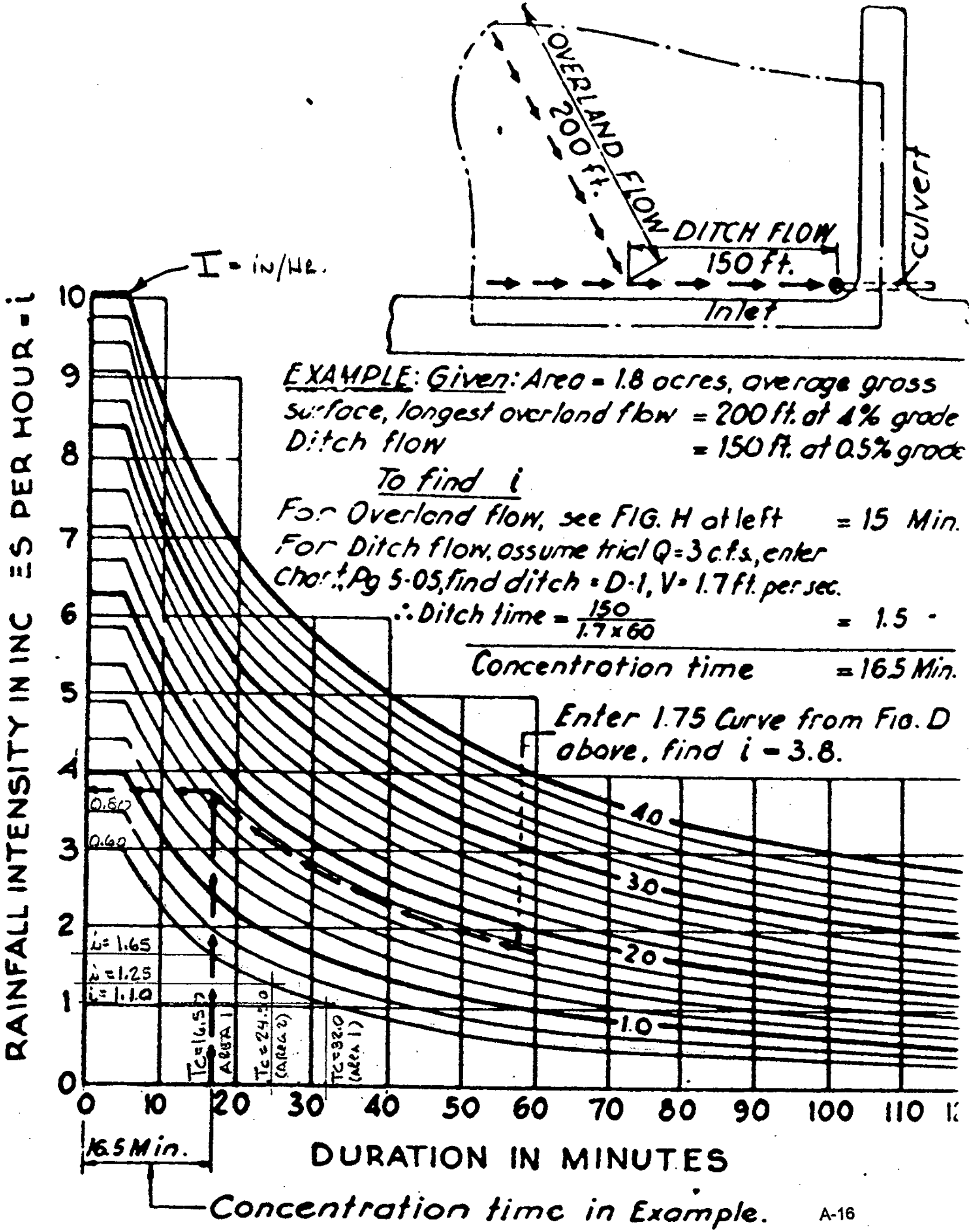
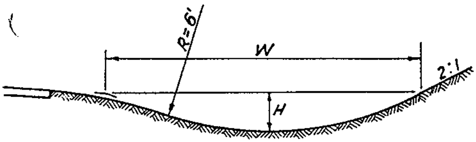


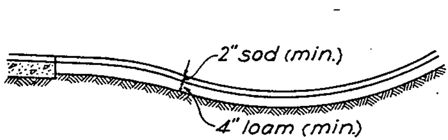
FIG. H-OVERLAND FLOW TIME.


OVERLAND FLOW
200 ft.
DITCH FLOW
150 ft.
Culvert
Inlet
I = in/Hr.
EXAMPLE: Given: Area = 1.8 acres, average gross surface, longest overland flow = 200 ft. at 4% grade
Ditch flow = 150 ft. at 0.5% grade
To find i
For Overland flow, see FIG. H at left = 15 Min.
For Ditch flow, assume trial Q = 3 c.f.s., enter Chart, Pg 5-05, find ditch = D-1, V = 1.7 ft. per sec.
∴ Ditch time = 150 / 1.7 x 60 = 1.5
Concentration time = 16.5 Min.
Enter 1.75 Curve from Fig. D above, find i = 3.8.
4.0
3.0
2.0
1.0
0.80
0.60
i = 1.65
i = 1.25
i = 1.10
Tc = 16.5 (AREA 1)
Tc = 24.0 (AREA 2)
Tc = 32.0 (AREA 1)
RAINFALL INTENSITY IN INCHES PER HOUR = i
DURATION IN MINUTES
16.5 Min.
Concentration time in Example.

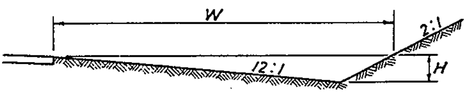
DRAINAGE- DITCHES - COMMON SECTIONS - I



D-1 SEGMENTAL

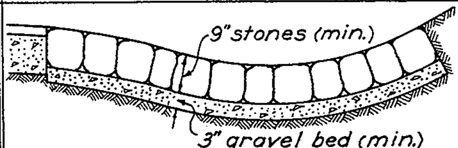


SODDED GUTTER

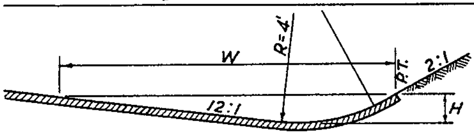


D-1A TRIANGULAR

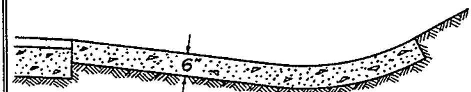
Unequal side slopes



COBBLED GUTTER

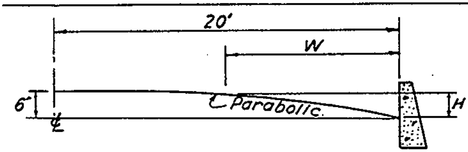


D-1B BITUMINOUS GUTTER

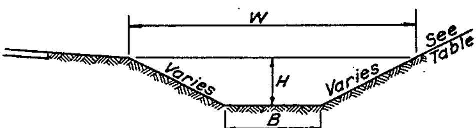


Base required same as for concrete pavement.

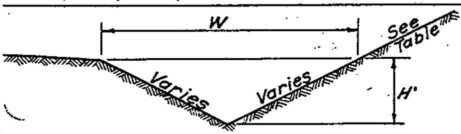
CONCRETE GUTTER



D-1C CURBED CROWNED STREET



D-2, D-3, D-4, D-5 TRAPEZOIDAL



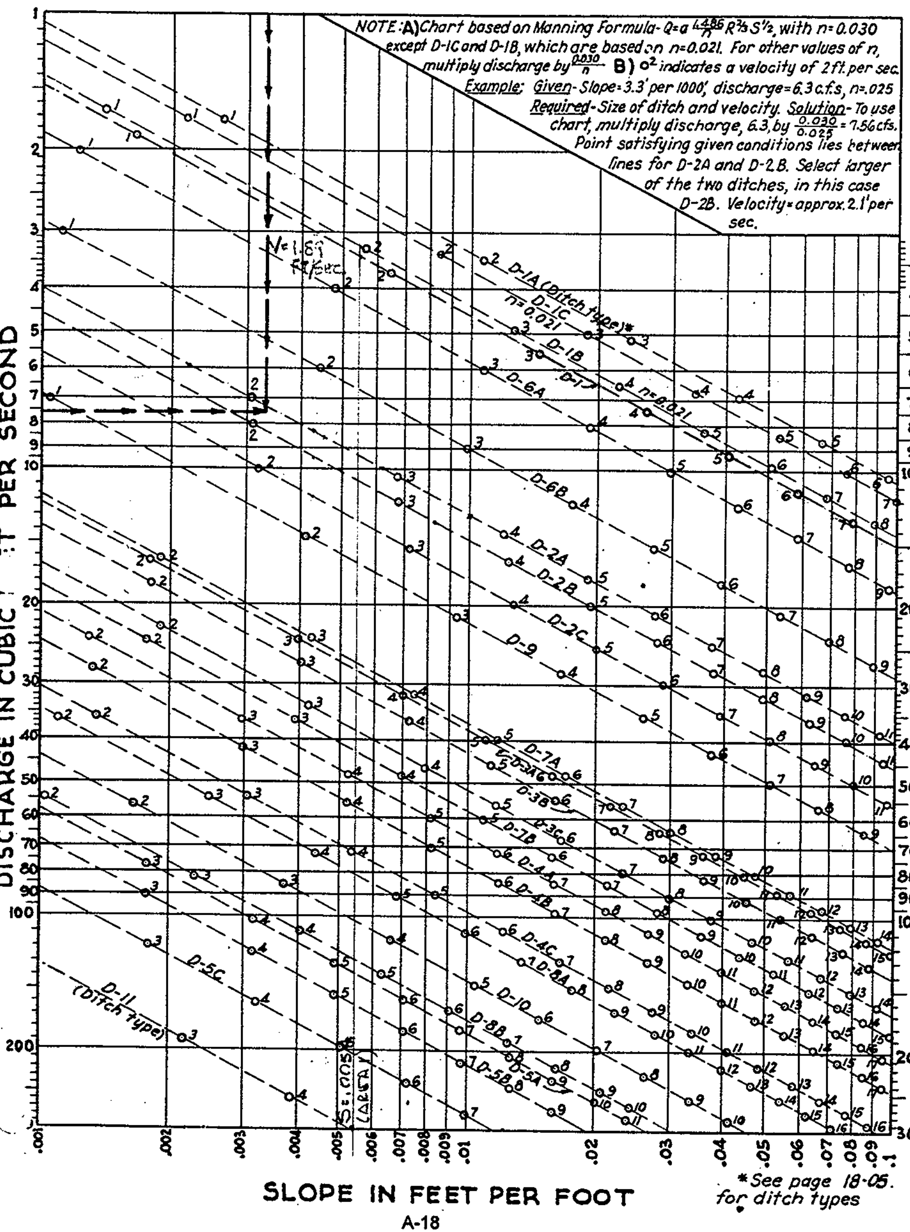
D-6, D-7, D-8, D-9, D-10, D-11
ISOSCELES TRIANGULAR

D-9, D-10 and D-11 - Airport ditches

TABLE A — PROPERTIES OF DITCHES.

NO.	DIMENSIONS				HYDRAULICS			
	SIDE SLOPES	B	H	W	a	p	R	$R^{2/3}$
D-1	—	—	6½"	5'-0"	1.84	5.16	0.356	0.502
D-1A	12:1 & 2:1	—	6"	7'-0"	1.75	7.14	0.245	0.392
D-1B	12:1 & 2:1	—	5"±	7'-0"	1.64	7.08	0.232	0.377
D-1C	½" to 1'-0"	—	4.5"	10'-0"	1.68	10.38	0.162	0.297
D-2A	1½:1'	2'-0"	1'-0"	5'-0"	3.50	5.61	0.624	0.730
B	2:1	2'-0"	1'-0"	6'-0"	4.00	6.47	0.618	0.726
C	3:1	2'-0"	1'-0"	8'-0"	5.00	8.32	0.601	0.712
D-3A	1½:1	3'-0"	1'-6"	7'-6"	7.88	8.41	0.937	0.958
B	2:1	3'-0"	1'-6"	9'-0"	9.00	9.71	0.927	0.951
C	3:1	3'-0"	1'-6"	12'-0"	11.25	12.49	0.901	0.933
D-4A	1½:1	3'-0"	2'-0"	9'-0"	12.00	10.21	1.175	1.114
B	2:1	3'-0"	2'-0"	11'-0"	14.00	11.94	1.173	1.112
C	3:1	3'-0"	2'-0"	15'-0"	18.00	15.65	1.150	1.097
D-5A	1½:1	4'-0"	3'-0"	13'-0"	25.50	14.82	1.721	1.436
B	2:1	4'-0"	3'-0"	16'-0"	30.00	17.42	1.722	1.437
C	3:1	4'-0"	3'-0'	22'-0"	39.00	22.97	1.698	1.423
D-6A	2:1	—	1'-0"	4'-0"	2.00	4.47	0.447	0.584
B	3:1	—	1'-0"	6'-0"	3.00	6.32	0.475	0.609
D-7A	2:1	—	2'-0"	8'-0"	8.00	8.94	0.895	0.929
B	3:1	—	2'-0"	12'-0"	12.00	12.65	0.949	0.965
D-8A	2:1	—	3'-0"	12'-0"	18.00	13.42	1.341	1.216
B	3:1	—	3'-0"	18'-0"	27.00	18.97	1.423	1.265
D-9	7:1	—	1'-0"	14'-0"	7.00	14.14	0.495	0.626
D-10	7:1	—	2'-0"	28'-0"	28.00	28.28	0.990	0.993
D-11	7:1	—	3'-0"	42'-0"	63.00	42.43	1.485	1.302

DRAINAGE-DITCHES-COMMON SECTIONS-2



Attach A-1

Battelle
Pacific Northwest Laboratories
P.O. Box 999
Richland, Washington U.S.A. 99352
Telephone (509)
Telex 15-2874

FACSIMILE: (509) 373-2865
VERIFICATION: (509 373-2716

DATE: Jim Booth

TO: 1-17-94

FROM: Ora Gifford

COMPANY:

PHONE: ( ) 373-3216

PHONE: ( )

CITY/STATE:

FACSIMILE NO: ( ) 376-9399

VERIFICATION: ( ) 376-4226

ATMOSPHERIC SCIENCES DEPARTMENT
P.O. BOX 999
RICHLAND WA 99352

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THIS TRANSMISSION CONSISTS OF 3 PAGES EXCLUDING COVER PAGE.

TABLE 61. Average Return Period (R) and Existing Record (ER) for Various Precipitation Amounts and Intensity During Specified Time Periods at Hanford (Based on Extreme Value Analysis of 1947 Through 1969 Records)

R (YEARS)	AMOUNT (INCHES) TIME PERIOD 20 MIN	60 MIN	2 HRS	3 HRS	6 HRS	12 HRS	24 HRS	INTENSITY (INCHES PER HOUR) TIME PERIOD 20 MIN	60 MIN	2 HRS	3 HRS	6 HRS	12 HRS	24 HRS
2	0.16	0.26	0.30	0.36	0.48	0.62	0.72	0.49	0.26	0.15	0.12	0.08	0.052	0.030
5	0.24	0.40	0.48	0.55	0.77	0.95	1.06	0.72	0.40	0.24	0.18	0.13	0.079	0.044
10	0.37	0.50	0.59	0.67	0.96	1.17	1.28	1.1	0.50	0.30	0.22	0.16	0.098	0.053
25	0.47	0.62	0.74	0.83	1.21	1.45	1.56	1.4	0.62	0.37	0.28	0.20	0.121	0.065
50	0.53	0.72	0.85	0.96	1.40	1.66	1.77	1.6	0.72	0.42	0.32	0.23	0.138	0.074
100	0.60	0.81	0.96	1.07	1.59	1.87	1.99	1.8	0.81	0.48	0.36	0.27	0.156	0.083
250	0.68	0.93	1.11	1.22	1.82	2.13	2.26	2.0	0.93	0.55	0.41	0.30	0.177	0.094
500	0.73	1.02	1.22	1.33	2.00	2.34	2.47	2.2	1.02	0.61	0.44	0.33	0.195	0.103
1000	0.80	1.11	1.33	1.45	2.20	2.55	2.68	2.4	1.11	0.67	0.48	0.37	0.212	0.112
ER	*	0.59	0.88	1.08	1.68	1.88	1.91	*	0.59	0.44	0.36	0.28	0.157	0.080
		6/12	10/1	10/1	10/1-2	10/1-2	10/1-2		6/12	10/1	10/1	10/1-2	10/1-2	10/1-2
DATE	--	1969	1957	1957	1957	1957	1957	--	1969	1957	1957	1957	1957	1957

* NO RECORDS HAVE BEEN KEPT FOR TIME PERIODS OF LESS THAN 60 MINUTES. HOWEVER, THE RAIN GAGE CHART FOR 6-12-69 SHOWS THAT 0.55 INCH OCCURRED DURING A 20-MINUTE PERIOD FROM 1835 TO 1855 PST. AN ADDITIONAL 0.04 INCH OCCURRED BETWEEN 1855 AND 1910 TO ACCOUNT FOR THE RECORD 60-MINUTE AMOUNT OF 0.59 INCH.

Attach. A-2

Attach A-3

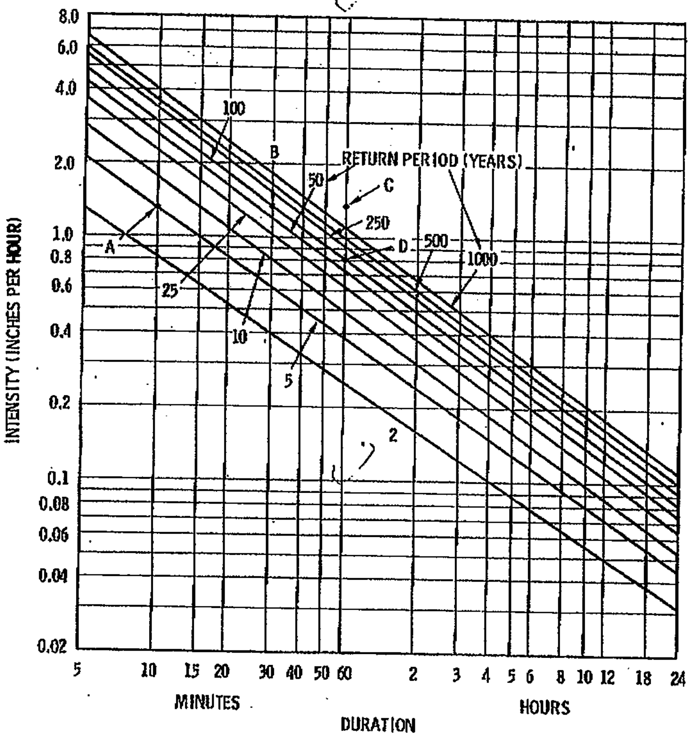


FIGURE 36. Rainfall Intensity, Duration and Frequency Based on the Period 1947 to 1969 at Hanford

TO USE THIS CHART, SELECT ANY DESIRED RAINFALL INTENSITY AND DURATION AND READ FROM THE DIAGONAL LINES THE EXPECTED FREQUENCY OF SUCH INTENSITY AND DURATION. FOR EXAMPLE, RAINFALL INTENSITY OF 1.3 INCHES PER HOUR FOR 10 MINUTES CAN BE EXPECTED TO OCCUR, ON AVERAGE, ONCE EVERY 5 YEARS (POINT A). HOWEVER, SUCH INTENSITY CAN BE EXPECTED FOR 30 MINUTES DURATION ONLY ABOUT ONCE IN 100 YEARS (POINT B). THE RETURN PERIOD FOR THIS INTENSITY FOR 60 MINUTES DURATION IS GREATER THAN 1000 YEARS (POINT C).

THERE ARE, OF COURSE, VARIATIONS IN USE OF THE CHART. SUPPOSE, FOR EXAMPLE, IT IS DESIRED TO FIND THE "100-YEAR STORM" FOR 60 MINUTES. THIS IS 0.8 INCH (POINT D).

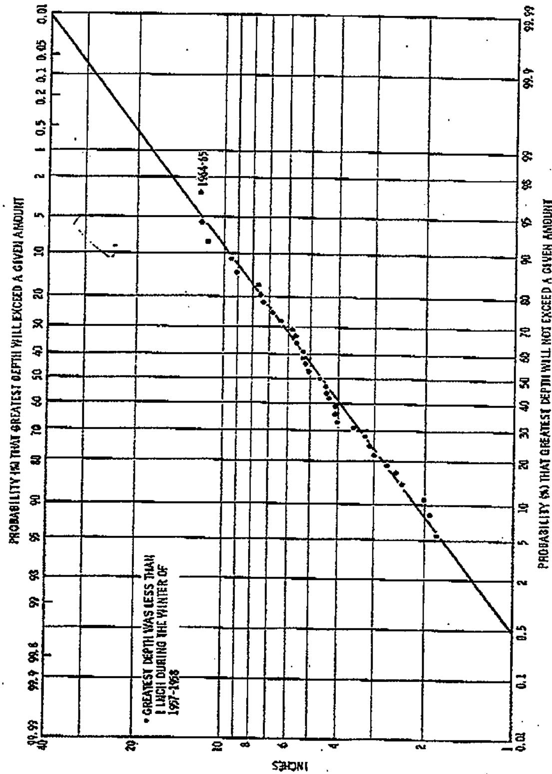
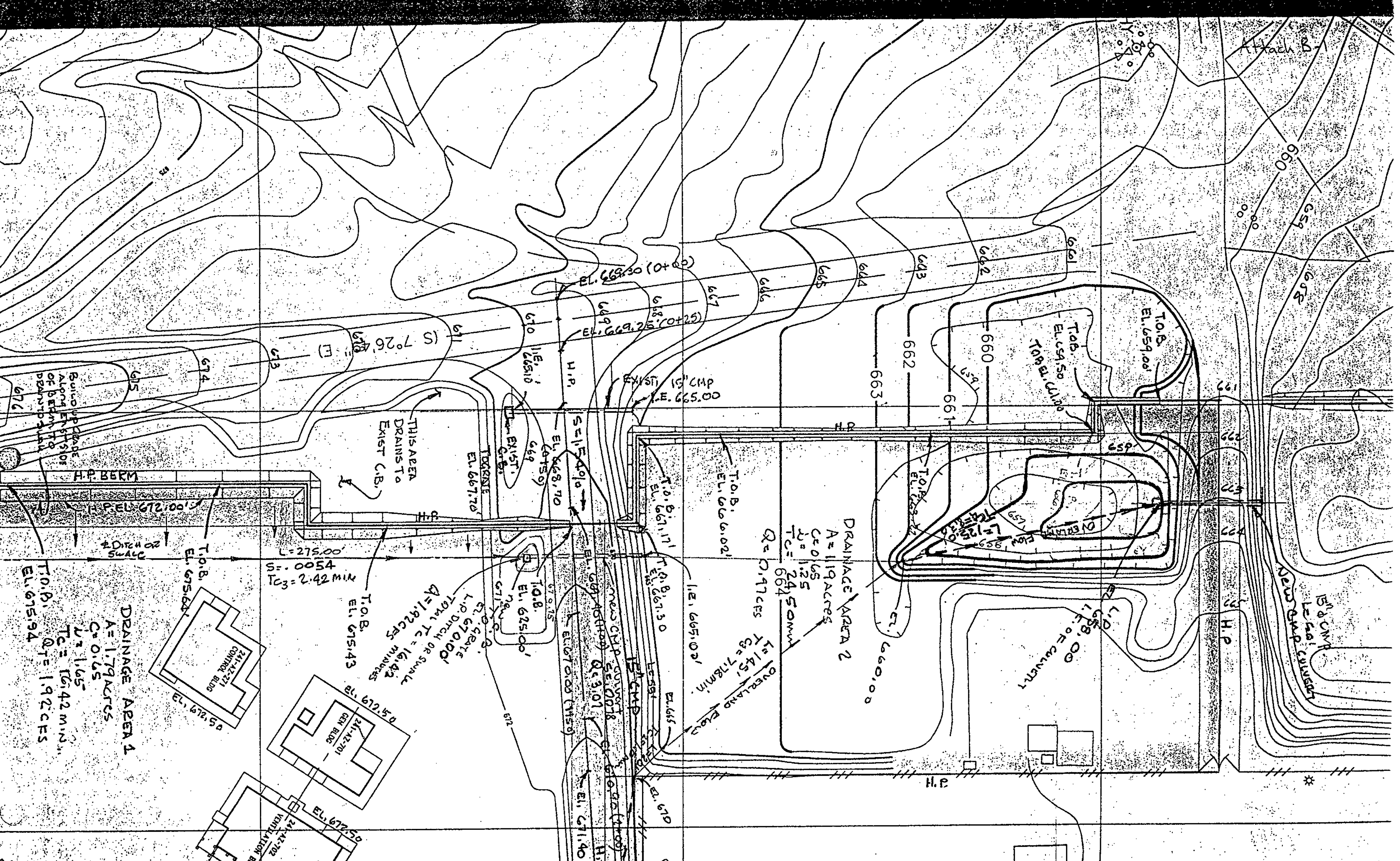
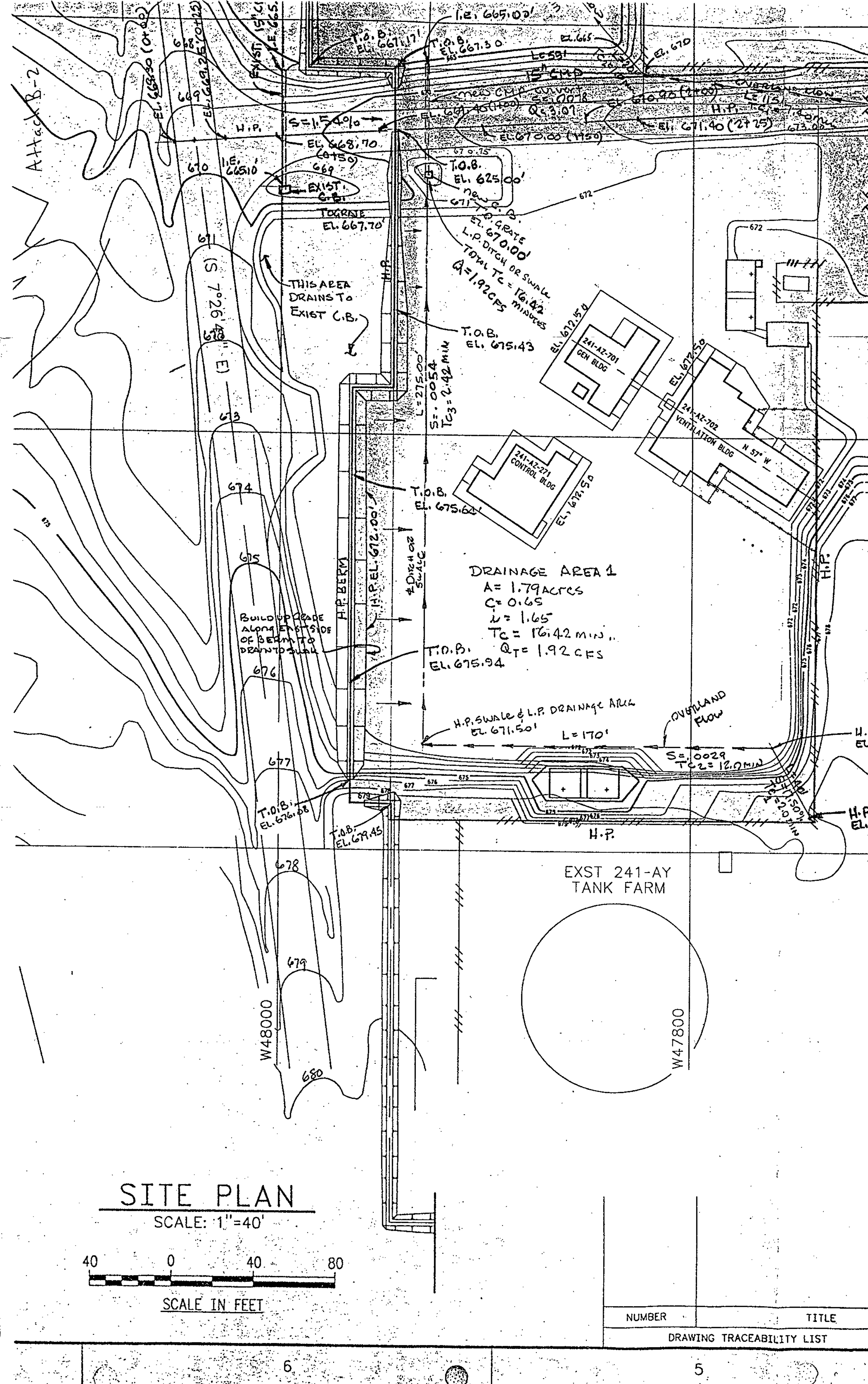


FIGURE 18. Greatest Depth of Snow on Ground During Winters of Record at Hanford 1946-47 Through 1980-81*


Attach B-1
DRAINAGE AREA 1
A = 1.79 ACRES
C = 0.65
i_2 = 1.65
Tc = 16.42 min.
T.O.B. Q = 1.92 CFS
EL. 675.94
H.P. BERM
H.P. EL. 672.00'
Build up grade along east side of berm to drain to swale
T.O.B. EL. 675.64
Ditch or swale
L = 275.00'
S = .0054
Tc_3 = 2.42 MIN
T.O.B. EL. 675.43
THIS AREA DRAINS TO EXIST C.B.
T.O. GRATE EL. 667.70
EXIST. C.B.
I.E. 665.10
H.P.
S = 1.5 4.0%
EL. 669.30 (0+00)
EL. 669.25 (0+25)
(S 7°26'40" E)
EXIST. 15" CMP
I.E. 665.00
T.O.B. EL. 625.00'
new C.B.
T.O. GRATE EL. 670.00
L.P. DITCH OR SWALE
Total Tc = 16.42 minutes
Q = 1.92 CFS
New CMP culvert
S = .0078
Q = 3.07
15" CMP
EL. 670.00 (1+50)
EL. 671.40 (2+20)
EL. 670
EL. 665
T.O.B. EL. 667.30
T.O.B. EL. 667.17'
I.E. 665.00'
T.O.B. EL. 666.02'
DRAINAGE AREA 2
A = 1.19 ACRES
C = 0.65
i_2 = 1.25
Tc = 24.50 min
Q = 0.97 CFS
Overland flow
L = 145'
Tc_3 = 7.18 min.
EL. 660.00
H.P.
T.O.B. EL. 659.50
TOP OF EL. 661.00
T.O.B. EL. 659.00'
OVERLAND FLOW
L = 125.00'
L.P. EL. 658.00
I.E. OF CULVERT
New CMP culvert
15" CMP
CONTROL BLDG 241-AZ-271
EL. 672.50
GEN BLDG 241-AZ-701
VENTILATION BLDG 241-AZ-702
663
662
661
660


SITE PLAN
SCALE: 1"=40'
40 0 40 80
SCALE IN FEET
NUMBER
TITLE
DRAWING TRACEABILITY LIST
6
5
EXST 241-AY
TANK FARM
W47800
W48000
DRAINAGE AREA 1
A= 1.79acres
C= 0.65
i = 1.65
Tc = 16.42 MIN.
QT = 1.92 CFS
T.O.B.
EL. 675.94
H.P. SWALE & L.P. DRAINAGE AREA
EL. 671.50'
L = 170'
OVERLAND FLOW
S= .0029
Tc2= 12.0 MIN
H.P.
H.P. BERM
H.P. EL. 672.00'
BUILD UP GRADE ALONG EAST SIDE OF BERM TO DRAIN TO SWALE
T.O.B.
EL. 675.64'
T.O.B.
EL. 675.43
L = 275.00'
S= .0054
Tc3 = 2.42 MIN
THIS AREA DRAINS TO EXIST C.B.
new C.B.
T.O. GRATE
EL. 670.00'
L.P. DITCH OR SWALE
TOTAL Tc = 16.42 minutes
Q=1.92 CFS
T.O.B.
EL. 625.00'
EXIST. C.B.
TO GRATE
EL. 667.70'
I.E. 665.10'
EL. 668.70
(0+50)
S=1.540%
new CMP culvert
S=.0078
Q=3.07
EL. 670.00 (1+50)
EL. 671.40 (2+25)
15" CMP
L=59'
T.O.B. EL. 667.17'
T.O.B. EL. 667.30
I.E. 665.00'
EL. 665
EL. 670
T.O.B. EL. 676.08
T.O.B. EL. 679.45
241-AZ-701 GEN BLDG
EL. 672.50
241-AZ-702 VENTILATION BLDG
N 57° W
241-AZ-271 CONTROL BLDG
(S 7°26'48" E)
Attach B-2

W320-21-002

W-320 Site Drainage at the Interfarm Transfer Line and C-Farm

	CALCULATION IDENTIFICATION AND INDEX	Page i of ii Date 03/18/97

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

Discipline: CIVIL WO/Job No.: E34262/ W-320 Calculation No.: W320-21-002

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

Calculation Item: W-320 SITE DRAINAGE AT THE INTERFARM TRANSFER LINE AND C FARM

These calculations apply to:

Dwg. No. H-2-818424 Sh 1, H-2-818426 Sh 1 Rev. No. 1/1

Dwg. No. H-2-818428 Sh 1, H-2-818431 Sh 1 Rev. No. 1/1

Other (Study, CDR): None 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 R. Custer Michael R. Custer 3/27/97		
Checked by	R. Dauter 4/1/97		
Approved by	R. Dauter 4/1/97		
Checked Against Approved Vendor Data	N/A		

INDEX

Design Analysis Page No.	Description
i	Calculation Identification and Index
ii	Calculation Cross Index
1	OBJECTIVE; CRITERIA; DATA; ASSUMPTIONS; METHODS; REFERENCES
2	CALCULATIONS; CONCLUSIONS
3-6	DESIGN / ANALYSIS
ATTACH. A	SEELYE'S (Graphs, Charts and Drainage Runoff Criteria), (5 Sheets)
ATTACH. B	ECN DRAWINGS (4 Sheets)

CALCULATION CROSS INDEX (Typical)

Subject Calculation No. W320-21-002, REV. 0

Page ii of ii

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-2-818424, Sh. 1	1	H-2-818424, Sh 1	1		✓		✓	
		H-2-818426, Sh. 1	1	H-2-818426, Sh 1	1		✓		✓	
		H-2-818428, Sh 1	1	H-2-818428, Sh 1	1		✓		✓	
		H-2-818431, Sh 1	1	H-2-818431, Sh 1	1		✓		✓	

KEH 1975.00 (12/88)

		Calc. No.: W320-21-002
		Revision: 0
DESIGN ANALYSIS		Page No.: 1 of 6
Client: NUMATEC HANFORD CORPORATION	WO/Job No. E34262/ W-320	
Subject: W-320 SITE DRAINAGE AT THE INTERFARM TRANSFER LINE AND C FARM	Date: 03/18/96	By: M R Custer MRC
	Checked: 4/1/97	By: RD
Location: TANK 241-C-106, 200E	Revised:	By:

OBJECTIVE:

The objective of this calculation is to determine the flow rates and design flow paths, as required to resolve flooding and erosion problems occurring at the InterfarmTransfer line berm and along the north fence of Tank 241-C-106. Recent rainfall has resulted in a breach in the berm of the InterfarmTransfer line and flooding of underground electrical vaults/ handholds and local erosion adjacent to and inside the north fence line in C farm.

CRITERIA:

1. WHC-SD-W320-FDC-001, Revision 2

DATA:

1. Battelle's Report of atmospheric data for the Hanford site.

ASSUMPTIONS:

1. Refer to the Design/ Analysis section of the calculation.

METHODS:

1. The Rational method for calculating runoff for drainage areas under 160 acres.

REFERENCES:

1. Drawing H-2-818424, Sh 1, Rev 0
2. Drawing H-2-818426, Sh 1, Rev 0
3. Drawing H-2-818428, Sh 1, Rev 0
4. Drawing H-2-818431, Sh 1, Rev 0
5. Seelye's Design Handbook for Engineers
6. Battelle's Atmospheric Data Report

		Calc. No.: W320-21-002
		Revision: 0
DESIGN ANALYSIS		Page No.: 2 of 6
Client: NUMATEC HANFORD CORPORATION	WO/Job No. E34262/ W-320	
Subject: W-320 SITE DRAINAGE AT THE INTERFARM TRANSFER LINE AND C FARM	Date: 03/18/96	By: M. R Custer MRC
	Checked: 4/4/97	By: RD
Location: TANK 241-C-106, 200E	Revised:	By:

CALCULATIONS:

Refer to the DESIGN/ ANAYSIS SECTION.

CONCLUSIONS:

The preceding evaluation provides design changes which satisfies the project design requirements and when implemented, will adequately address the flooding and erosion problems occurring at the locations described in the OBJECTIVE section of the calculation.

	Calc. No. W320-21-002
	Revision 0
DESIGN ANALYSIS	Page No. 3 of 6
Client: NUMATEC HANFORD CORPORATION	WO/Job No. E34262/ W-320
Subject: W320 SITE DRAINAGE AT THE INTERFARM TRANSFER LINE AND C FARMS	Date: 03/18/97 By: M.R Custer MRC
	Checked: 4/1/97 By: RD
Location: 241-C-106, 200E AREA	Revised: By:

DESIGN/ANALYSIS:

This calculation is provided to evaluate the drainage areas contributing to the flooding and erosion occurring at the Inter-farm Transfer Line and the area along the north fence line of C Farm. The evaluation will be developed in two parts, (1) the Inter-farm Transfer Line area and, (2) C Farm area.

INTER-FARM TRANSFER LINE AREA:

The drainage area south of Seventh Avenue and west of Buffalo Avenue is currently contributing runoff to the drainage system located on the east side of Buffalo Avenue. This runoff in combination with the existing flow on the east side, results in flooding conditions during occasional periods of heavy rainfall. The total runoff on the east side of Buffalo Avenue, flows into a low area southeast of intersection of Seventh and Buffalo Avenues, adjacent to the Inter-farmTransfer line berm. After ponding develops, the runoff overflows (north) across Seventh Avenue, along the berm to another low area at a 90 degree turn in the berm. Depending on the duration of the rainfall, portions of the berm at this location are eroded, as the flow continues through the berm and into the natural drainage route. Resolution of this condition consists of (1) providing drainage flow paths for the isolated (low) areas along the berm and, (2) determine the drainage area and flow rate originating on the west side of Buffalo Avenue and designing an independent drainage system for this flow. The drainage system on the east side of Buffalo Avenue currently consists of a watershed area of approximately, 3 acres (Reference to calculation W320-21-001, Rev 0).

1) Determine the approximate drainage area southwest of the intersection of Seventh and Buffalo Avenue:

- Width of the drainage area along Seventh Avenue = 500 ft
- Length of the drainage area along Buffalo Avenue = 1000 ft

AREA = 0.5 (500 ft X 1000 ft) = 250000 sq ft = **5.7 acres**

2) Determine the slope and drainage routes for the area, based on the high and low points of the drainage area:

- Highest point in the drainage area along Buffalo Avenue = 685.78 ft.
- Highest point in the drainage area along Seventh Avenue = 674.54 ft.
- Lowest point in the drainage area = 660.90 ft , (located at the south and west side of the intersection)

FLOW PATH (1):

Slope overland to ditch line along Buffalo Avenue = (678.23 ft - 671.60 ft)/ 250 ft = **0.027 ft/ foot**
Slope along Buffalo Avenue = (671.60 ft - 660.90 ft)/ 400 ft = 10.70/ 400 = 0.027 = **0.027 ft/ foot**

FLOW PATH (2):

Slope overland to ditch line along Seventh Avenue = (678.23 ft - 668.53 ft)/ 275 ft = **0.035 ft/ foot**
Slope along Seventh Avenue = (674.54 ft - 660.90 ft)/ 500 ft = 13.64/ 500 = 0.027 = **0.027 ft/ foot**

FLOW PATH (3):

Slope along Buffalo Avenue = (685.78 ft - 660.90 ft)/ 1000 ft = 24.88/1000 = 0.025 = **0.025 ft/foot**

	Calc. No. W320-21-002
	Revision 0
DESIGN ANALYSIS	Page No. 4 of 6
Client: NUMATEC HANFORD CORPORATION	WO/Job No. E34262/ W-320
Subject: W320 SITE DRAINAGE AT THE INTERFARM TRANSFER LINE AND C FARMS	Date: 03/18/97 By: M.R Custer MRC
	Checked: 4/1/97 By: [signature]
Location: 241-C-106, 200E AREA	Revised: By:

FLOW PATH (4):

Slope along Seventh Avenue = (674.75 ft - 660.90 ft)/ 500 ft = 13.85/ 500 = 0.027 = **0.027 ft/ foot**

3) Determine the rainfall intensity (inches / hour) for a 25 year storm = **0.62" / hour**

4) Determine the Inlet Time of Concentration (based on Seelye's Overland flow time chart, Ref. Attachment A, page 2 and calculated ditch time to the inlet), based on the following:

- Character of Ground : Bare Soil
- Percent of Slope = Use the calculated values or a minimum of 0.50 %
- Ditch type: D-6 (Isosceles Triangle) , typ. , (n= 0.040 for ave. jagged and irregular ditch bed)

Velocity, vb (ditch @ Buffalo) = $1.486/n\,(R)^{2/3}\,(S)^{1/2} = 1.486/0.040\,(0.584)(0.027)^{1/2} =$

vb = 3.56 ft/sec, Ditch time = 400 ft/ 3.6 ft/ sec (60) = 1.85 minutes

Velocity, v7 (ditch @ Seventh) = $1.486/n\,(R)^{2/3}\,(S)^{1/2} = 1.486/0.040\,(0.584)(0.027)^{1/2} =$

v7 = 3.56 ft/sec, Ditch time = 500 ft/ 3.6 ft/sec (60) = 2.3 minutes

Time of Concentration:

a) Overland to Buffalo Avenue,	Tof C = 10.3 minutes	(Attachment A, page 2)
b) Ditch along Buffalo Avenue to inlet,	Tof C = 1.9 minutes	(Attachment A, page 3)
c) Overland to Seventh Avenue,	Tof C = 10.5 minutes	(Attachment A, page 2)
d) Ditch along Seventh Avenue to inlet,	T of C = 2.3 minutes	(Attachment A, page 3)

TC1 = a + b = 12.2 min.
TC2 = c + d = 12.8 min.

5) Determine the rainfall intensity, (Ir) for TC = 12.8, say 13 min:

I = 0.62 inches per hour (25 year storm for a 1 hour rainfall), Use I = 0.60

Ir = 2.0 inches/ hour (Attachment A , page 3)

6) Determine the total flow from the south west area, Q:

Q = A x C x Ir, where A = 5.7 acres, Ir = 2.0
C = 0.50 (Runoff coefficient)

Q = 5.7 cu ft/ sec

DESIGN ANALYSIS	Calc. No. W320-21-002 Revision 0 Page No. 5 of 6
Client: NUMATEC HANFORD CORPORATION	WO/Job No. E34262/ W-320
Subject: W320 SITE DRAINAGE AT THE INTERFARM TRANSFER LINE AND C FARMS	Date: 03/18/97 By: M.R Custer MRC Checked: 4/1/97 By: RD
Location: 241-C-106, 200E AREA	Revised: By:

7) Design culvert(s) required to drain area, based on: Q = 5.7 cu ft/sec, v = 2.5 ft/sec (assures clean out of culvert)

A = Q/ v = 5.7/ 2.5 = 2.28 sq ft, Area of (1) = 2.28/ 2 = 1.14 sq ft

Dia. Culvert = $[4(2.28 \text{ sq ft}) / \Pi]^{1/2}$ = 1.70 ft = 20 inches (providing 1 culvert)

- 12" dia. cmp (A = 0.79 sq ft),
- 15" dia. cmp (A = 1.23 sq ft),
- 18" dia. cmp (A = 1.76 sq ft)
- 21" dia. cmp (A = 2.41 sq ft)
- 24" dia. cmp (A = 2.52 sq ft)

2- 15" culvert = 2.46 sq ft > 2.28,

∴ Use 2-15" dia culverts (A = 2.45 sq ft) > 2.28 sq ft, (use, 2 culverts to reduce the depth requirements under the road crossings and provide a minimum of 12" cover over the pipe with a soil compaction of 85%)

8) Design the drainage system from the inlet at the intersection of Buffalo and Seventh Avenues to the outlet:

The cross-section of the ditch lines along Seventh and Buffalo Avenues is designed based on an isosceles triangle configuration (Attachment A, ditch type, D-6A) w/ 1.0 ft depth and 4.0 ft width channel, w/ side slopes of 2 to 1, typical. The beginning point the of 2 - 15" dia CMP discharge culverts starts at the southwest side of the intersection of Buffalo and Seventh Avenues at a catch (T.O.B), EL. 660.90 and routes under Seventh Avenue to the north side of the road to ground level, discharging into a stone lined ditch. The flow proceeds along the stone lined ditch to the corner of the berm and into 2-15" dia. PVC culverts thru the berm and discharges on the north side of the berm into a new ditch line. The flow proceeds down the ditch line to the discharge outlet. Modifications to the existing ground contours are required to establish the new stone lined ditch from the north side of Seventh Avenue to the south side of the berm and from the north side of the berm to the discharge outlet. (Refer to Attachment B for required modifications).

9) Design a ditch line from the inlet of the ditch at the north side of Seventh at Buffalo to the berm and from the berm to the discharge outlet:

Maximum Q (total) = 5.7 cu ft/ sec + 2.2 cu ft/ sec = 7.9 cu ft/ sec (Required flow by design)
$v = 1.486/n\ (R)^{2/3}\ (S)^{1/2}$, where n = 0.050 (riprapped ditch), $R^{2/3}$ = 0.584, S = 19.1 ft / 322.0 ft = 0.059
v = 4.22 ft/ sec., A (ditch type, D - 6A) = 2.0 sq ft

Per Attachment A, slope = 0.059 and TYPE D-6A ditch, velocity = 7.0 ft/ sec
Q (provided) = 14.3 cu ft/ sec > Q (required) = 7.9 cu ft/ sec .... ok

PROVIDE Ditch Type D-6A. (Attachment A, page 4)

10) Design outlet discharge culvert: (size and number)

Q (design) = 14.3 cu ft/ sec, v =7.0 ft/sec (based on capacity of the ditch to be provided)

A (req'd) = Q/ v = (14.3 cu ft/ sec) / (7.0 ft/sec) = 2.04 sq ft.

		Calc. No. W320-21-002
		Revision 0
DESIGN ANALYSIS		Page No. 6 of 6
Client: NUMATEC HANFORD CORPORATION	WO/Job No. E34262/ W-320	
Subject: W320 SITE DRAINAGE AT THE INTERFARM TRANSFER LINE AND C FARMS	Date: 03/18/97	By: M.R.Custer MRC
	Checked: 4/1/97	By: RD
Location: 241-C-106, 200E AREA	Revised:	By:

Considering the infrequent nature of heavy rainfall for the area at the non-critical location of the outlet, the culvert will be designed for 75% of the maximum 25 year storm (0.62"/ hour).

A = 0.75 x 2.04 sq ft = 1.53 sq ft, A (2-12" dia.) = 0.79 sq ft (2) = 1.58 sq ft > 1.53 sq ft .... ok

Use 2 - 12" dia. culverts at the outlet discharge (at the existing 4" dia. pipe)

C FARM AREA:

Excessive flooding into existing electrical vaults and handholds and the initial stages of erosion has occurred in the area adjacent to and along the north fence line in C Farm. A berm line is to be constructed, parallel to the fence line to provide a controlled route for the runoff. The runoff originates from Tank 241-C-106 in C Farm, and flows northeast down the tank embankment, through the fence line, where the flooding and erosion occurs. The runoff then continues downhill to an unused area north of the tank farm. An estimated 20% to 30% of the tank farm area runoff drains over this route. The slope of the ground across the top of the tank is approximately 0.0039. The slope from the top to the base of the embankment is 0.40.

1) Determine the estimated drainage area contributing to the flow:

A = 300 ft x 300 ft = 90000 sq ft/ 43560 sq ft or approximately 2.1 acres

2) Overland flow time,

Across the top of the tank:
- Estimated distance = 400 ft
- Time of Concentration, Tc = 17 min. (Attachment A, page 2)

Down the tank embankment):
- Estimated distance = 32 ft
- Time of Concentration, Tc = 2 min.

4) Concentration Time (total), 17 min + 2 min = 19 min

5) Rainfall intensity, Ir = 1.5 in/ hour (Attachment A, page 3)

6) Determine the total flow from the area, Q:

Q = A x C x Ir, where A = 2.1 acres, Ir = 1.5 in/ hr, C = 0.65 (runoff coefficient)
Q = 2.1 cu ft/ sec

7) Determine the ditch cross-section required:

- The segmental ditch, D-1 will accommodate the required flow with the flexibility to increase the height of the channel to address concerns due to the velocity of the runoff entering the ditch area. (Attachment A, page 4)

Provide a built-up berm adjacent to the north fence line, approximately 15" to 18" high, beginning at the foot of the slope of the embankment turning an arc w/ radius of 20 ft and continuing parallel 15 ft off the fence line to within approximately 40 ft of the northwest corner of the fence line.

DRAINAGE — RUNOFF — 2

Q = Aci RATIONAL FORMULA (Logical approach).

Q = RUNOFF = Peak discharge of watershed in cubic feet per second (c.f.s.) due to maximum storm assumed. See Figs. A to F, Pg. 18-01 (Usually 10 – 25 years).
A = Area of watershed in acres.
C = Coefficient of runoff, Table B below (Measure of losses due to infiltration, etc.).
i = Intensity of rainfall in inches per hour based on concentration time. See Pg. 18-01. Concentration time = time required for rain falling at most remote point to reach discharge point. Concentration time may include overland flow time, Fig. H, Pg. 18-01, and Channel flow time, Pg. 18-05, 18-06, 18-69 and 18-71.

TABLE A-COMPUTATION FORM FOR RATIONAL FORMULA.

LOCATION			A			TIME OF FLOW-MIN.					DESIGN					PROFILE				
STREET	FROM	TO	INCREMENT	TOTAL	C	TO INLET	IN CHANNEL	TIME OF CONC	i *	Q c.f.s.	CHANNEL OR PIPE SIZE	SLOPE ft. per ft.	n	CAPACITY FULL c.f.s.	V ft. per Sec.	LENGTH ft.	FALL ft.	OTHER LOSSES ft. †	INV. ELEV. UPPER END	INV. ELEV. LOWER END
FIRST ST.	A	B	1.8	1.8	.44	16.5	0.3	16.5	3.8	3.0	15"	.008	.015	4.6	3.9	60	0.48	0	82.00	81.52
MAIN RD.	B	C	1.9	3.7	.50		2.5	16.8	3.7	6.8	D-2	.011	.030	12.0	2.8	420	4.62	0	81.52	76.90
" "	C	D	2.0	5.7	.50		1.8	19.3	3.5	10.0	21"	.007	.015	11.1	4.5	480	3.36	2.20	74.70	70.34

*Note that the sequence of design as in example, Fig. J, Pg. 18-01 involves trial assumptions in determining i.
†Fall in manhole.

TABLE B – VALUES OF $C = \frac{RUNOFF}{RAINFALL}$

SURFACES			VALUE PROPOSED MIN.	VALUE PROPOSED MAX.	VALUE BY OTHER AUTHORITY MIN.	VALUE BY OTHER AUTHORITY MAX.	
ROOFS, slag to metal.							
PAVEMENTS	Concrete or Asphalt.		0.90	1.00	0.70	0.95	①
	Bituminous Macadam, open and closed type.		0.90	1.00	0.95	1.00	③
	Gravel, from clean and loose to clayey and compact.		0.70	0.90	0.70	0.90	③
R.R. YARDS			0.25	0.70	0.15	0.30	①
EARTH SURFACES			0.10	0.30	0.10	0.30	①
	SAND, from uniform grain size, no fines, to well graded, some clay or silt.	Bare	0.15	0.50	0.01	0.55	④
		Light Vegetation	0.10	0.40	0.01	0.55	④
		Dense Vegetation	0.05	0.30	0.01	0.55	④
	LOAM, from sandy or gravelly to clayey.	Bare	0.20	0.60			
		Light Vegetation	0.10	0.45			
		Dense Vegetation	0.05	0.35			
	GRAVEL, from clean gravel and gravel sand mixtures, no silt or clay to high clay or silt content.	Bare	0.25	0.65			
		Light Vegetation	0.15	0.50			
		Dense Vegetation	0.10	0.40			
	CLAY, from coarse sandy or silty to pure colloidal clays.	Bare	0.30	0.75	0.10	0.70	④
		Light Vegetation	0.20	0.60	0.10	0.70	④
		Dense Vegetation	0.15	0.50	0.10	0.70	④
COMPOSITE AREAS	City, business areas.		0.60	0.75	0.60	0.95	⑤
	City, dense residential areas, vary as to soil and vegetation.		0.50	0.65	0.30	0.60	⑤
	Suburban residential areas. " " "		0.35	0.55	0.25	0.40	⑤
	Rural Districts, " " "		0.10	0.25	0.10	0.25	②
	Parks, Golf Courses, etc., " " "		0.10	0.35	0.05	0.25	①

NOTE: Values of "C" for earth surfaces are further varied by degree of saturation, compaction, surface irregularity and slope, by character of subsoil, and by presence of frost or glazed snow or ice.

① [illegible]iant & Kuichling, Report, Back Bay Sewerage District, Boston, 1909.
② Metcalf and Eddy, American Sewerage Practice, 1928. McGraw-Hill.
③ Used by City of Boston, reported by Metcalf & Eddy.
④ Used by City of Detroit, reported by Metcalf & Eddy.
⑤ L.C. Urquhart, Civil Engineering Handbook, 1940. McGraw-Hill.

ATTACHMENT A
CALC. W320-21-002
REV. 0
SHT. 2 OF 5

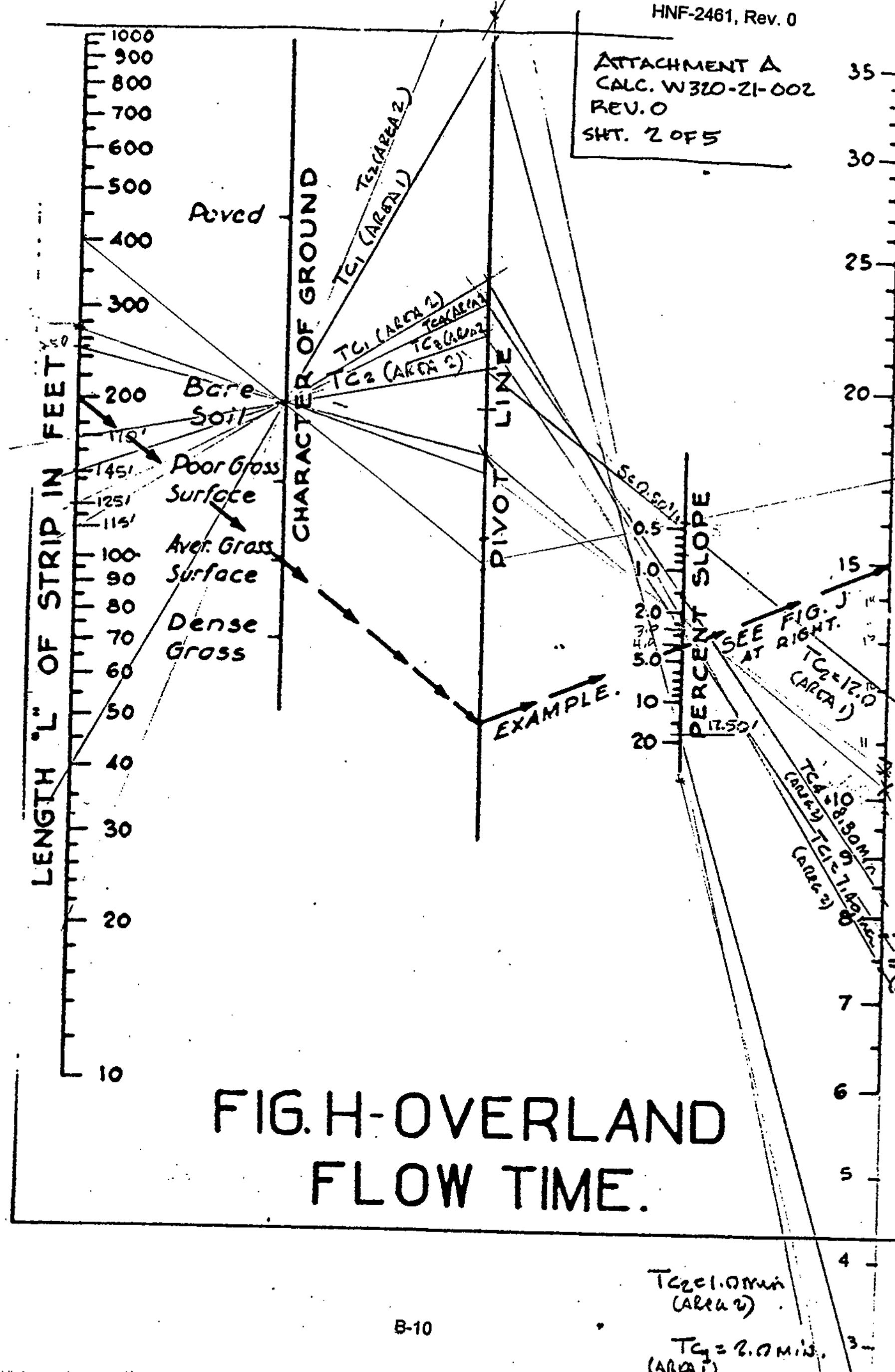
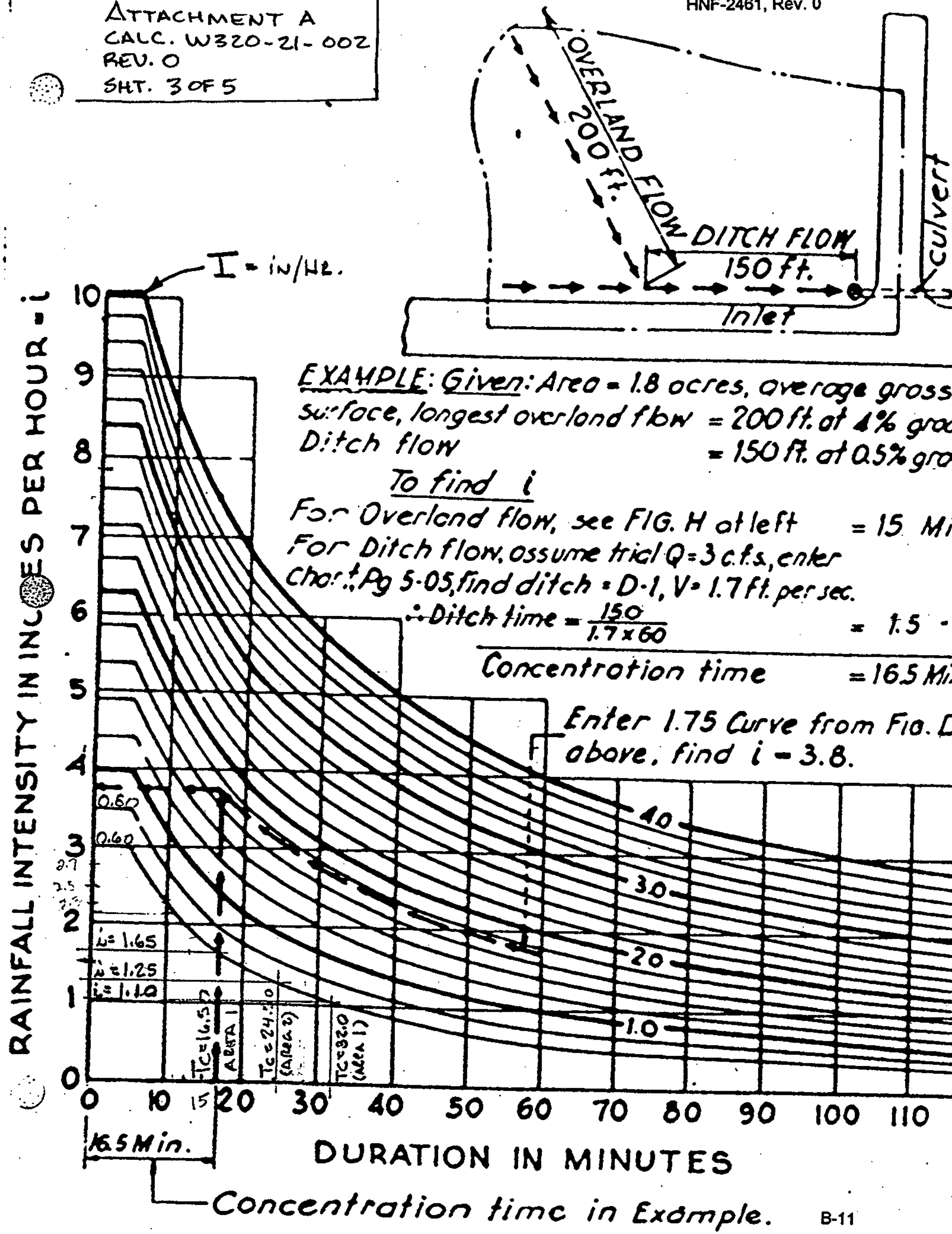


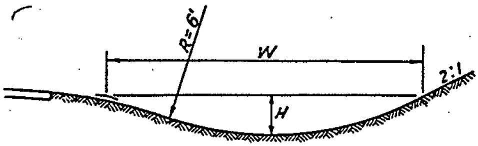
FIG. H-OVERLAND FLOW TIME.

ATTACHMENT A
CALC. W320-21-002
REV. 0
SHT. 3 OF 5

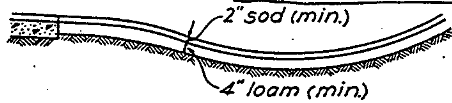


DRAINAGE-DITCHES-COMMON SECTIONS-I

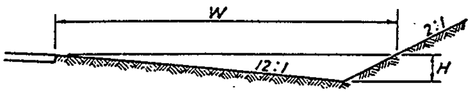
ATTACHMENT A
CALC. W320-21-002, REV.0
SHT. 4 OF 5



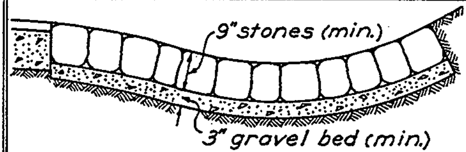
D-1 SEGMENTAL



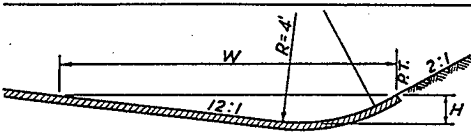
SODDED GUTTER



D-1A TRIANGULAR
Unequal side slopes



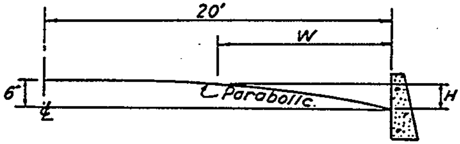
COBBLED GUTTER



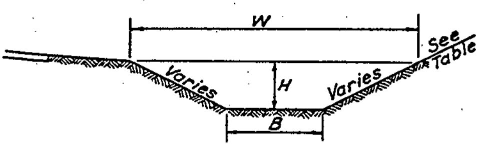
D-1B BITUMINOUS GUTTER

Base required same as for concrete pavement.

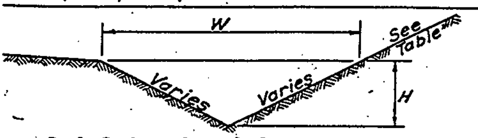
CONCRETE GUTTER



D-1C CURBED CROWNED STREET



D-2, D-3, D-4, D-5 TRAPEZOIDAL

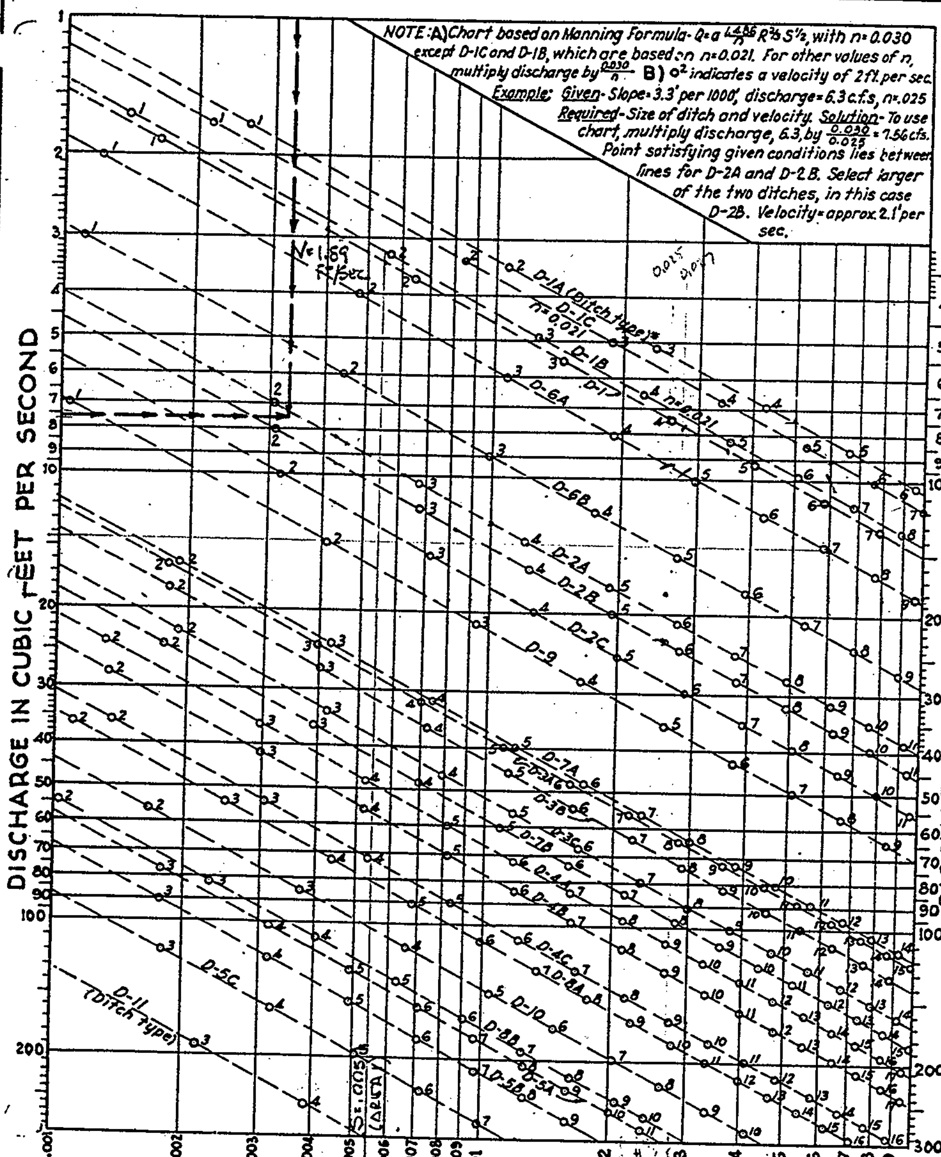


D-6, D-7, D-8, D-9, D-10, D-11
ISOSCELES TRIANGULAR
D-9, D-10 and D-11-Airport ditches

TABLE A — PROPERTIES OF DITCHES

NO.	DIMENSIONS				HYDRAULICS			
	SIDE SLOPES	B	H	W	a	p	R	$R^{2/3}$
D-1	—	—	6½"	5'-0"	1.84	5.16	0.356	0.502
D-1A	12:1 & 2:1	—	6"	7'-0"	1.75	7.14	0.245	0.392
D-1B	12:1 & 2:1	—	5"±	7'-0"	1.64	7.08	0.232	0.377
D-1C	½" to 1'-0"	—	4.5"	10'-0"	1.68	10.38	0.162	0.297
D-2A	1½:1	2'-0"	1'-0"	5'-0"	3.50	5.61	0.624	0.730
B	2:1	2'-0"	1'-0"	6'-0"	4.00	6.47	0.618	0.726
C	3:1	2'-0"	1'-0"	8'-0"	5.00	8.32	0.601	0.712
D-3A	1½:1	3'-0"	1'-6"	7'-6"	7.88	8.41	0.937	0.958
B	2:1	3'-0"	1'-6"	9'-0"	9.00	9.71	0.927	0.951
C	3:1	3'-0"	1'-6"	12'-0"	11.25	12.49	0.901	0.933
D-4A	1½:1	3'-0"	2'-0"	9'-0"	12.00	10.21	1.175	1.114
B	2:1	3'-0"	2'-0"	11'-0"	14.00	11.94	1.173	1.112
C	3:1	3'-0"	2'-0"	15'-0"	18.00	15.65	1.150	1.097
D-5A	1½:1	4'-0"	3'-0"	13'-0"	25.50	14.82	1.721	1.436
B	2:1	4'-0"	3'-0"	16'-0"	30.00	17.42	1.722	1.437
C	3:1	4'-0"	3'-0"	22'-0"	39.00	22.97	1.698	1.423
D-6A	2:1	—	1'-0"	4'-0"	2.00	4.47	0.447	0.584
B	3:1	—	1'-0"	6'-0"	3.00	6.32	0.475	0.609
D-7A	2:1	—	2'-0"	8'-0"	8.00	8.94	0.895	0.929
B	3:1	—	2'-0"	12'-0"	12.00	12.65	0.949	0.965
D-8A	2:1	—	3'-0"	12'-0"	18.00	13.42	1.341	1.216
B	3:1	—	3'-0"	18'-0"	27.00	18.97	1.423	1.265
D-9	7:1	—	1'-0"	14'-0"	7.00	14.14	0.495	0.626
D-10	7:1	—	2'-0"	28'-0"	28.00	28.28	0.990	0.993
D-11	7:1	—	3'-0"	42'-0"	63.00	42.43	1.485	1.302

DRAINAGE-DITCHES-COMMON SECTIONS-2



ATTACHMENT A
CALC. W320-21-002, REV. 0
SHT. 5 OF 5

* See page 18-05. for ditch types

W320-24-001

Cold Test Facility Mock-ups

KAISER ENGINEERS HANFORD	CALCULATION IDENTIFICATION AND INDEX	Page i of iii Date 11/17/93

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

Discipline STRUCTURAL   WO/Job No. ER4289 - EQUIPMENT REMOVAL SYSTEM (ERS)   Calculation No. W320-24-001

Project No. & Name PROJECT W-320; TANK 241-C-106 - REMOVAL OF IN-TANK EQUIPMENT

Calculation Item COLD TEST FACILITY MOCK-UPS

These calculations apply to:

Dwg. No. H-6-13294 1/1, H-6-13295 1/1, H-6-13296 1/1   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	James A. Rupert 2/3/94	James A. Rupert 6/22/94	
Checked by	Michael R. Custer 2/7/94	Michael R. Custer 6/29/94	
Approved by	R.W. Davidson 2-11-94	R.W. Davidson 6/29/94	
Checked Against Approved Vendor Data		Ann S. Langevin 4/7/98	

<u>INDEX</u>

Design Analysis Page No.	Description
1,2	OBJECTIVES; CRITERIA; DATA; ASSUMPTIONS; METHODS; REFERENCES; CALCULATION; CONCLUSIONS.
⚠1 3-~~14~~20	Body of Calculation & SUMMARY SKETCHES (CKR: MRC 6/29/94)
App. A A-1 A-2,3 A-4	 DSI (12/6/93) stating "Cold Test Facility Input Loads" Waste tank vapor space negative pressure design criteria Crosby "Heavy Duty Swivel Hoist Rings"
	SUMMARY OF REV 1 CHANGES: Page i, Revised Index & Added PE Stamp Page 1, Revised Objective & References Page 9, Added HDI Interaction Formula Page 13, Modified Adapter Plate Design

RONALD W. DAVIDSON
STATE OF WASHINGTON
24180
REGISTERED
PROFESSIONAL ENGINEER
R.W. Davidson 6/29/94
EXPIRES 03-03-94

KEH 0378.00 (06/92) KEF072

CALCULATION CROSS INDEX (Typical)

Subject Calculation No. W320-24-001 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	—	W320-25-004	0				✓		✓	[illegible] 2-11-94
		W320-25-005	0				✓		✓	
		W320-25-006	0				✓		✓	
		W320-25-008	0				✓		✓	
		W320-25-009	0				✓		✓	
		W320-25-010	0				✓		✓	

90156

KEH 1975 00 (12/88)

DESIGN VERIFICATION SCREENING CRITERIA

HNF-2461, Rev. 0

PER MOP ES 7.3 M2

Project/Document No. W 320 ; CALCULATION NO. W-320-24-001

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?
	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?

M VanAtta
Assigned Lead Engineer

2, 10, 94
Date

R.W. Davidson
Responsible Discipline Manager

2-11-94
Date

Original Design Package Distribution:

Project Manager
Design Verification Officer
Engineering Document Control

Design Change Distribution:

Attach to Engineering Change Notice

KEH-1981.00 (06/91)

KAISER ENGINEERS *HANFORD*		Calc. No. W320-24-001
		Revision ~~0~~ 1
DESIGN ANALYSIS		Page No. 1 of 20
Client WHC	WO/Job No. ER4289	
Subject COLD TEST FACILITY: MOCK-UPS FOR TANK PITS 241-CR-06A,B AND 241-AY-02B.	Date 11/17/93	By J.G. RUPERT JGR
	Checked 2/7/94	By MRC
Location CAISSON W-106, N40587.4, W59513.2	Revised 6/22/94	By J.G. Rupert

OBJECTIVE

Using the existing Cold Test Facility (Project W-106), design an adjustable steel platform to support mock pumps and risers and transition-spools to the flexible receiver. The designs shall be based on existing tank pits 241-CR-06A,B and 241-AY-02B. Detail three mock risers to match appropriate parameters of the existing risers installed in the tank pits. The mock-up facility will be used for training personnel in removal of existing equipment from underground storage tanks 241-C-106 and 241-AY-102. The necessity of a seismic analysis was considered. Because the 1/2" platform is not attached to the ledger angle support (it rests on a neoprene gasket), the support would not be affected by lateral seismic activity so no seismic analysis was performed.

MRC 6/29/94 △1

CRITERIA

DOE ORDER 6430.1A, 04/06/89
FUNCTIONAL DESIGN CRITERIA: WHC-SD-W320-FDC-001 REV. 2
LETTERS OF INSTRUCTION: LOI 9357428 (9/8/93), LOI 9358855 (10/20/93), LOI 9360642 (1/5/94)

DATA

SEE APPENDIX A OF CALCULATION:
1. Mock pump and transition spool weights
2. Vacuum load in vapor space of tank
   241-C-106: -5.9 in. wg (See OSD-T-151-00013, Rev. D-1, p. 12)
   241-AY-102: -4.0 in. wg (See WHC-SD-WM-OSR-004. Rev 0, p. 3-17)
3. Heavy Duty Swivel Hoist Rings

ASSUMPTIONS

The maximum operating vacuum load allowed in these tanks is -5.9 in. wg. A maximum vacuum of -8.0 in. wg is assumed for the Cold Test Facility.

METHODS: Hand Calculations

REFERENCES

MRC 6/29/94 △1

1. AISC MANUAL OF STEEL CONSTRUCTION; 9th ed., 1989
2. ICBO EVALUATION REPORT No. 2895, 1/91
3. DESIGN OF WELDED STRUCTURES, BLODGETT, O.; 14th ed., 1991.
4. SDC 4.1, REV. 11
5. AWS D1.1-92, STRUCTURAL STEEL WELDING CODE
6. DWG. H-6-10602 REV. 2; CAISSON VAULT
7. TUBE TURN CATALOG, NO. 311
8. ROARK'S FORMULAS FOR STRESS AND STRAIN; 6th ed.

KAISER ENGINEERS HANFORD		Calc. No. W320-24-001
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DESIGN ANALYSIS		Page No. 2 of 20
Client WHC	WO/Job No. ER4289	
Subject COLD TEST FACILITY: MOCK-UPS FOR TANK PITS 241-CR-06A,B AND 241-AY-02B.	Date 11/17/93	By J.G. RUPERT
	Checked	By
Location CAISSON W-106, N40587.4, W59513.2	Revised	By

CALCULATION

SEE ATTACHED CALCULATION

CONCLUSIONS

The mock-up platform represents the "floor" of the existing pits from which equipment will be removed. These calculations provide for a 1/2" plate platform which is supported by a frame made of L 6X4X1/2 which is designed to accept the full design load. No load carrying capability is credited to the plate (ie., not a composite structure). The 1/2" plate platform is to be supported by a L 5X3X3/8 ledger attached with 5/8" HDIs to the inside perimeter of the CTF concrete pit.

To allow for the negative pressure maintained in the vapor space of the actual waste tanks, the platform is designed to resist a vacuum load of -8.0 inches of water (gage). This is approximately 33% greater than the maximum negative pressure allowed in the tank. Vacuum seal is maintained by using 1/8" neoprene gaskets and polyethylene tape with an acrylic adhesive.

A 43-1/2" diameter hole in the center of the platform allows installation of the various mock riser assemblies. These risers are complete with dowels and studs to locate and secure (if necessary) the mock pumps. In addition to the vacuum loading, the platform is designed to support the weight of a three part assembly composed of the mock riser, a transition spool piece (used to adapt the flexible receiver to the riser flange), and a mock pump.

Note: At this time, training is scheduled to be performed using the mock assemblies for the 241-CR-06A and -06B pits. Since equipment must be removed from the 241-AY-02B pit also, and due to the changing decisions on which pits should receive simulation training, mock-up assemblies are designed and drawn for this pit also. Preliminary calculations show the mock-up assembly for this pit is the heaviest of the three and if not considered could cause significant rework/recalculation of the CTF platform structure.

KAISER ENGINEERS
HANFORD

DESIGN ANALYSIS

Calc. No. W-320-24-001
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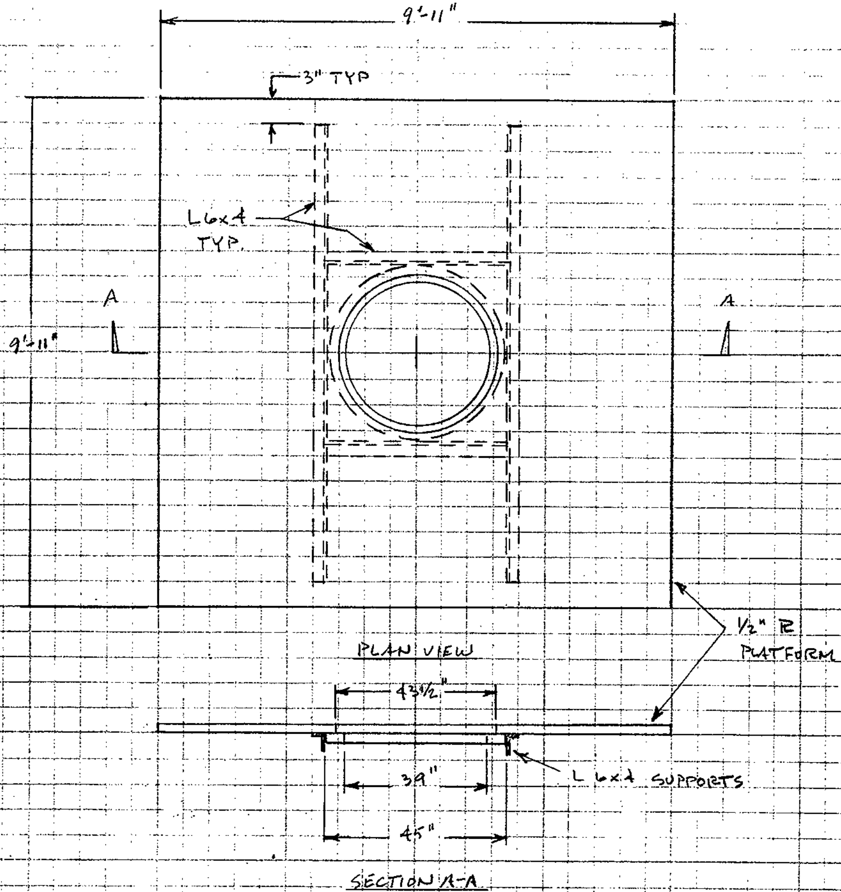
Client WHC	WO/Job No. ER 4289		
Subject COLD TEST FACILITY: MOCK-UPS FOR TANK PITS 241-CR-06A, B AND 241-AY-02B	Date 1/4/94	By	L.M. Rupert
	Checked 2/7/94	By	MRC
Location CAISSON W-106	Revised	By	

DESIGN AN ADJUSTABLE PLATFORM/SUPPORTS AND DETAIL MOCK RISERS FOR A TEST/TRAINING FACILITY (CTF) TANK PIT MOCK-UP.
241-CR-06A; 241-CR-06B; 241-AY-02B:



KAISER ENGINEERS HANFORD

DESIGN ANALYSIS

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Subject: COLD TEST FACILITY: MOCK-UPS FOR TANK PITS 241-CR-06A,B AND 241-AY-02B	Date 1/4/94	By	J. M. Rupert
	Checked 2/7/94	By	MRC
Location: CAISSON W-106	Revised	By	

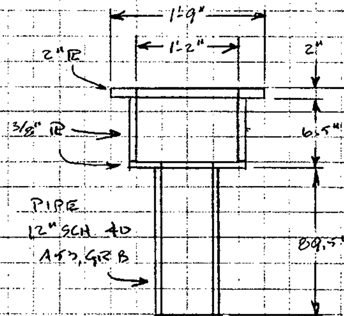
DETERMINE PLATFORM LOADING

THE FOLLOWING WEIGHTS FOR THE MOCK PUMPS AND THE TRANSITION SPOOL PIECES WERE TRANSMITTED BY KEH ME GROUP ON A DSI (12/6/93). SEE APPENDIX A.

ITEM		WT (LB)	TOTAL (LB)
241-CR-06A	TRANSFER PUMP	1530	
"	SPOOL PIECE	1276	
"	MOCK RISER *	560	
			3366
241-CR-06B	HEEL JET PUMP	3152	
"	SPOOL PIECE	886	
"	MOCK RISER *	983	
			5021
241-AY-02B	AGITATOR PUMP	2780	
"	SPOOL PIECE	1633	
"	MOCK RISER *	929	
			5342

* WTS. OF MOCK RISERS:

241-CR-06A



2" PL FLANGE (81.6 psf - REF. 1, p. 1-111)
1.75' OD x 1.17' ID x 81.6 psf
$\pi/4\,(1.75^2 - 1.17^2)\ ft^2 * 81.6\ psf = 109\ lb$

3/8" PL x 6 1/2" : 8.29 plf
$\pi D = \pi(1.17')\ 8.29\ plf = 30.5\ lb$

12" SCH 40 PIPE (50 plf, REF. 1, p. 1-93)
7.46' (50 plf) = 372.9 lb

DOWELS (REF. 1, p. 1-108)
2" φ @ 10.7 plf (DOWELS)
(15" + 18")/12 * 10.7 plf = 29.4 lb
1 1/4" φ @ 4.18 plf
(4 STUDS) x 9"/12 * 4.18 plf = 12.5 lb

3/8" PL 14" OD x 12.0" ID x 15.3 psf
$\pi/4\,(1.17^2 - 1.0^2)\ ft^2 * 15.3\ psf = 4.3\ lb$

TOTAL RISER WT. = 109 + 30.5 + 372.9 + 29.4 + 12.5 + 4.3 = 558.6 lb. SAY 560 lb

KAISER ENGINEERS HANFORD

DESIGN ANALYSIS

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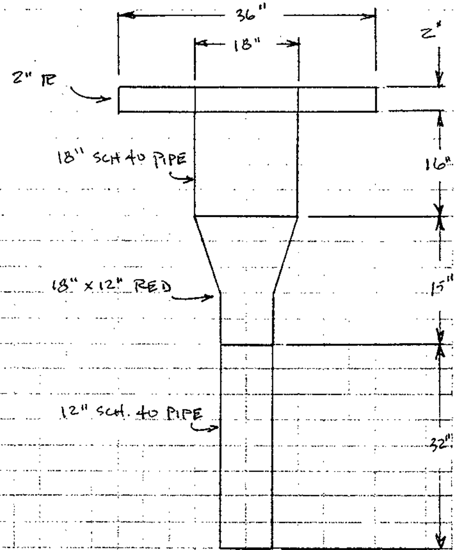
Client WHC		WO/Job No. ER4289	
Subject COLD TEST FACILITY: MOCK-UPS FOR TANK PITS 241-CR-06 A,B AND 241-AY-02B		Date 1/4/94	By A. Rupert
		Checked 2/7/94	By MLC
Location CAISSON W-106		Revised	By

241-CR-06B



* 2" ℞ FLANGE (REF. 1, 1-111
3' OD × 1'-6" ID
$\frac{\pi}{4}(3^2 - 1.5^2)\ ft^2 * 81.6\ psf = 433$

* 18" SCH 40 PIPE (REF. 7)
32"/12 * 104.7 plf = 279 Lb

* 18" × 12" REDUCER - STD (REF. 7)
90 Lb

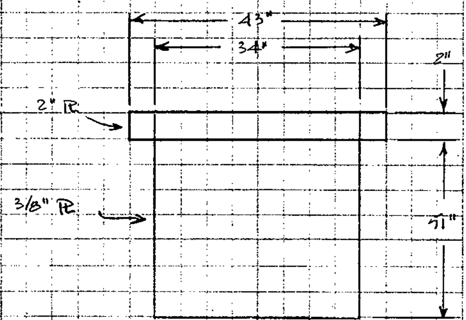
* 12" SCH 40 PIPE (REF. 1, 1-93)
32"/12 * 50 plf = 133 Lb

* DOWELS - 2" Φ (REF. 1, 1-108)
$\frac{(15" + 18")}{12}$ ft * 10.7 plf = 29.4 Lb

STUDS - 1¼" Φ
6 STUDS * 9"/12 ft * 4.18 plf = 18.8 Lb

TOTAL RISER WT. = 433 + 279 + 90 + 133 + 29.4 + 18.8 ≈ 983 Lb

241-AY-02B



* 2" ℞ FLANGE (REF. 1, 1-111)
43" OD × 34" ID
$\frac{\pi}{4}(3.58^2 - 2.83^2)\ ft^2 * 81.6\ psf = 308\ Lb$

* 3/8" ℞ PIPE
π · D · H * 15.3 psf
$\frac{\pi}{144}(34")(51")\ 15.3\ psf = 579\ Lb$

* DOWELS - 2" Φ (REF. 1, 1-108)
$\frac{(15" + 18")}{12}$ ft * 10.7 plf = 29.4 Lb

STUDS - 1¼" Φ
4 STUDS * 9"/12 ft * 4.18 plf = 12.5 Lb

TOTAL RISER WT. = 308 + 488 + 29.4 + 12.5
≈ 929 Lb

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

KAISER ENGINEERS
HANFORD

Calc. No. W-320-24-001
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DESIGN ANALYSIS

Client WHC	WO/Job No. ER4289		
Subject COLD TEST FACILITY: MOCK-UPS FOR TANK PITS 241-CR-06A,B AND 241-AY-02B	Date 1/4/94	By	J. O. Rupert
	Checked 2/7/94	By	MRC
Location CAISSON W-106	Revised	By	

DETERMINE PLATFORM LOADING (CONT.)

DEAD LOADS: 1/2" PL @ 20.4 psf (REF. 1, 1-111), L6x4x1/2 @ 16.2 plf (REF. 1, 1-47)

a) 1/2" PL: 10' * 10' * 20.4 psf = 2040 Lb

b) L6x4x1/2: 2(120"+45")/12 * 16.2 plf = 446 Lb

TOTAL: (2040 + 446) Lb = 2486 Lb ASSUME L WT. IS DIST. WITH PLATE

⇒ 2486 Lb/100 ft² = 24.86 psf OR ≈ 0.173 psi

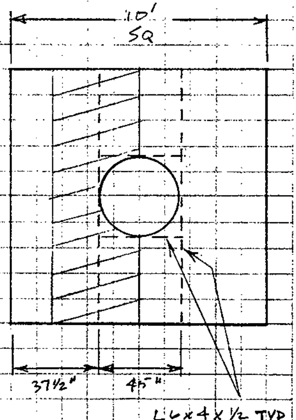
LIVE LOADS: SEE p. 4 & APP. A OF CALCS

a) HEAVIEST MOCK RISER/SPOOL/PUMP ASS'Y (241-AY-02B) = (2780+1633+929) Lb = 5342 Lb

b) VACUUM LOAD: MAX. -ve PRESSURE IS 6" H2O, DESIGN ASS'Y FOR 8" H2O -ve PRESSURE

$\frac{62.4 \text{ Lb H}_2\text{O}/ft^3}{144} * \frac{8"}{12} = 0.290$ psi SEE APP. A OF CALCS.

SIZE PLATFORM STRONGBACKS (USE F_y = 36 ksi FOR ALL STRUCTURAL STEEL)



TRIBUTARY LOADING (DISTRIBUTED)

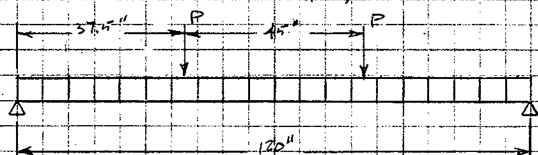
$w = \frac{(37.5+45)"}{2}(0.173+0.290)\text{ psi} = 19.1$ pli

$M_x = \frac{w_{ST} L^2}{8} = \frac{19.1 \text{ pli} (120")^2}{8} = 34380$ in-Lb

ASSUME MOCK ASS'Y IS APPLIED TO THE THE STRONGBACK AS TWO EQUAL CONCENTRATED LOADS SYMMETRICALLY PLACED.

$P = \frac{5342 \text{ Lb}}{4} = 1336$ Lb, a = 37.5"

$M_x = Pa = 1336$ Lb $(37.5") = 50100$ IN-Lb (REF. 1, 2-298)



$M_{MAX} = (34380 + 50100)$ IN-Lb = 84480 IN-Lb

$F_{bx} = 0.66 F_y$ (REF. 1, p. 5-312, SECT. 5.1.2 & C5.1.2)

$S_x = \frac{M_{MAX}}{F_{bx}} = \frac{84480 \text{ IN-Lb}}{0.66(36000)\text{ psi}} = 3.56$ IN³ REQ'D

KAISER ENGINEERS
HANFORD

DESIGN ANALYSIS

Client WHC | WO/Job No. ER4289
Subject COLD TEST FACILITY: MOCK-UPS FOR TANK PITS 241-CR-06A,B AND 241-AY-02B | Date 1/4/94 By J. D. Rupert
Location CAISSON W-106 | Checked 2/7/94 By MRC
Revised By

STRONGBACKS (CONTINUED)

$S_x = 3.56 \text{ in}^3$ REQ'D

USE L 6x4x½, $S_x = 4.33 \text{ in}^3$ (REF. 1, p. 1-47)

ANGLES ARE ASSUMED TO BEND ABOUT A GEOMETRIC AXIS (REF. 1, p. 5-312, SECT. 5.2.1)
MUST PROVIDE LATERAL-TORSION RESTRAINT ALONG MEMBER. USE 3/16" FILLET
WELD - INTERMITTENT: 2" @ 12" o/c

CHECK STRESS ON ½" PL - STRESS IN THE FIELD OF THE PL

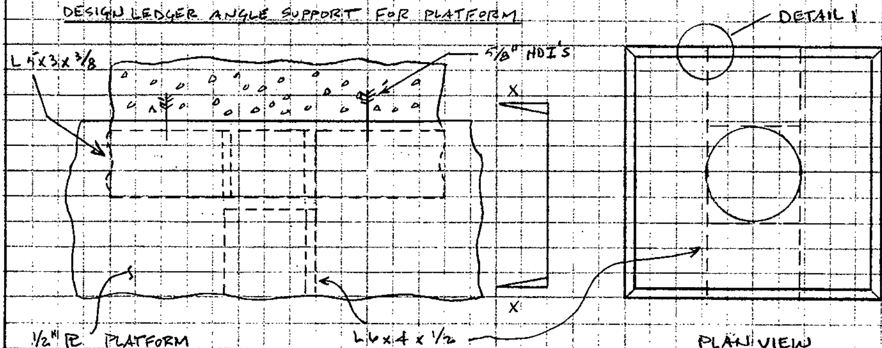
MODEL A 1" WIDE STRIP x 45" LONG (WORST CASE) SIMPLY SUPPORTED.
LOADING: ½" PL 20.4 psf (1 ft²/144 in²) = 0.142 psi
VACUUM: 0.290 psi

$$M_x = \frac{wL^2}{8} = \frac{(0.290 + 0.142)\text{ pli } (45")^2}{8} = 109 \text{ in-lb}$$

(REF. 1, p. 5-148)

$$f_b = \frac{M_x}{S_x} = \frac{M_x}{bd^2/6} = \frac{109 \text{ in-lb}}{1"(0.500)^2/6} = 2616 \text{ psi} < 0.75F_y = 27000 \text{ psi} \quad \text{OK}$$

DESIGN LEDGER ANGLE SUPPORT FOR PLATFORM



DETAIL 1

(TYP. @ SUPPORT, 4 PLCS)

KAISER ENGINEERS HANFORD

DESIGN ANALYSIS

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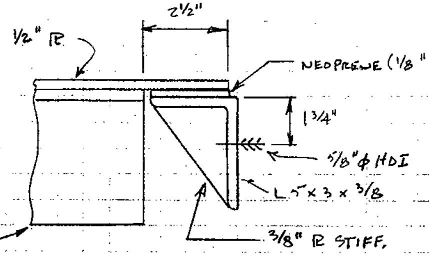
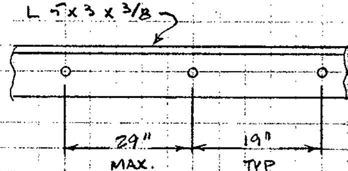
Client WHC
WO/Job No. ER4289
Subject COLD TEST FACILITY : MOCK-UPS FOR TANK PITS 241-CR-06A,B AND 241-AY-02B
Date 1/4/94 By J. G. Rupert
Checked 2/7/94 By MRC
Location CAISSON W-106
Revised By

DESIGN LEDGER ANGLE SUPPORT

* 29" MAX. SPACING OF 29" ALLOWS FOR 27" (2'-3") NOMINAL SPACING + 1" EA END TO ADJUST HDI'S IN CASE OF REBAR INTERFERENCE.



SECTION X-X



CHECK FLEXURAL STRENGTH OF LEDGER ANGLE
ASSUME TOTAL LOAD ON PLATFORM IS EVENLY DISTRIBUTED ALONG PERIMETER. (CONSERVATIVE)

LOADS: L 5x3x3/8, $S_x = 2.24\ in^3$ (REF. 1, 1-48)
- PUMP + MOCK-UP RISER = 5342 Lb
- ½" R = 2040 Lb
- VACUUM = 0.290 psi $(120")^2$ = 4176 Lb
- TOTAL = 11558 Lb

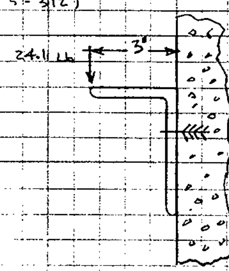
$w = \frac{11558\ Lb}{4 \times 120"} = 24.1\ pli$ $\qquad M_x = \frac{wL^2}{8} = \frac{24.1\ pli\ (29")^2}{8} = 2534\ in\text{-}Lb$

$f_{bx} = \frac{M_x}{S_x} = \frac{2534\ in\text{-}Lb}{2.24\ in^3} = 1131\ psi < 0.66\ F_y$ OK (REF. 1, p. 5-312)

CHECK CANTILEVER ACTION OF L LEG. (USE 1" WIDE STRIP)

$P = 24.1\ pli \times 3" = 72.3\ in\text{-}Lb$ (CONSERVATIVE)

$f_b = \frac{M_x}{S_x} = \frac{72.3\ in\text{-}Lb}{1"(0.375")^2 / 6\ in^3} = 3085\ psi < 0.75\ F_y$ OK



∴ USE L 5x3x3/8 FOR LEDGER ANGLE SUPPORT

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

KAISER ENGINEERS
HANFORD

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	Checked 2/7/94	By	MRC
Location CAISSON W-106	Revised 6/22/94	By	J. A. Rupert

SIZE HILTI DROP-IN ANCHORS TO SECURE ANGLE LEDGER TO PIT WALL

THERE ARE 4 SUPPORT POINTS WHERE THE L 6 x 4 x 1/2 STRONGBACKS TRANSFER THE LOAD THROUGH THE 1/2" P PLATFORM TO THE L 5 x 3 x 3/8 LEDGER ANGLE.

DETERMINE LOAD TRANSFERED

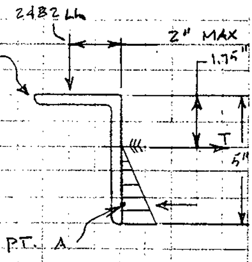
DIST LOAD (p. 6 OF CALCS) $\frac{19.1 \text{ pli} \times 120''}{2} = 1146$ Lb

PUMP/RISER LOADS $\frac{5342 \text{ Lb}}{4} = 1336$ Lb

TOTAL LOAD @ SUPPORT: (1146 + 1336) Lb = 2482 Lb / SUPPORT POINT

LOADS ON ANCHORS (REF. 1, p. 6 OF CALCS.)

- SHEAR: 2482 Lb / 2 ANCHORS = 1241 Lb / ANCHOR
- TENSION: SEE BELOW



$\Sigma M_A = 2482 \text{ Lb} \times 2'' - T \times \frac{2}{3}(5 - 1.75 - 1)''$

T = 3309 Lb (THE 1" ALLOWS FOR RELOCATION OF THE HDI UP TO 1" IN CASE OF REBAR INTERFERENCE)

ALLOW LOADS ON HDI (USE ICBO EVALUATION REPORT NO. 2895 - 1991)

$f'_c = 4000$ psi (REF. DWG. H-6-10602, 1/1, REV. 2 & SPEC. W-106-C1, SECT. 3300, p. 3)

5/8" HDI:

MRC 6/29/94

$T_{MAX} = 2.440^k \Rightarrow 2 \times 2.440 = 4.88^k > 3.31^k$ OK

$V_{MAX} = 3.070^k \Rightarrow 2 \times 3.070 = 6.14 > 1.24^k$ OK

⚠ $\frac{V}{V_{ALLOW}} + \frac{T}{T_{ALLOW}} = \frac{1.24^k}{6.14^k} + \frac{3.31^k}{4.88^k} = 0.88 < 1.0$ OK

∴ USE 5/8" HDI's @ 9" MIN. SPACING AND 11" MAX SPACING TO SUPPORT THE CONCENTRATED LOADS (4 PLCS) OF THE PLATFORM ON THE LEDGER ANGLE.

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

KAISER ENGINEERS HANFORD

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Client WHC
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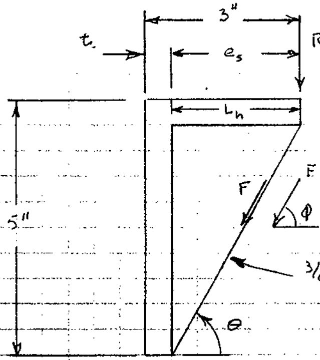
Subject COLD TEST FACILITY: MOCK-UPS FOR TANK PITS 241-CR-06A,B AND 241-AY-02B
Date 1/4/94 By P.S. Rupert
Checked 2/7/94 By MRC
Location CAISSON W-106
Revised By

SIZE STIFFENER PLATES @ SUPPORTS



$F_y = 36$ ksi $e_s = 3" - 0.375" = 2.625"$ $\theta = \phi = 59.04°$

$R = 2482$ Lb $L_h = 2.625"$ $t = 0.375"$

TREAT STIFFENERS AS ECCENTRICALLY LOADED COLUMNS (REF 3, p. 5.3-1)

$$f_y = \frac{F}{A} + \frac{M}{S}$$

$$= \frac{R(6e_s - 2L_h)}{t \cdot L_h \sin^2\phi} = \frac{2482(6 \times 2.625 - 2 \times 2.625)}{2 \times 0.375 (2.625) \sin^2(59.04)} = 18001 \text{ psi} < 0.60 F_y \text{ OK}$$

∴ USE TWO 3/8" PL (A36) STIFFENERS @ EACH OF 4 SUPPORT POINTS TO STRENGTHEN L 5x3x3/8 LEDGER ANGLE.

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

KAISER ENGINEERS HANFORD

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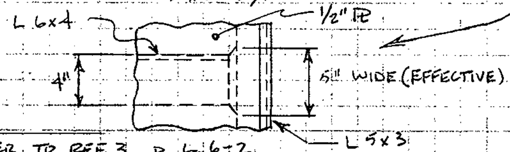
Client WHC — WO/Job No. ER4289
Subject COLD TEST FACILITY : MOCK-UPS FOR TANK PITS 241-CR-06A,B AND 241-AY-02B — Date 1/4/94 By J. G. Rupert
Checked 2/7/94 By MRC
Location CAISSON W-106 — Revised By

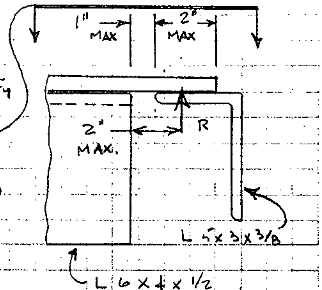
CHECK FLEXURAL STRESS OF PLATFORM PLATE (1/2") @ LEDGER SUPPORT

PLATE ACTS AS A CANTILEVER. MAXIMUM BENDING STRESS OCCURS WHERE L 6 x 4 x 1/2 STIFFENERS TRANSFER TRIBUTARY LOAD TO THE L 5 x 3 x 3/8 LEDGER, THROUGH THE 1/2" PL.

SEE "SECTION" SKETCH, p. 7 OF CALCS. $F_y = 36$ ksi

$f_{bx} = \frac{M_x}{S_x} = \frac{R*L}{bd^2/6} = \frac{2482 \text{ Lb} \times 2''}{5'' \times (0.5)^2/6} = 23827$ psi $< 0.75 F_y$ OK (P.B OF CALCS.)

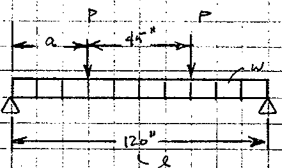




OR REFER TO REF. 3, p. 6.6-2.

$e = \frac{\sqrt{t_s * r_c}}{2}$; $t_s = 0.500''$, $r_c = \infty$ } $e \le 12 t_s = 6''$ HERE.

CHECK PLATFORM DEFLECTIONS



1. L 6 x 4 x 1/2 : $I_x = 17.4$ in^4 (REF 1, p. 1-47)
   $P = 1336$ Lb (5342 Lb/4) — $a = 37.5''$
   $w = 19.1$ pli — $x = 60''$ (CTR.)

$\delta = \frac{5 w \ell^4}{384 EI} + \frac{Pa}{24 EI}(3\ell^2 - 4a^2)$ (REF. 1, p. 2-296 & 2-298)

$\delta = \frac{5(19.1 \text{ pli})(120'')^4}{384(29E6 \text{ psi})(17.4 \text{ in}^4)} + \frac{1336 \text{ Lb } (37.5'')}{24(29E6 \text{ psi})(17.4 \text{ in}^4)}(3 * 120^2 - 4(37.5^2)) = 0.10 + 0.16$

$\delta = 0.26'' < \ell/240 = 120/240 = 0.50$ OK

2. PLATE CANTILEVER @ SUPPORT
   1/2" PL ; $b = 5''$, $d = 0.500''$ — $P = 2482$ Lb (p. 8 OF CALCS.)
   I_x PL $= \frac{bd^3}{12} = \frac{5''(0.500'')^3}{12} = 0.052$ in^4 (CONSERVATIVE)

$\delta_{PL} = \frac{P\ell^3}{3EI} = \frac{2482 \text{ Lb } (2.0'')^3}{3 * 29E6 * 0.052 \text{ in}^4} = 0.004'' < \ell/240 = 2''/240 = 0.008$ OK

∴ USE 1/2" PL AND L 6x4x 3/8 TO CONSTRUCT PLATFORM.

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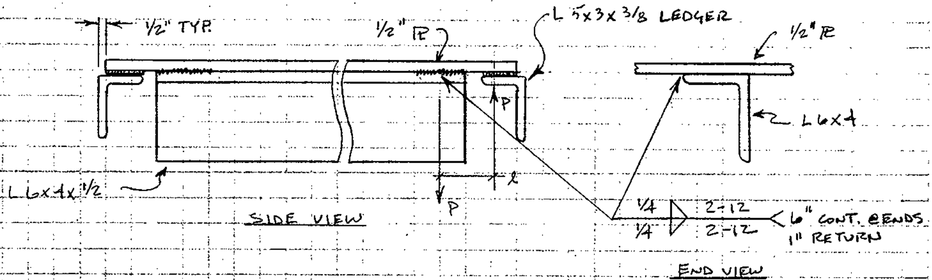
Client WHC	WO/Job No. ER4289		
Subject COLD TEST FACILITY: MOCK-UPS FOR TANK PITS 241-CR-06A,B AND 241-AY-02B	Date 1/4/94	By	J. G. Rupert
	Checked 2/7/94	By	MRC
Location CAISSON W-106	Revised	By	

SIZE PLATFORM WELDS

INTERMITTENT WELDS WILL BE USED TO PROVIDE LATERAL-TORSIONAL RESTRAINT. (REF. 1, p. 5-312, SECT. 5.2) FOR THE 4" (COMPRESSION) LEG OF THE L6x4x½.

WELDS AT THE ENDS OF THE L6x4x½ TRANSFER THE REACTION LOAD OF 2482 Lb. THESE WELDS ARE ANALYZED BELOW.



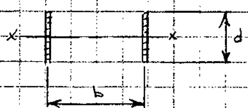
TREAT ¼" SKIP WELDS AS LINES: (REF. 3, p. 7.4, TABLE 5)
NO CREDIT TAKEN FOR 1" RETURNS

$P = 2482$ Lb

$\ell = (1.5" + 1" + 3") = 5.5"$

$M_x = P\ell = 2482\text{ Lb} \times 5.5" = 13651$ IN-Lb

$S_w = \frac{d^2}{3}$



$d = 6"$

$b = 4"$

$S_w = \frac{(6")^2}{3} = 12.0\ \text{in}^2$

$f_v = \frac{M_x}{S_w} = \frac{13651\ \text{IN-Lb}}{12.0\ \text{IN}^2} = 1138$ pli

$F_v = S(0.7071)(L) \times 0.3(70\text{ ksi})$

$= (0.25")(0.7071)(1") \times 0.3 \times 70\,000\text{ psi} = 3712\text{ pli} > f_v = 1138\text{ pli}$ OK

∴ USE ¼" FILLET SKIP WELDS, 2" @ 12" O/C, TO ATTACH L6x4x½ TO 3/8" PL PLATFORM AND 6" LENGTH OF WELD @ ENDS W/ 1" RETURN.

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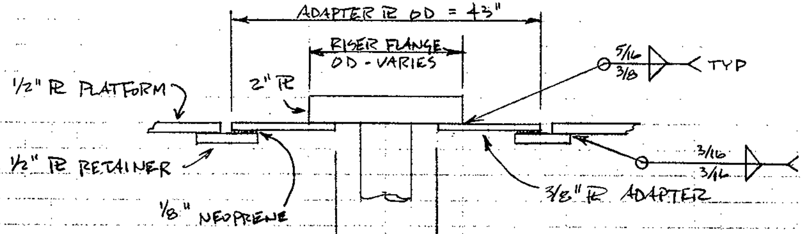
Client WHC		WO/Job No. ER4289	
Subject COLD TEST FACILITY: MOCK-UPS FOR TANK PITS 241-CR-06A & B AND 241-AY-02B		Date 1/4/94	By J. A. Rupert
		Checked 2/7/94	By MRC
Location CAISSON W-106		Revised 6/22/94	By J. A. Rupert

DESIGN ADAPTER PLATES TO STANDARDIZE INSTALLATION OF VARIOUS RISERS IN A SINGLE 1/2" PL PLATFORM.



$F_y = 36{,}000$ psi

241-CR-06A (1'-4" ID)
241-CR-06B (2'-6" ID)

⚠1 MRC 6/29/94

(REF 8, TABLE 24, CASE 1b) OUTER EDGE SIMPLY SUPPORTED, INNER EDGE GUIDED.
USE WORST CASE: $M_{MAX} = M_{rb}$, $r_o = b \Rightarrow M = K_m w a$; $\sigma_r > \sigma_t$

FOR 241-CR-06A RISER ASS'Y TOTAL WT: 3366 Lb + 431 Lb VACUUM LOAD = 3797 Lb
3/8" PL ADAPTER: 3'-7" OD x 1'-4" ID $\Rightarrow r_o = b = 8"$, $a = 21.5"$
$b/a = 8/21.5 \cong 0.4 \Rightarrow K_{m\,rb} = 0.404$ (INTERPOLATE)
w = TOTAL ASS'Y WT / π * OD OF RISER FLANGE (CONSERVATIVE)
= 3797 Lb / π * 21.0 = 57.6 pli

$$f_b = \frac{M_{MAX}}{S_x} = \frac{K_M \times w \times a}{bd^2/6} = \frac{0.404 \times 57.6 \times 21.5}{1"(0.375")^2/6} = 21347 \text{ psi} < 0.75 F_y \text{ ok}$$

(REF. 1, p. 5-48)

FOR 241-CR-06B RISER ASS'Y TOTAL WT: 5021 Lb + 431 Lb VACUUM LOAD = 5452 Lb
3/8" PL ADAPTER: 3'-7" OD x 2'-6" ID $\Rightarrow r_o = b = 15"$, $a = 21.5"$
$b/a = 15/21.5 = 0.70 \Rightarrow K_{m\,rb} = 0.274$
* w = 5452 Lb / π * OD OF RISER FLANGE = 5452 Lb / π * 36" = 48.2 pli

$$f_b = \frac{K_M \times w \times a}{bd^2/6} = \frac{0.274 \times 48.2 \times 21.5"}{1" \times (0.375")^2/6} = 12115 \text{ psi} < 0.75 F_y \text{ ok}$$

CHECK SHEAR ON 3/8" PL ADAPTER
ID OF 1/2" PL RETAINER = 39"
$A_V = \pi \times \text{DIA} \times t$

$$F_v = \frac{5773 \text{ Lb}}{\pi \times 39" \times 0.375"} = 125 \text{ psi} < 0.4 F_y \text{ ok}$$

CHECK STRESS ON WELDS CONNECTING 1/2" PL RETAINER TO 1/2" PL PLATFORM
TRY 3/16" FILLET; TAKE CREDIT FOR INSIDE WELD (43.5" DIA.) ONLY
$F_v = t_e \times 0.3 \times 70 \text{ ksi} \times l = 0.7071(3/16)(0.3)(70)(\pi \times 43.5") = 380^k$ CAPACITY
* $V = (5342 + 431) = 5773$ Lb << 380^k ok FOR 241-AY-02B ASS'Y (HEAVIEST)
* VACUUM LOAD = 0.290 psi * $\pi(43.5")^2/4$ in² = 431 Lb; @ 8" H₂O, 2X OPERATING VACUUM

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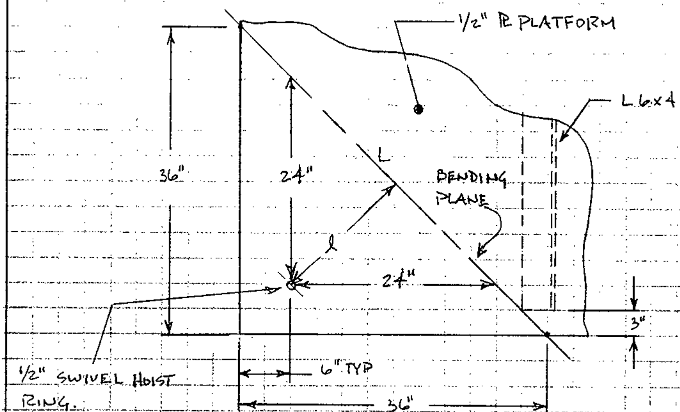
	Checked 2/7/94	By MRC	
Location CAISSON W-106	Revised	By	

CHECK BENDING STRESS ON 1/2" ℞ PLATFORM DUE TO RIGGING LOADS.



$l = \frac{24"}{\sqrt{2}} = 16.97"$ $S_{℞} = \frac{bd^2}{6} = \frac{50.9"(0.5")^2}{6} = 2.12 \text{ in}^3$

LOAD ON SWIVEL:

1/2" ℞ : 10' x 10'	2040 Lb
L 6x4 x 1/2 x 27.5'	446
SPOOL/PUMP/RISER ASS'Y	5342
	7828 Lb

$\Rightarrow$ LOAD/SWIVEL $= \frac{7828 \text{ Lb}}{4} = 1957 \text{ Lb}$

$M_x = (1957 \text{ Lb})(16.97") = 33\,211 \text{ in-Lb}$

$f_b = \frac{M_x}{S_{℞}} = \frac{33\,211 \text{ in-Lb}}{2.12 \text{ in}^3} = 15\,665 \text{ psi} < 0.75\, F_y = 27\,000 \text{ psi}$ OK

SIZE LIFTING RINGS FOR PLATFORM.

TRY 1/2" SWIVEL HOIST RING (CROSBY # 1016909 OR APPROVED EQUAL)
@ SWL = 2500 Lb EACH. (ONE EA. CORNER OF 1/2" ℞ PLATFORM)

4 SWIVELS * 2500 Lb/SWIVEL = 10,000 Lb > 7828 Lb LOAD OK

∴ USE 4 EA. 1/2" SWIVEL HOIST RINGS @ SWL = 2500 Lb EACH TO RIG PLATFORM.

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Client WHC
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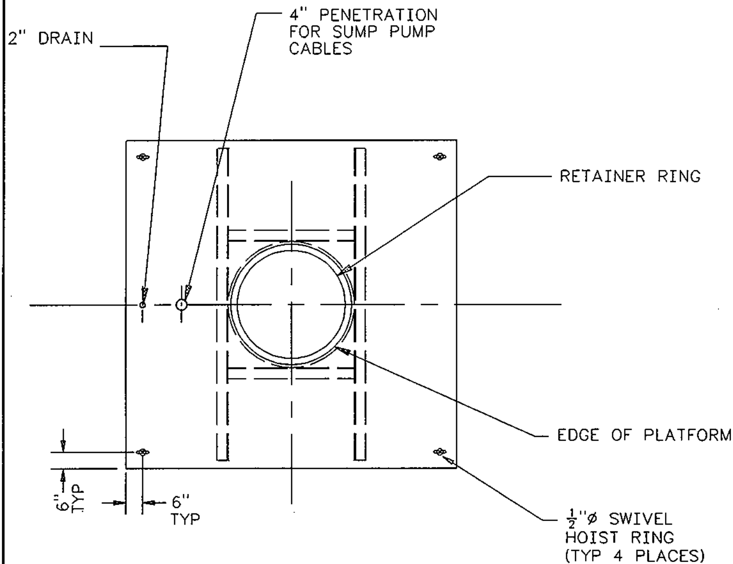
Location CAISSON W-106

WO/Job No. ER4289
Date 1/4/94
Checked 2/7/94
Revised

By J.G. RUPERT
By MRC
By

SUMMARY SKETCHES



PLAN VIEW

PLATFORM PLATE/SUPPORT FRAME

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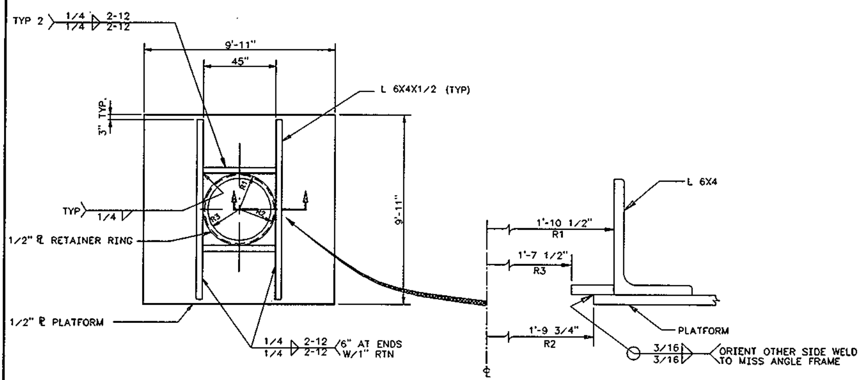
	Checked *2/7/94*	By *MRC*
Location CAISSON W-106	Revised	By

SUMMARY SKETCHES



BOTTOM VIEW - WELD MAP

PLATFORM PLATE/SUPPORT FRAME

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Client WHC	WO/Job No. ER4289	
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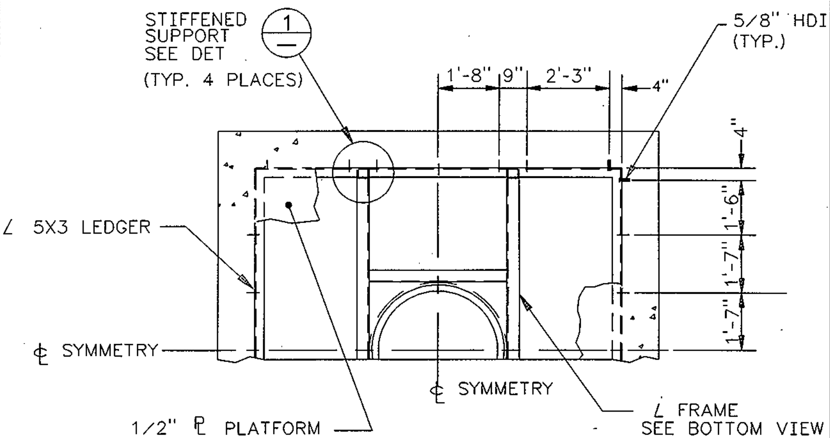
	Checked *2/17/94*	By *MRC*
Location CAISSON W-106	Revised	By

SUMMARY SKETCHES



PARTIAL PLAN

PLATFORM SUPPORT FRAME

LEDGER ANCHOR BOLT LAYOUT

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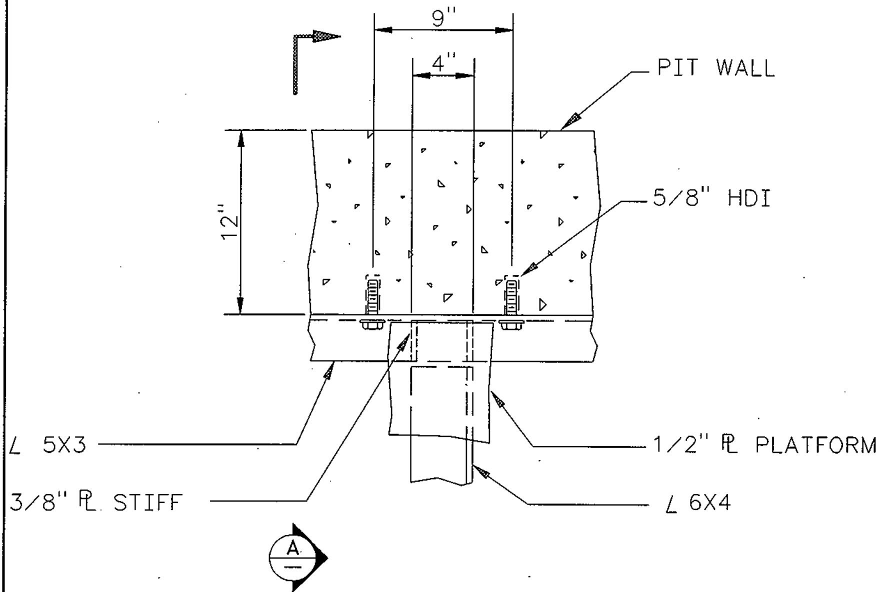
DESIGN ANALYSIS

Client WHC
Subject COLD TEST FACILITY: MOCK-UPS FOR TANK PITS 241-CR-06A,B AND 241-AY-02B.
Location CAISSON W-106

WO/Job No. ER4289
Date 1/4/94 By J.G. RUPERT JGR
Checked 2/7/94 By MRC
Revised By

SUMMARY SKETCHES



DETAIL 1

STIFFENED SUPPORT
TYP FOUR PLACES

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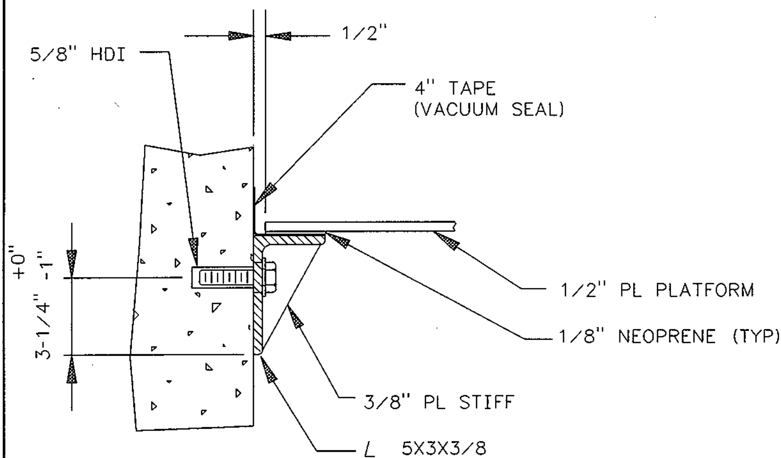
	Checked *2/1/94*	By *MRC*
Location CAISSON W-106	Revised	By

SUMMARY SKETCHES



SECTION A
STIFFENED SUPPORT

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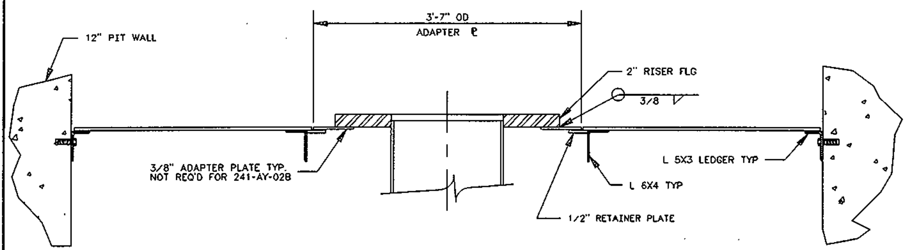
Client WHC	WO/Job No. ER4289	
Subject COLD TEST FACILITY: MOCK-UPS FOR TANK PITS 241-CR-06A,B AND 241-AY-02B.	Date 1/4/94	By J.G. RUPERT JMR
	Checked 2/7/94	By MRC
Location CAISSON W-106	Revised	By

SUMMARY SKETCHES



TYPICAL PLATFORM SECTION
SHOWING TYP RISER INSTALLED

DON'T SAY IT --- Write It!

DATE: December 6, 1993

TO: James G Rupert

FROM: Rodney C. Campbell Carroll M. Jones
Telephone: 376-7364

cc: Dean Jones, Don MacIsaac, Mark Manderbach

SUBJECT: Cold Test Facility Input Loads

These items are in reference to the CC:Mail message that you sent Dean Jones. For item 1:

1. The weight of the Transfer Pump in 241-CR-06A is 1530 lbs as calculated in W320-25-006.

2. The weight of the Heel Jet in 241-CR-06B is 3152 lbs as calculated in W320-25-004.

3. The weight of the Agitator Pump in 241-AY-02B is 2780 lbs as calculated in W320-25-005.

4. The 241-AY-02B spool piece weight is 1633 lbs as calculated in W320-25-008.

5. The 241-CR-06A spool piece weight is 1276 lbs as calculated in W320-25-009.

6. The 241-CR-06B spool piece weight is 886 lbs as calculated in W320-25-010.

For item 2:

The drawings that you listed and are designing to are correct.

For item 3:

Please keep us updated so that we can keep our cross index up to date. The above~~d~~ referenced numbers are so that you can create your cross index.

54-3000-101 (9/59) (EF) GEF014
DSI

Detection/Control: Active ventilation systems are equipped with continuous air monitors (CAMs) and record samplers. CAMs are interlocked to shutdown the ventilation fan when radionuclides exceed the high level setpoint. Record samples are collected continuously and analyzed weekly for gross beta/gamma and alpha.

Recovery Action: If the specification limits are violated, the Tank Farm shift manager shall notify the managers of Tank Farm Operations, SSTPE, Tank Farm Plant Engineering (TFPE), and Health Physics. If the required monitoring and sampling is inoperable for more than 24 hours, the exhauster shall be shutdown and all risers to the affected tanks sealed according to 13.2.2.D.1.

C. Ventilation Operating Pressures

Variable	Specification Limit
Ventilation Operating Pressure	Maximum: -0.1 in wg Minimum: -5.9 in wg

Technical Basis: See SD-RE-TI-035, Technical Basis for Single-Shell Tank Operating Specifications, p. 18. Filter failure will be indicated by alarm on the continuous air monitor.

Detection/Control: The active ventilation systems are equipped with pressure sensors. Pressures in some tanks are measured periodically during psychrometric measurements of each ventilation system.

Limiting Control Setting Recovery Action: If this specification limit is violated, the system shall be restored within one shift to within the requirement. The Tank Farm shift manager shall contact the managers of Tank Farm Operations and SSTPE. Immediate recovery actions may include an adjustment of the air-inleakage to actively ventilated tanks under the direction of the shift manager where provisions have been made for variable inflow.

Calc. No. W-320-24-001
Rev. 0
Appendix A, p. A-2

3.3 PRESSURE MONITORING SYSTEMS

3.3.2 Primary Tank Vapor Space Pressure

LCO 3.3.2 The pressure in each primary tank vapor space, relative to atmospheric pressure, shall be maintained $\geq$ -4 and < 0 inches water gauge.

APPLICABILITY: OPERATION, STANDBY, REPAIR and RESTRICTED tank MODES.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Primary tank vapor space pressure outside limit.	A.1 VERIFY that primary tank vapor space pressure is within the limits specified by SL 2.3, Primary Tank Minimum Vapor Space Pressure, and SL 2.4, Primary Tank Maximum Vapor Space Pressure. AND A.2 Restore primary tank vapor space pressure to within limit.	Immediately AND Each 8 hours thereafter Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.3.2.1	VERIFY primary tank vapor space pressure is $\geq$ -4 and < 0 inches water gauge.	36 hours

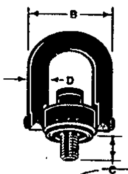
Calc. No. W-320-24-001
Rev. 0
Appendix A, p. A-3

Calc. No. W-320-24-001
Rev. 0
Appendix A, p. A-4

MCMASTER-CARR, CATALOG #94

Lifting Eyes, Nuts, & Swivels

Heavy-Duty Safety Hoist Rings



Pivot 180° and swivel 360° to compensate for pitch, roll, and sway when lifting unbalanced loads. Reduce risks in lifting, moving, and turning heavy equipment. alloy steel construction. Load ratings are for lifts in any direction.

The 2949T series is made from 300 series stainless steel. It is suitable for corrosive atmospheres and environments. The 3052T series is made from alloy steel.

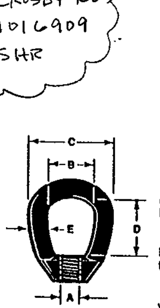
Available: Load limits to 75,000 lbs.; long-lifting ba[se] models; ti-cad plating; and metric sizes. Specify re[quirements] and 3052T999. Prices on request.

SAFETY NOTE: Some loosening may develop after prolonged service in a permanent installation. It is advisable to periodically re-tighten the mounting screws to maintain the specified torque.

CROSBY NO 1016909 SHR

Bolt Size	Thread Torque Ft. Lbs.	Inside Bale Radius	Dimensions B	C	D	Alloy Steel Work Load Limit, Lbs.	No.	NET EACH	Stainless Steel Work Load Limit, Lbs.	No.	NET EACH
5/16"-18	7	7/16"	1 5/8"	9/16"	3/8"	800	3052T55	$65.01	400	2949T11	$276.3
3/8"-16	12	7/16"	1 5/8"	9/16"	3/8"	1,000	3052T56	62.31	500	2949T12	278.9
1/2"-13	28	11/16"	2 7/16"	1 1/16"	1/2"	2,500	3052T57	79.06	1,250	2949T13	330.7
1/2"-13	28	7/8"	3 1/4"	3/4"	3/4"	2,500	3052T58	79.61	1,250	2949T14	337.1
1/2"-13	28	7/8"	3 1/4"	1 1/4"	3/4"	2,500	3052T81	79.72	1,250	2949T15	342
5/8"-11	60	7/8"	3 1/4"	1"	3/4"	4,000	3052T59	79.98	2,000	2949T16	337
5/8"-11	60	7/8"	3 1/4"	1 1/4"	3/4"	4,000	3052T61	79.98	2,000	2949T17	342
3/4"-10	100	7/8"	3 1/4"	1"	3/4"	5,000	3052T62	79.98	2,500	2949T18	345.7
3/4"-10	100	7/8"	3 1/4"	1 1/2"	3/4"	5,000	3052T63	79.98	2,500	2949T19	348
3/4"-10	100	1 13/32"	4 13/16"	1"	1"	7,000	3052T64	171.43	3,500	2949T21	737.7
3/4"-10	100	1 13/32"	4 13/16"	1 17/32"	1"	7,000	3052T82	173.86	3,500	2949T22	743
7/8"-9	160	1 13/32"	4 13/16"	1"	1"	8,000	3052T65	171.43	4,000	2949T23	750
1"-8	230	1 13/32"	4 29/32"	1 1/4"	1"	10,000	3052T66	179.28	5,000	2949T24	762
1"-8	230	1 13/32"	4 29/32"	1 1/2"	1"	10,000	3052T67	193.25	5,000	2949T25	768
1"-8	230	1 13/32"	4 29/32"	2 9/32"	1"	10,000	3052T83	197.34	5,000	2949T26	775
1 1/4"-7	470	1 3/4"	6"	1 7/8"	1 1/4"	15,000	3052T68	324.66	7,500	2949T27	1254
2"-4 1/2	800	2 1/4"	8"	3 1/8"	1 3/4"	30,000	3052T69	462.68	—	—	—

Drop-Forged Eye Nuts



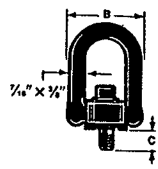
These drop-forged eye nuts are available in standard-duty galvanized steel; standard-duty 18-8 type 316 stainless steel; and heavy-duty self-colored steel.

Eye nuts are tapped with Unified National Coarse Class 2-B threads. Heavy-duty eye nuts have 1½ to 2 times larger thread lengths that enable higher working load limits.

Note: Loads shown apply to eye nuts only, based on a vertical pull, and not to any connecting bolt or stud.

Thread Dia. (A)	Dimensions B	C	D	E	Work Load Limit, Lbs.	No.	NET EACH 1-23	24-Up
STANDARD-DUTY GALVANIZED STEEL								
1/4"	3/4"	1 1/4"	1 1/16"	1/4"	520	3019T14	$2.92	$2.63
5/16"	3/4"	1 1/4"	1 1/16"	1/4"	840	3019T15	2.92	2.63
3/8"	1"	1 5/8"	1 1/4"	5/16"	1240	3019T16	2.95	2.66
7/16"	1 1/4"	2"	1 1/2"	3/8"	1700	3019T17	2.97	2.68
1/2"	1 1/4"	2"	1 1/2"	3/8"	2240	3019T18	2.97	2.68
5/8"	1 1/2"	2 1/2"	2"	1/2"	3600	3019T19	3.68	3.32
							1-11	12-Up
3/4"	1 3/4"	3"	2 3/8"	5/8"	5200	3019T21	$6.83	$6.16
7/8"	2"	3 1/2"	2 5/8"	3/4"	7200	3019T22	9.06	8.10
1"	2 1/4"	4"	3 1/16"	7/8"	10000	3019T23	13.33	12.02
1 1/8"	2 1/4"	4"	3 1/16"	7/8"	12300	3019T24	16.00	14.30
1 1/4"	2 1/2"	4 1/2"	3 1/2"	1"	15500	3019T25	20.36	18.19
1 1/2"	3 1/8"	5 5/8"	4"	1 1/4"	22500	3019T27	39.69	35.47
HEAVY-DUTY SELF-COLORED								
							1-23	24-Up
3/8"	7/8"	1 1/2"	1 3/16"	5/16"	1800	3274T41	$4.14	$3.79
1/2"	1 1/8"	2"	1 5/16"	7/16"	3600	3274T42	5.19	4.81
5/8"	1 3/8"	2 1/2"	1 15/16"	9/16"	5800	3274T43	6.74	6.17
							1-11	12-Up
3/4"	1 1/2"	3"	1 7/8"	3/4"	10600	3274T44	$12.55	$11.39
1"	1 3/4"	3 3/4"	1 15/16"	1"	18800	3274T46	23.22	20.81
316 STAINLESS STEEL								
1/4"	3/4"	1 1/4"	1 1/16"	1/4"	460	3061T14	$16.53	$14.91
5/16"	3/4"	1 1/4"	1 1/16"	1/4"	7[illegible]	[illegible]	[illegible]	[illegible]

Large Opening Swivel Hoist Rings



Same as the 3052T series (Heavy-Duty Safe[ty] Hoist Rings) listed above, except swivel ey[e] which is forged from one piece of steel. Provide[s] working load with four times factor of safety in a[ll] directions. Inside bale radius is .645" for 2994T[61-] T48; .880" for T49-T55. The swivels with 3/8"-16 scre[w] thread meet Military Spec. MS5-1937. 12 thre[ad] torque ft.-lbs. for all hoist rings.

Work Load Limit, Lbs.	Thread Torque Ft., Lbs.	Thread Length C	B	No.	NET EACH
5/16"-18 Thread					
800	7	0.56"	2.29"	2994T61	$68
800	7	1.06"	2.29"	2994T62	69
3/8"-16 Thread					
1.000	12	0.56"	2.29"	2994T63	$73
1.000	12	1.06"	2.29"	2994T64	74
1/2"-13 Thread					
2.500	28	1.00"	3.13"	2994T65	$8
2.500	28	1.25"	3.13"	2994T66	84
5/8"-11 Thread					

Lif

Use these pad
machinery, equip
Eye Shou
I.D. O.D. Di
CARBON STEEL
1/4" ..... 5/8" 5/8
3/8" ..... 7/8" 7/8
5/8" ..... 1 1/8" ..... 1"
3/4" ..... 1 1/2" 1 1/
1" ..... 2 1/8" 1 7/
1 1/4" ..... 2 5/8" 1 3/4

S Lifti

For temporary
and construction
machine bolt, and
ed to heavy steel b
on a line through
ed minimum bolt l
T23 and T27: and
Bolt Hole
Dia. × Ht. Th
SINGLE SWIVEL
1/4" × 1 3/8"
1 × 1 3/8"
DOUBLE SWIVEL
1 × 2"
1 1/4" × 2 3/4"
1 1/2" × 2 3/4"
♦ Has a rectangul

NOTE: ALL HOOK

Steel and Screw H

Standard ceiling
hooks. Select fro
steel and solid bra
Nos. 9587T13, 9
9587T11, and 9588
and 9588T78 come 5
others come 100 pe

A B C
080" ..... 11/32" .. 1 5/16
105" ..... 7/16" 1 11/1
135" ..... 9/16" 2 1/16
162" ..... 11/16" .. 2 9/16
192" ..... 1 1/8" .... 3 3/8"
225" ..... 1 3/8" .... 3 7/8"
262" ..... 1 1/2" 4 7/16
306" ..... 1 5/8" 4 15/1

Solid B Shoulder

Supplied 100 per
for 9586T6, 9586T7
which are 50 per bo
Wire Dia. H
072" ..... 1/4"
080" ..... 5/16"
090" ..... 11/32"
120" ..... 15/32"

W320-24-005

Design Two Electrical Equipment Skids
and One Concrete Slab

KAISER ENGINEERS HANFORD	CALCULATION IDENTIFICATION AND INDEX	Page i of iii Date 06/15/94

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

Discipline STRUCTURAL   WO/Job No. ER5735   Calculation No. W320-24-005

Project No. & Name PROJECT W-320; EQUIPMENT REMOVAL SYSTEM

Calculation Item DESIGN TWO ELECTRICAL EQUIPMENT SKIDS AND ONE CONCRETE SLAB

These calculations apply to:

Dwg. No. H-2-820756 SHT 2/2   Rev. No. 0

Dwg. No. H-2-820755 SHT 1/1   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	J.D. Rupert 06/23/94		
Checked by	R.W. Davidson 6/30/94		
Approved by	R.W. Davidson 10/14/94		
Checked Against Approved Vendor Data	Ann Langevin 4/7/98		

INDEX

Design Analysis Page No.	Description
1	OBJECTIVES; CRITERIA; DATA; ASSUMPTIONS; METHODS; REFERENCES; CALCULATION; CONCLUSIONS.
2 - 19	Body of Calculation
App. A	Copy of H-2-820756 sht 2/2, showing equipment loads and dimensions.

RONALD W. DAVIDSON
STATE OF WASHINGTON
24180
REGISTERED PROFESSIONAL ENGINEER
Ronald W. Davidson 10/14/94
EXPIRES 03/03/96

CALCULATION CROSS INDEX (Typical)

Subject Calculation No. W320-24-005, Rev. 0

Page ii 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	
0	-	H-2-820750	0	H-2-820755	0		X		-	RW Davidson 10/14/98
		H-2-820756	0							

DESIGN VERIFICATION SCREENING CRITERIA

HNF-2461, Rev. 0

Project/Document No. Calculation No. W320-24-005-Rev. 0, p. iii of iii

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?
	X	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?
	X	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?
	X	4. Does this design or design change involve or change design that has previously undergone formal design verification?

RWDavidson — Assigned Lead Engineer — Date: 6/30/94

RWDavidson — Responsible Discipline Manager — Date: 10/14/94

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. W320-24-005
		Revision 0
DESIGN ANALYSIS		Page No. 1 of 19
Client WHC	WO/Job No. ER5735	
Subject W320 EQUIPMENT REMOVAL SYSTEM	Date 06/15/94	By J.G. RUPERT 6/23/94
	Checked 6/30/94	By RW Dorsten
Location 241-C, 241-AY TANK FARMS	Revised	By

OBJECTIVE

Design a Transformer/Breaker Skid (Skid #1) and a Transfer Switches/Breakers Skid (Skid #2). Design a slab and anchors to support Skid #1.

CRITERIA

DOE ORDER 6430.1A, 04/06/89
FUNCTIONAL DESIGN CRITERIA: WHC-SD-W320-FDC-001 REV. 2

DATA

See copy of Dwg. H-2-820756 Sht 2/2, showing equipment weights and materials.

ASSUMPTIONS

Weights and depths of equipment shall not exceed those shown on the marked-up drawing referenced under "DATA".

METHODS:

Hand Calculations

REFERENCES

1. AISC MANUAL OF STEEL CONSTRUCTION; 9th ed., 1989
2. UNISTRUT - GENERAL ENGINEERING CATALOG, NO. 12, 1992
3. SDC 4.1, REV. 11
4. ANSI/ASCE 7-88
5. UBC-91
6. SDC 4.2, REV. 0
7. ACI 318-89
8. ROARK'S FORMULAS FOR STRESS & STRAIN, YOUNG, W., 5th ED.

CALCULATION

See attached calculation

CONCLUSIONS

Build two skids as shown in attached summary sketches. To support the electrical Transformer/Breaker Skid (Skid #1) use a concrete slab 4'W X 12'L X 6"T with one mat of #4 temperature steel @ 9" O/C, E.W. Use 4 ea. 1/2" HKB II concrete anchors (min. embedment) to attach Skid #1 to the slab. Skid #2 is to be supported on soil due to the temporary use of the electrical equipment. Fill the two cavities in the base of Skid #2 with concrete to provide overturning stability.

KAISER ENGINEERS HANFORD

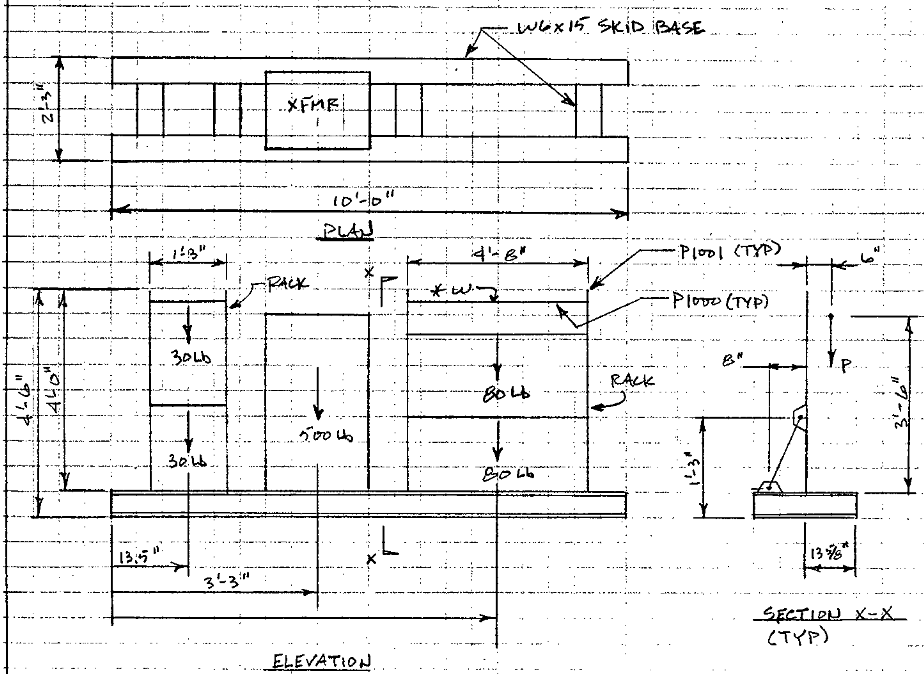
Calc. No. W320-24-005
Revision 0
Page No. 2 of 19

DESIGN ANALYSIS

Client WHC		WO/Job No. ER 5735	
Subject W320 EQUIPMENT REMOVAL SYSTEM		Date 06/15/94	By J. A. Rupert
		Checked 6/30/94	By R. W. Dourdan
Location 241-C, 241-AY TANK FARMS		Revised	By

DESIGN TWO ELECTRICAL SKIDS TO SUPPORT ELECTRICAL EQUIPMENT REQUIRED FOR THE TANK FARM EQUIPMENT REMOVAL SYSTEM (ERS) OPERATIONS

SKID #1 XFMR/BRKR SKID (TWO EQUIPMENT SUPPORT RACKS + XFMR)



* WIREWAY; 150 # UNIFORMLY DISTRIBUTED OVER 4'-8".

KAISER ENGINEERS HANFORD

DESIGN ANALYSIS

Calc. No. W320-24-005
Revision 0

Client WHC | WO/Job No. ER 5735
Subject W320 EQUIPMENT REMOVAL SYSTEM | Date 06/15/94 By J. G. Rupert
Checked 6/30/94 By R. Davidson
Location 241-C, 241-AY TANK FARMS | Revised By

1. CHECK STRESS ON W6X15 SKID. ASSUME ALL EQUIPMENT LOADS ARE TAKEN BY ONE W6x15 x 10'-0" (CONSERVATIVE).

LOADS

XFMR: 500 Lb

1'-3" RACK: EQUIP - 60 Lb

UNISTRUT - P1000 @ 1.9 plf, P1001 @ 3.8 plf } REF. 2, p. 23

$(2 \times 4')3.8\ plf + (2 \times 1.25')1.9\ plf = 35\#$

TOTAL: $(60 + 35)$ Lb = 95 Lb

4'-8" RACK: EQUIP. $(150 + 160)$ Lb = 310 Lb

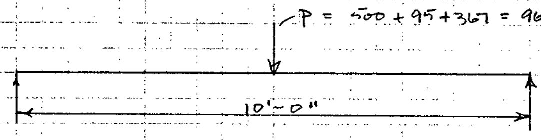
UNISTRUT $(3 \times 4.67')1.9\ plf + (2 \times 4')3.8\ plf = 57$ Lb

TOTAL: $(310 + 57)$ Lb = 367 Lb

NEGLECT W6x15 SELF-WEIGHT.

ASSUME TOTAL LOAD IS TAKEN @ CTR OF SIMPLE BEAM (CONSERVATIVE)

$P = 500 + 95 + 367 = 962$ Lb



W6x15: $S_x = 9.72\ in^3$, $b_f = 5.99"$, $I = 29.1\ in^4$ (REF. 1, p. 1-32)

$$f_b = \frac{M_x}{S_x} = \frac{P \times L/4}{S_x} = \frac{962\ Lb \times 120"/4}{9.72\ in^3} = 2969\ psi$$

NOTE: W6x15 IS NONCOMPACT (REF. 1, p 2-73)

$L_u = 12.0'$

$L_c = 6.3'$

THE W6x15 IS BRACED @ 4'-8" MAX. (56") $< \frac{76\, b_f}{\sqrt{F_y}} = \frac{76(5.99")}{\sqrt{36}} = 75.9"$ OK

USE $F_b = 0.6 F_y$ (REF. 1, p. 5-46)

$\therefore f_b = 2969\ psi < F_b = 0.6 \times 36\,000\ psi = 21,600\ psi$ OK

KAISER ENGINEERS HANFORD

DESIGN ANALYSIS

Client WHC | WO/Job No. ER 5735
Subject W320 EQUIPMENT REMOVAL SYSTEM | Date 06/15/94 By J.A. Rupert
Checked 6/30/94 By K.C. Donaldson
Location 241-C, 241-AY TANK FARMS | Revised By

CHECK SKID DEFLECTION: ASSUME ALL LOAD IS TAKEN @ MID-SPAN OF ONE W6X15.

$$\Delta = \frac{P\ell^3}{48EI} = \frac{9626 \cdot (120'')^3}{48(29E6\ psi)(29.1\ in^4)} = 0.04'' < \frac{\ell}{240} = 0.5''\ \text{OK}$$

∴ USE W6X15 FOR MAIN SKID MEMBERS

2. CALCULATE WIND & SEISMIC LOADING

NOTE: THE SKID FRAME TAKES VERTICAL LOAD ONLY WHEN THE SKID IS BEING MOVED. OTHERWISE, THE SKID IS CONTINUOUSLY SUPPORTED ON A CONCRETE SLAB. HORIZONTAL SEISMIC AND WIND LOADS ARE CONSIDERED TO CAUSE NEGLIGIBLE STRESS IN THE WEAK AXIS DIRECTION OF THE W6X15 FRAME. VERTICAL SEISMIC LOAD IS TAKEN BY THE SLAB ⇒ THE W6 FRAME IS NOT SUBJECT TO FLEXURE.

WIND LOAD (SC-3)

SPEED: 70 mph
I: 1.07
EXP: C

} REF. 3, p. 8

$F = q_z G_h C_f A_f$ (REF. 4, TABLE 4)

$q_z = 0.00256\ K_z\ (IV)^2$; $K_z = 0.80$ (REF. 4, TABLE 6)
$= 0.00256\ (0.8)(1.07 \times 70)^2 = 11.5\ psf$

$G_h = 1.32$ (REF. 4, TABLE 8)
$C_f = 1.2$, $\nu \leq 3$ (REF. 4, TABLE 13)
A_f = VARIES BY SITUATION/COMPONENT

$F = 11.5\ psf\ (1.32)(1.2)A_f = 18.2\ psf \times A_f$

KAISER ENGINEERS HANFORD

Calc. No. W320-24-005
Revision 0
Page No. 5 of 19

DESIGN ANALYSIS

Client WHC | WO/Job No. ER5735
Subject W320 EQUIPMENT REMOVAL SYSTEM | Date 06/15/94 | By J.A. Rupert
Checked 6/30/94 | By K.W. Donaldson
Location 241-C, 241-AY TANK FARMS | Revised | By

SEISMIC LOAD (SC-3)

$I = 1.25$ (REF. 3, p.9)

$Z = 0.20$ (REF. 5, TABLE 23 I)

W_p = VARIES BY SITUATION/COMPONENT

HORIZONTAL FORCE FACTOR, $C_p = 2.0 * 0.75 = 1.50$ (REF. 5, TABLE 23P & SECT. 2336)

$F_p = Z I C_p W_p$

$= 0.2 * 1.25 * 1.50\ C_p = 0.375\ C_p$

3. DETERMINE OVERTURNING STABILITY OF SKID.

WIND: ASSUME SKID PRESENTS A SOLID AREA OF: $4.5' * 10' = 45\ ft^2$ (CONSERVATIVE)

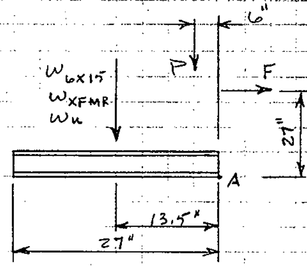
$P = 150 + 160 + 60 = 370$ Lb (EQUIP. WT.)

$W_u = 35 + 57 = 92$ Lb (UNISTRUT WT.; SEE p.3)

$W_{6x15} = 15 plf (2 \times 10 + 4 \times 1.25)' = 375$ Lb

$W_{XFMR} = 500$ Lb

$F = 18.2 psf (4.5' * 10') = 819$ Lb



SIDE VIEW

ΣM ABOUT POINT A TO FIND

$M_{OT} = 819 Lb * 27'' = 22113$ "-#

$M_R = 370 Lb \times 6'' + (375 + 92 + 500)\ 13.5'' = 15274$ "-#

$\frac{M_{OT}}{M_R} = \frac{22113 "-\#}{15274 "-\#} = 1.4 > 2/3 \Rightarrow$ NEED ANCHORS (REF. 4, 6.1.2)

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DESIGN ANALYSIS

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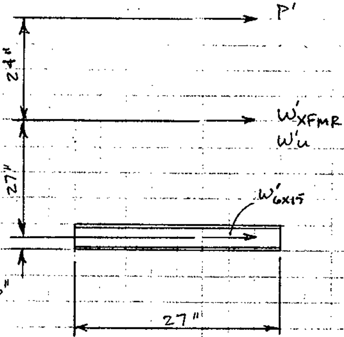
SEISMIC:

$M_R = 15274$ "-# (SEE p. 5)

$W'_{XFMR} = 0.375\,(500\text{ Lb}) = 188\text{ Lb}$
$W'_u = 0.375\,(92\text{ Lb}) = 35\text{ Lb}$
$P' = 0.375\,(370\text{ Lb}) = 139\text{ Lb}$
$W'_{6\times15} = 0.375\,(375\text{ Lb}) = 141\text{ Lb}$



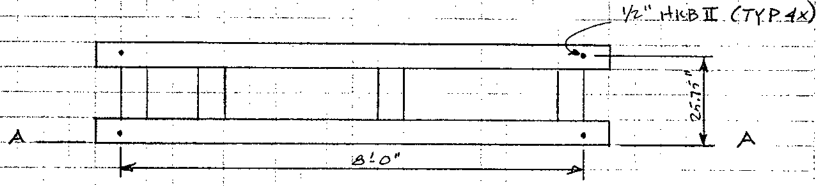
ONLY SEISMIC LOADS SHOWN

$M_{OT} = 139\text{ Lb} * 54" + (188 + 35)\text{ Lb} * 30" + 141\text{ Lb} * 3" = 14619$ "-#

M_{OT} FOR WIND (22113 "-#) CONTROLS

4. DESIGN ANCHORS FOR SKID

ALLOW ANCHORS TO RESIST FULL M_{OT} WIND (CONSERVATIVE)

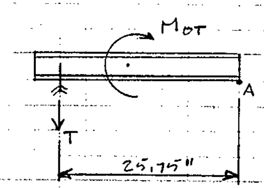


W6X15 FRAME PLAN

TRY 1/2" HKB II, $f'_c = 4000$ psi

$\Sigma M_A = T * 25.75" - M_{OT} = 0$

$T = \dfrac{22113\text{ "-\#}}{25.75" * 2\text{ BOLTS}} = 429\text{ Lb / BOLT}$



$V = \dfrac{F}{4\text{ BOLTS}} = \dfrac{819\text{ Lb}}{4\text{ BOLTS}} = 205\text{ Lb / BOLT}$

$T_{ALLOW} = 1200\text{ Lb/BOLT}$, 2 1/4" EMBED > 429 Lb OK
$V_{ALLOW} = 1420\text{ Lb/BOLT}$, 2 1/4" EMBED > 205 Lb OK (REF. 6, TABLE 1B)

(FOR MIN. EDGE DISTANCE FOR HKB II SEE REF. 6., TABLE 1.0)

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$\frac{V}{V_{ALLOW}} + \frac{T}{T_{ALLOW}} = \frac{205}{1420} + \frac{429}{1200} = 0.50 \le 1.0$ OK

∴ USE 1/2" HKB II TO ANCHOR SKID #1 TO SLAB

5. SIZE UNISTRUT COLUMNS & BEAMS USED FOR 4'-8" WIDE EQUIPMENT RACK (MEMBER SIZES ARE ALSO SUFFICIENT FOR THE 1'-3" WIDE RACK)

SEISMIC LOAD ON RACK:

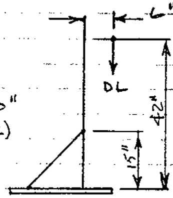
W_p = WT PANELS + WT WIREWAY + WT UNISTRUT (SEE p.3)
= 160 + 150 + 57 = 367 Lb

$F_p = Z I C_p W_p = 0.375 * 367$ Lb = 138 Lb
M_p = 138 Lb (42"-15") = 3726"-# (W_p TAKEN @ 42" ABOVE BASE => CONSERVATIVE)
CONTROLS

WIND LOAD ON RACK:

F = 18.2 psf × A_f = 18.2 psf (4' * 4.67') = 340 Lb
M_F = 340 Lb (24" - 15") = 3060"-# (F TAKEN @ COLUMN MID HT.)

TRY P1001 UNISTRUT FOR COLUMNS



MODEL COLUMN AS FLAGPOLE => K = 2.1 (REF 1, p. 5-135)
EFFECTIVE LENGTH OF COLUMN = KL = 2.1 (42"-15") = 57" SAY 60" (CONSERVATIVE)

MAX. ALLOWABLE LOAD @ SLOT FACE = 5690 Lb @ 60" HT (REF 2, p. 25)

IMPUTE MAX. ALLOW MOMENT
$M_x = 5690$ Lb × $\frac{3.25"}{2}$ = 9246"-# / P1001 COLUMN

COMBINE LOADS (D + W OR Z, REF. 4, 2.3)

M_x = (150 + 160) Lb × 6" + 3726"-# = 5586"-#

$\frac{M_x}{2\ COLS} = \frac{5586"-\#}{2}$ = 2793"-#/COL < 9246"-# ALLOWED OK

CHECK: S_x = 0.572 IN³ F_y = 33 KSI (REF. 2, p. 20, 25)
$f_b = \frac{M_x}{S_x} = \frac{2793"-\#}{0.572\ IN^3}$ = 4883 psi < 0.6 (33000) = 19800 psi OK

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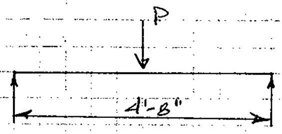
TRY P1000 UNISTRUT FOR RACK BEAMS - ASSUME ALL GRAVITY LOAD IS TAKEN @ CTR SPAN AS A SIMPLE BEAM - TWO P1000 (CONSERVATIVE)

P = PANEL + WIREWAY
160 + 150 = 310 Lb OR P/2 = 155 Lb



UNIFORM LOAD MAX: SEE p. 2 OF CALCS
60/56 × 680 = 729 Lb > 150 Lb (REF 2, p. 24)
WIREWAY OK

MAX. ALLOWABLE P-LOAD FOR 4'-8" LENGTH OF P1000
(REF 2, p. 24 - SEE FOOTNOTE 3)

$P_{MAX} = 0.5 \times 680\text{ Lb} \times 60"/56" = 364\text{ Lb} > P/2\text{ cols} = 182\text{ Lb}$ OK

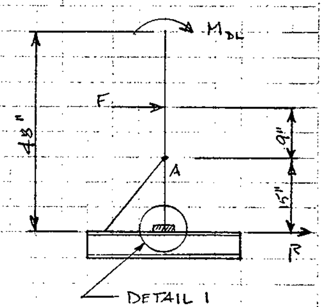
∴ USE P1001 COLUMNS AND P1000 BEAMS FOR EQUIP. RACKS FOR SKID #1.

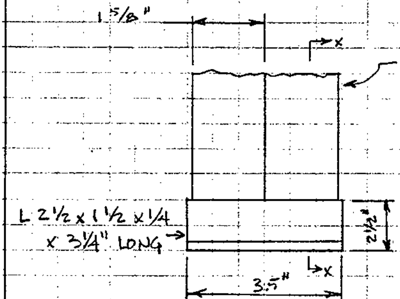
6. SIZE WELDS FOR P1001 CONNECTION TO W6 X 15 SKID BASE

F = 340 Lb (WIND)

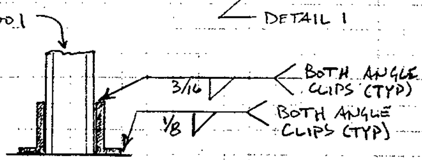
$M_{DL} = (150 + 160)\text{ Lb} \times 6" = 1860\text{ "-\#}$

$R = \dfrac{340\text{ Lb} \times 9" + 1860\text{ "-\#}}{15" \times 2\text{ cols}} = 164\text{ Lb/column}$





DETAIL 1



SECTION X-X

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CAPACITY OF 2 * 3" = 6" OF 1/8" FILLET WELD

F_V = 0.125" * 0.7071 * 0.3 * 70,000 psi * 6" = 11,136 Lb >> R/2 = 164 Lb

∴ USE 1/8" MIN. FILLET WELD * 6" TO ATTACH P1001 UNISTRUT COLS. TO BASE

7. SIZE WELD FOR MOUNTING XFMR TO W6X15 SKID BASE

F_w = 18.2 psf * 2'-2" * 4' = 158 Lb

F_p = 0.375 * 500 Lb = 188 Lb CONTROLS

TRY 4 ANGLE CLIPS, ONE @ EACH CORNER OF XFMR, CLIPS ARE SAME AS FOR MOUNTING UNISTRUT COLUMNS (p. 8); 3/16" FILLET WELDS

4 CLIPS * 3" WELD / CLIP = 12" OF 3/16" FILLET WELD. FROM p. 8 OF CALCS; CAPACITY = 2 * 16,705 Lbs = 33,410 Lbs >> F_p

∴ USE 4 ANGLE CLIPS (L 2½ x 1½ x ¼ x 3" LONG) AND MOUNT TO SKID BASE w/ 3/16" FILLET WELDS x 3" LONG.

8. SIZE FORGED STEEL (F.S.) EYEBOLTS FOR LIFTING SKID #1

TOTAL SKID WT.
- XFMR: 500 Lb
- W6X15: 27' * 15 plf = 405 Lb
- P1000 UNISTRUT: (4 x 4'-8" + 3 * 1'-6") 1.9 plf = 44 Lb
- P1001 UNISTRUT: 4 * 4' * 3.8 plf = 61 Lb
- MISC. CLIPS/STIFFENERS: 15 Lb
- PANELS: (1 * 60 Lb + 4 * 40 Lb + 1 * 150 Lb) = 370 Lb

TOTAL: (500 + 405 + 44 + 61 + 15 + 370) Lb = 1395 Lb SAY 1400 Lb

DIRECT TENSION LOAD (USE 4 EYEBOLTS) = $\frac{1400 \text{ Lb}}{4}$ = 350 Lb/BOLT

RATED SWL FOR A ½" F.S. EYEBOLT IS 2600 Lb >> 350 Lb

USE ARMSTRONG # 89025, ½" LIFTING EYE, F.S. (OR EQUAL)
CAPACITY: 2600 # STRAIGHT LIFT (0°), 1200 # @ 30° FROM VERTICAL

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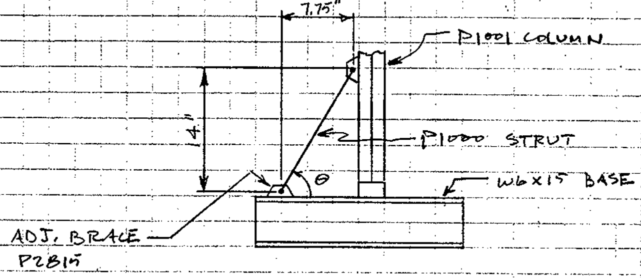
9. DETERMINE STRUT FORCES

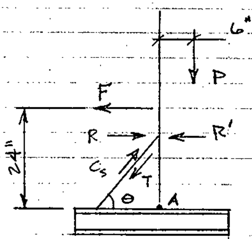
TRY UNISTRUT ADJUSTABLE BRACES PN P2B15 (REF 2, p. 111). THIS ASSEMBLY USES P1000 UNISTRUT AS THE COMPRESSION MEMBER.



LENGTH OF P1000 STRUT = $\sqrt{14^2 + 7.75^2}$ = 16", $\theta = \tan^{-1}(14/7.75) = 61°$
END CONDITION: ASSUME PIN-PIN ⇒ K = 1.0
LOAD IS APPLIED @ C.G. BY DESIGN OF ADJUSTABLE BRACES

REF. 2, p. 25, ALLOWS A MAXIMUM COLUMN LOAD OF C = 9320 Lb FOR A 24" P1000 COLUMN USING THE ABOVE LOADING CONDITIONS.

P = (160 + 150) Lb = 310 Lb



NOTE: TO PLACE THE STRUTS IN COMPRESSION THE WIND LOAD MUST ALWAYS OPPOSE THE DEAD LOAD OF THE EQUIPMENT. ASSUME D.L. = 0 (CONSERVATIVE) & STRUTS TAKE FULL COMPRESSIVE FORCE OF WIND.

F = 18.2 psf * 4.67' * 4' = 340 Lb (SEE p. 4)

$\Sigma M_A = 0 = 340\text{ Lb} * 24" - R * 14" = 0$ (NOTE: 14" IS CONSERVATIVE)

$R = \dfrac{340 * 24}{14 * 2\text{ STRUT}} = 291$ Lb/STRUT

$C_s = \dfrac{R}{\cos\theta} = \dfrac{291\text{ Lb}}{\cos(61°)} = 600$ Lb/STRUT < 9320 Lb

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TENSION: DIRECTION OF WIND & D.L. MOMENT ARE SAME. TOTAL LOAD TAKEN BY TWO P1000 STRUTS.

$$\Sigma M_A = 0 = 310\,Lb * 6'' + 340\,Lb * 24'' - R' * 14'' = 0$$

$$R' = \frac{310 * 6 + 340 * 24}{14 * 2\ \text{STRUTS}} = 358\,Lb$$

$$T = \frac{R'}{\cos(\theta)} = \frac{358\,Lb}{\cos(61°)} = 738\,Lb < 9320\,Lb \ *$$

MATERIAL: UNISTRUT IS ASTM A570 GR 33, 12 GA.; $F_y = 33{,}000$ psi
$A = 0.556\ IN^2$ (REF. 2, p. 22)

* ALLOWABLE TENSILE FORCE AT LEAST EQUALS ALLOWABLE COMPRESSIVE FORCE SINCE ALLOWABLE COMPRESSIVE FORCE INVOLVES REDUCTION FOR BUCKLING WHICH DOES NOT OCCUR IN TENSION.

THE 2 - 1/2" BOLTS USED TO MOUNT THE ADJUSTABLE BRACES TO THE SKID BASE AND TO THE UNISTRUT ARE CONSIDERED SUFFICIENT TO TRANSFER THE ABOVE LOADS.

MAX. PULLOUT & SLIP LOADS FOR CHANNEL NUTS (REF. 2, p. 69)
1/2-13 FOR P1000
PULL-OUT STRENGTH: 2000 Lb
SLIP RESISTANCE: 1500 Lb
TORQUE: 50 FT-Lb

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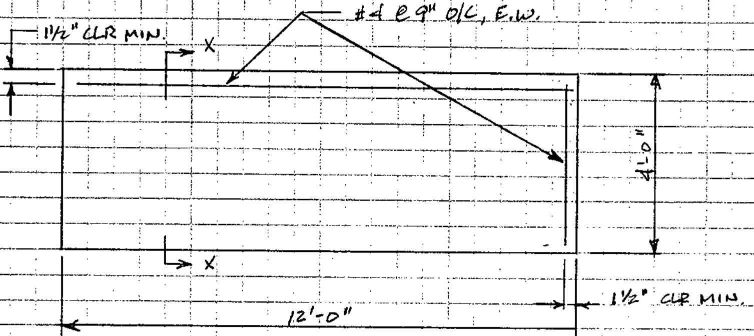
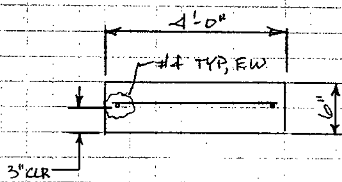
Client WHC | WO/Job No. ER 5135
Subject W320-EQUIPMENT REMOVAL SYSTEM | Date 06/15/94 By L.G. Rupert
Checked 6/30/94 By VW Sheridan
Location 241-C, 241-AY TANK FARMS | Revised By

10. DESIGN SLAB-ON-GRADE TO SUPPORT SKID # 1

USE 6" CONCRETE SLAB, f'_c = 4000 psi, w/ #4 TEMP STEEL 9" O/C E.W.





SECTION X-X

TEMP. STEEL: f_y = 60 000 psi

$\rho_s = \dfrac{12/9 * 0.20 \text{ in}^2}{6" * 12"} = 0.0037 > 0.0018$ OK (REF. 6, 7.12.2.1)

TOTAL SKID WT. IS 1400 LBS. => VERY SMALL STRESS ON SLAB

∴ USE 6" CONCRETE (f'_c=4000 psi) SLAB w/ #4 @ 9" E.W. - ASTM A615, GR 60

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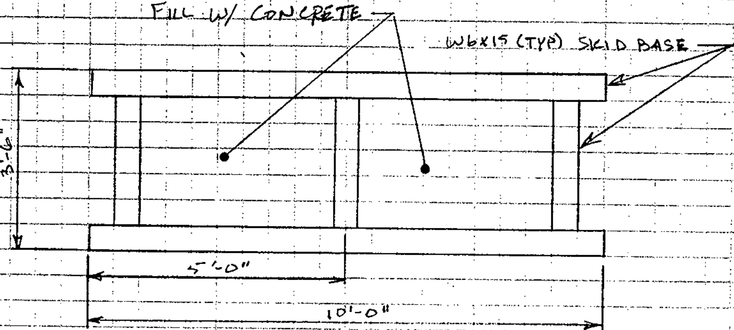
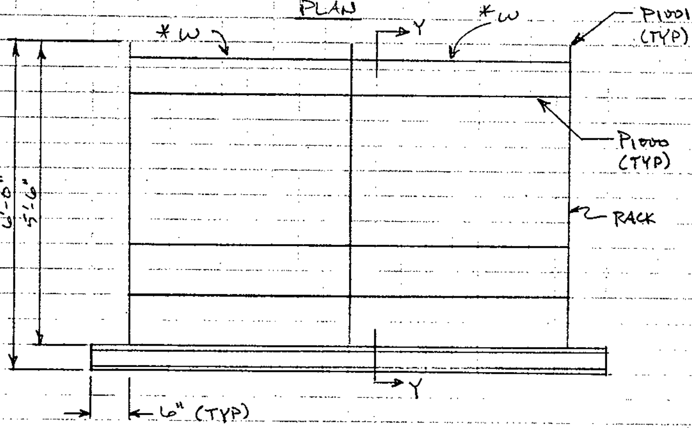
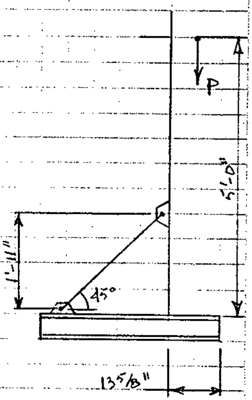
SKID #2 TRANSFER SW/BRKR SKID (EQUIPMENT SUPPORT RACK)



PLAN



ELEVATION



SECTION Y-Y

* 75 # UNIFORMLY DISTRIBUTED LOAD OVER 4'-6" (WIREWAY).

SKID #2 MUST REMAIN PORTABLE. NOT TO BE ANCHORED TO A SLAB OR SOIL - MUST BE FREE-STANDING.

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1. CHECK STRESS ON W6x15 SKID BASE

[FOR W6x15 PROPERTIES SEE p.3 OF CALCS.]

LOADS: SEE SKETCH IN APP. A OF CALCS.
PANELS/BRKRS: 340 Lb, WIREWAY: 150 Lb
UNISTRUT: P1001 - 3 * 5.5' (3.8 plf) = 63 Lb
P1000 - 4 * 9.0' (1.9 plf) = 68 Lb
TOTAL EQUIPMENT LOAD = 621 Lb

WT. OF CONCRETE IN SKID BASE CAVITIES:
3' * 9' * 0.5' THK. (150 pcf) = 2025 Lb

ASSUME TOTAL LOAD (621 + 2025) Lb = 2646 Lb IS TAKEN AT THE MIDSPAN OF ONE W6x15 * 10' AS A CONCENTRATED LOAD. NEGLECT SELFWEIGHT OF BEAMS. (CONSERVATIVE)

$$f_b = \frac{M_x}{S_x} = \frac{PL/4}{S_x} = \frac{2646\text{ Lb} * 120''/4}{9.72\text{ IN}^3} = 8167\text{ psi} < 0.60 F_y \text{ OK}$$

∴ USE W6x15 AS SKID BASE

2. DETERMINE WIND & SEISMIC LOADING (SC-3)

WIND LOAD: MAX. WHEN PERPENDICULAR TO PANEL FRONT
SEE p. 4 OF CALCS.

$$F = 18.2\text{ psf} * A_f = 18.2\text{ psf}\,(6\times 9) = 983\text{ Lb}$$

SEISMIC LOAD: MAX. EFFECT WHEN TAKEN PERPENDICULAR TO PANEL FRONT
SEE p. 5 OF CALCS. FOR SEISMIC COEFFICIENTS.

$$F_p = 0.375\, W_p$$

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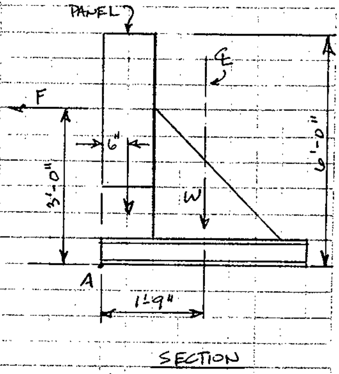
3. DETERMINE OVERTURNING STABILITY OF SKID # 2

DUE TO THE VARIABILITY OF POSSIBLE ELECTRICAL PANEL TYPES & WEIGHTS, USE ONLY 1/2 THE EQUIPMENT/RACK WEIGHT CONTRIBUTION TO THE RIGHTING MOMENT.



WIND

$F = 18.2\ psf * A_f$

$= 18.2\ psf(6' * 9') = 983\ lb$

$W = W_{EQ} + W_B + W_C$

$W_{EQ} = \frac{EQUIP\ WT}{2} = \frac{621\ lb}{2} = 310\ lb$ (SEE p. 14 OF CALCS.)

W_B = WT. 6x15 SKID BASE = $(2 * 10' + 3 * 3')\ 15\ plf = 435\ lb$

$W_C = 9' * 3' * 0.5' * 150\ pcf = 2025\ lb$

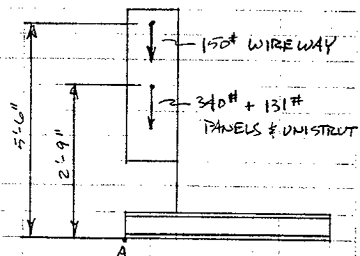
$M_R = 310\ lb * 6" + 435\ lb * 21" + 2025\ lb * 21" = 53520$ "-#

$M_{OT} = F * 36" = 18.2\ psf(9' * 6') * 36" = 35380$ "-#

$FS_{OT} = 1.5$, $1.5 * M_{OT} = 53071$ "-# $< M_R = 53520$ "-# ok

SEISMIC

SEE p. 14 OF CALCS FOR LOADS



$M_{OT} = 0.375 [150\ lb * 54" + 471 * 39" * 2025 * 3]$

$= 12204$ "-# < WIND $M_{OT} = 35380$ "-#

=> WIND CONTROLS

∴ SKID #2 IS STABLE AS DESIGNED, FILL SKID BASE WITH CONCRETE

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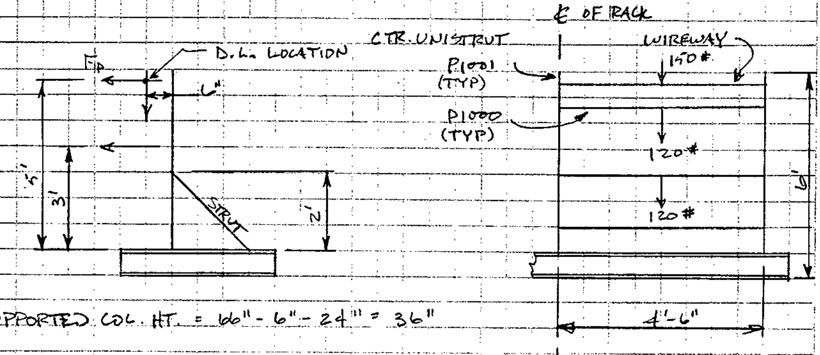
4. SIZE UNISTRUT COLUMNS & BEAMS USED FOR EQUIPMENT RACK



UNSUPPORTED COL. HT. = 66" - 6" - 24" = 36"

SEISMIC LOADING - ON 1/2 RACK

W_p = WT PANELS + WT WIREWAY + WT UNISTRUT
= 240 Lb + 150 Lb + (131/2) Lb = 456 Lb (ASSUME SAME LOADING ON BOTH HALVES OF RACK; CONSERV.)

$F_p = ZIC_pW_p$ = 0.375 * 456 Lb = 171 Lb

M_p = 171 Lb * 36" = 6156 "-# CENTER COL. CONTROLS

WIND LOADING - ON 1/2 RACK

F = 983 Lb TOTAL; 1/2 TO CTR COL. = 492 Lb

M_F = 492 Lb (36" - 24") = 5904 "-#

TRY P1001 UNISTRUT FOR COLUMNS

MODEL COLUMN AS FLAGPOLE => K = 2.1 (REF. 1, p. 5-135)
EFFECTIVE LENGTH OF COLUMN = KL = 2.1 (60" - 24" - 6") = 63"

MAX. ALLOWABLE @ SLOT FACE = (60/63) 5960 = 5676 Lb
IMPUTE MAX. ALLOWABLE MOMENT: 5676 * 1.625 = 9224 "-# / P1001 COLUMN
COMBINE LOADS (D + W OR Z, REF. 4, 2.3)
M_x = (150 + 240) Lb * 6" + 6156 "-# = 8496 "-# < 9224 "-#

CHECK: S_x = 0.572 IN³ F_y = 33 KSI (REF. 2, p. 20, 25)

$$f_b = \frac{M_x}{S_x} = \frac{8496\text{ "-\#}}{0.572\text{ IN}^3} = 14853\text{ "-\#} < 0.6F_y = 19800\text{ psi OK}$$

NOTE: THIS IS VERY CONSERVATIVE SINCE ALL D.L. IS CONSIDERED TO BE LOCATED @ 60" ABOVE SKID BASE.

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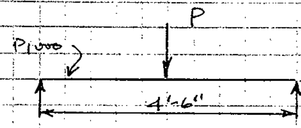
Checked 6/30/94 By [signature]
Location 241-C, 241-AY TANK FARMS
Revised By

TRY P1000 UNISTRUT FOR RACK BEAMS. ASSUME ALL GRAVITY LOAD IS TAKEN @ MID-SPAN AS A SIMPLE BEAM. BY TWO P1000. (CONSERVATIVE)

$$P = \frac{456 \text{ Lb}}{2 \text{ BEAMS}} = 228 \text{ Lb}$$



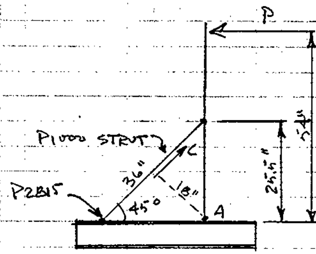
UNIFORM LOAD MAX: (REF. 2, p. 24)
60/54 * 680 Lb = 756 Lb > 150 Lb UNIFORM LOAD OF WIREWAY

MAX. ALLOWABLE P-LOAD FOR 4'-6" LENGTH OF P1000
(REF. 2, p. 24 - SEE FOOTNOTE 3)

$$P_{MAX} = 0.5 * 680 * 60"/54" = 378 \text{ Lb} > 228 \text{ Lb} \quad \text{OK}$$

∴ USE P1001 COLUMNS & P1000 BEAMS FOR EQUIPMENT RACK FOR SKID #2

5. CHECK CAPACITY OF COMPRESSION STRUTS



STRUT IS MOUNTED TO FRAME USING ADJUSTABLE BRACE UNISTRUT PN P2815

TREAT P1000 STRUT AS A COLUMN OF LENGTH l = 36" W/ K=1.0.

=> MAX ALLOWABLE COMPRESSIVE LOAD
= 7000 Lb (REF. 2, p. 25)

LET C = 7000 Lb

$$\Sigma M_A = 7000 * \frac{36"}{2} - P_{MAX} * 54" = 0$$

$$P_{MAX} = 7000 * \frac{18"}{54} = 2333 \text{ Lb/STRUT} \gg \text{SEISMIC OR WIND AND D.L. (SEE p. 16)} \quad \text{OK}$$

USE UNISTRUT ADJUSTABLE BRACE P2815 W/ P1000 STRUT BY 36" LONG MAX.

KAISER ENGINEERS HANFORD

Calc. No. W320-24-005
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Page No. 18 of 19

DESIGN ANALYSIS

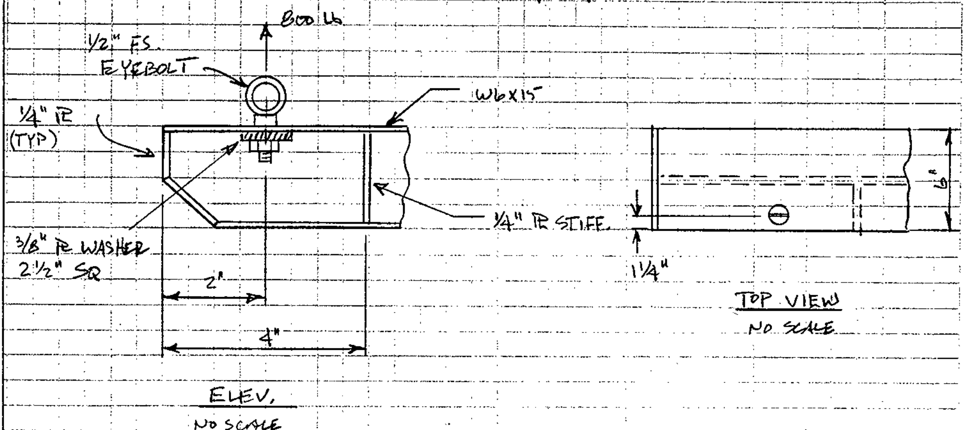
Client WHC — WO/Job No. ER5735
Subject W320 - EQUIPMENT REMOVAL SYSTEM — Date 06/15/94 By [signature]
Checked 6/30/94 By [signature]
Location 241-C, 241-AY TANK FARMS — Revised By

6. CHECK LIFTING CAPACITY/STRESS @ STIFFENED ENDS OF W6X15 & 1/2" EYEBOLT

TOTAL SKID #2 WT

PANELS/BRKR	1621 Lb
W6 X 15 BASE	458 Lb
WT CONCRETE	2025 Lb
	3104 Lb SAY 3200 Lb

LOAD / 1/2" F.S. EYEBOLT = $\frac{3200 \text{ Lb}}{4 \text{ BOLTS}}$ = 800 Lb/BOLT



MODEL W6X15 TOP FLANGE AS (F_y = 36 ksi)
1. A PL W/ EDGES FIXED, SIMPLE, SIMPLE, FREE
2. A PL W/ EDGES SIMPLE, SIMPLE, SIMPLE, FREE

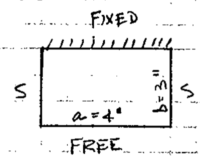
1.) REF. 8, p. 463, CASE 7a (CONSERVATIVE)

$a/b = 4/3 = 1.33$ $\quad q = \frac{800 \text{ Lb}}{(2.5")^2} = 128$ psi (CONSERV.) ← 3/8" WASHER SIZE

$\beta_1 = 1.08$

$\beta_2 = 0.674$

$t_f = 0.26"$



$$\sigma_1 = \frac{\beta_1 q b^2}{t^2}$$

$$\sigma_1 = \frac{1.08(128)(3)^2}{(0.26)^2} = 18405 \text{ psi} < 0.75 F_y$$ @ CTR OF FIXED EDGE

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

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DESIGN ANALYSIS

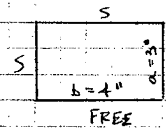
Calc. No. W320-24-005
Revision 0

Client WHC
WO/Job No. ER5735
Subject W320 - EQUIPMENT REMOVAL SYSTEM
Date 06/15/94 By [signature]
Checked 6/30/94 By [signature]
Location 241-C, 241-AY TANK FARMS
Revised By

$\sigma_2 = \frac{\beta_2 q b^2}{t^2} = \frac{0.674 (128)(3)^2}{(0.26)^2} = 11486$ psi $< 0.75 F_y$ ok
@ CTR OF FREE EDGE

2.) REF. 8, p. 461, CASE 2a

$a/b = 3/4 = 0.75$
$\beta = 0.50$
$q = \frac{800 \text{ Lb}}{(2.5")^2} = 128$ psi (CONSERV.)



$\sigma_{MAX} = \frac{\beta q b^2}{t^2} = \frac{0.50 (128)(4)^2}{(0.26)^2} = 15148$ psi $< 0.75 F_y$ ok

∴ USE 1/2" FS EYEBOLT @ END OF STIFFENED W6x15 SKID BASE

7. SIZE F.S. EYEBOLTS FOR LIFTING SKID #2

TOTAL SKID WT = 3200 Lb (SEE p. 18)

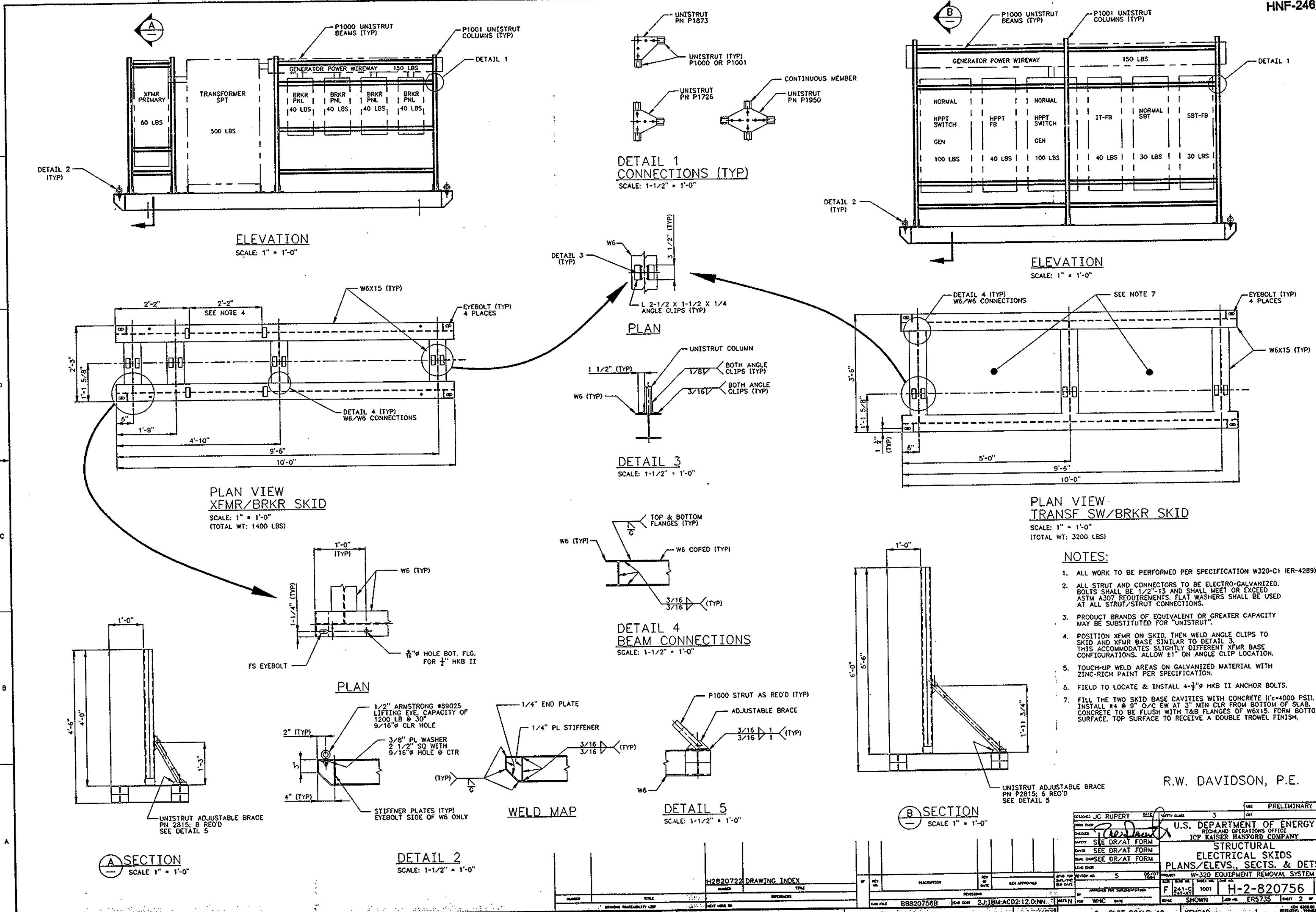
DIRECT TENSION LOAD (USE 4 EYEBOLTS) = $\frac{3200 \text{ Lb}}{4 \text{ BOLTS}}$ = 800 Lb/BOLT

USE ARMSTRONG 1/2" F.S. EYEBOLT # 89025 (OR EQUAL)
CAPACITY:
2600 Lb STRAIGHT LIFT (0° FROM VERTICAL)
1200 Lb @ 30° FROM VERTICAL

8. CONNECTIONS FOR P1001 & ADJUSTABLE BRACE TO W6x15 SKID BASE

USE 3/16" FILLET WELDS TO FASTEN L 2 1/2 x 1 1/2 x 1/4 ANGLE CLIPS x 3" LONG TO W6x15 BASE (SEE p. 8 & 9 OF CALCS.) AND TO P1001 COLUMNS. USE 1/8" FILLET WELDS TO ATTACH ANGLE CLIPS TO P1001 UNISTRUT (12 GA.).
WELD CAPACITY / L CONNECTION IS 11136 Lb >> WIND, SEISMIC, D.L. COMB.

9. RACKING (SHEAR) OF THE UNISTRUT FRAMES IS CONSIDERED TO BE SUFFICIENTLY RESISTED BY THE 1/4" CONNECTOR PLATES AND THE DIAPHRAGM ACTION OF THE SHEET METAL PANELS.



CALCULATION NO. W320-24-005
APPENDIX A
PAGE 1 OF 1

W320-24-006

Distribution Panel Skid & Pad Design

KAISER ENGINEERS HANFORD	CALCULATION IDENTIFICATION AND INDEX	Page i of iii Date 4/20/94

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

Discipline Structural WO/Job No. ER4289/W-320 Calculation No. W320-24-006

Project No. & Name Project W-320, Equipment Removal System

Calculation Item Distribution Panel Skid & Pad Design

These calculations apply to:

Dwg. No. H-2-820755 Rev. No. 0

Dwg. No. H-2-820756 Rev. No. 0

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

The status of these calculations is:

☐ Preliminary Calculations

☒ Final Calculations

☐ Check Calculations (On Calculation Dated)

☐ Void Calculation (Reason Voided)

RONALD W. DAVIDSON STATE OF WASHINGTON 24180 REGISTERED PROFESSIONAL ENGINEER 5/17/94

EXPIRES 3/3/96

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	James R Booth / 4-20-94		
Checked by	Michael R Custer 5/5/94		
Approved by	R W Davidson 5/17/94		
Checked Against Approved Vendor Data	Ann Shangevin 4/7/98		

INDEX

Design Analysis Page No.	Description
1-2	Objective, Criteria, Data, Assumptions, Methods, References Input, and Conclusion
3-14	Calculations
ATTACH 1-1	Skid Drawing (H-2-820756 sh. 1)
ATTACH 1-2	Pad Drawing (H-2-820755 sh. 1)
ATTACH 2-1	Electrical Input (H-2-820749 sh. 5)
ATTACH 2-2	" " (H-2-820752 sh. 3

KEH 0378.00 (06/92)

CALCULATION CROSS INDEX (Typical)

Subject Calculation No. W320-24-006

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-2-820749 Sh.5	0	H-2-820755 Sh.1	0		✓		N/A	[illegible] 5/17/94
0	N/A	H-2-820752 sh3	0	H-2-820756 Sh.1	0		✓		N/A	

KEH 1975.00 (12/88)

DESIGN VERIFICATION SCREENING CRITERIA

Project/Document No. W-320 / W320-29-006

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] 5/17/94
Assigned Lead Engineer — Date

[signature] 5/17/94
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 (06/91)

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HANFORD

DESIGN ANALYSIS

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Client WHC
WO/Job No. ER4289 / W-320
Subject Distribution Panel Skid & Pad Design
Date 4-20-94 By JR Booth
Checked 5/4/94 By MRC
Location 200E
Revised By

Objective: To design the steel skid and concrete pad to support the Distribution Panels shown on H-2-82749 sh5. and H-2-820752 sh. 3. These panels are of the same design and therefore will be supported by similar skids and pads.

Criteria:

1) DOE Order 6430.1A
2) SDC 4.1 Rv. 11
3) UBC (1991 edition)

Data: See H-2-820749 sh. 5 & H-2-820752 sh. 3 for size and weight of Distribution Panel.
$f'_c = 4000$ psi   Resteel $f_y = 60000$ psi
A36 steel   A325 bolts

Assumptions: A conservative assumption of 1200 # for the Distribution Panel was made by Tim Kasnik, Elec. Lead Engineer, based on component weights.

Methods: Hand Calculations

References:
1) ASCE 7-88
2) SDC 4.1, Rev. 11
3) UBC 91
4) AISC -LRFD ; 1ST ED
5) SDC 4.2, Rev. 0
6) ACI 318-89
7) UCRL 15910

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DESIGN ANALYSIS

Client	WHC	WO/Job No.	ER 4289 / W-320
Subject	Distribution Panel Skid & Pad Design	Date 4-20-94	By JR Booth
		Checked 5/4/94	By MRC
Location	200E	Revised	By

Conclusion: 1. See attachment 1-1 for steel skid design.
2. Attach Distribution Panel to skid with 4 - ½" Ø A307 bolts.
3. See pg. 12 for reinforcing steel guide
4. See main body of calc for design.
5. Load for Distribution Panel provided by Tim Kasnick, Electrical Lead Engineer for project W-320. Also see attachment 2.
6. See ATTACH 1-2 for Pad design.

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HANFORD

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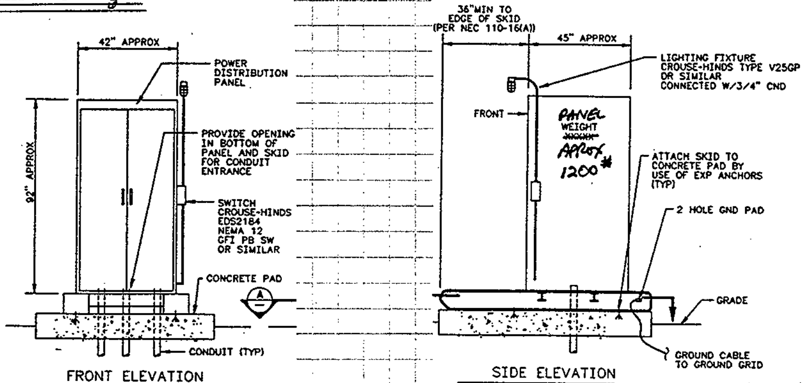
DESIGN ANALYSIS

Client WHC | WO/Job No. ER4289 / W-320
Subject Distribution Panel SKid & Pad Design | Date 4-20-94 By JR Booth
Checked 5/4/94 By MLC
Location 200E | Revised By

SKid Design



DISTRIBUTION PANEL SKID

Determine Loads:

Live: $L = 60$ psf, ASCE 7-88, pg. 4 Walkways & Elevated Platforms

Wind: $F = q_z G_h C_f A_f$, (ASCE 7-88, pg. 10)

$q_z = 0.00256 K_z (IV)^2$ pg. 11
where $V = 70$ mph SDC 4.1
$I = 1.07$ SDC 4.1
$K_z = 0.80$ pg. 12
$q_z = 0.00256(0.80)[(1.07)(70)]^2 = 11.49$ psf
$G_h = 1.32$ pg. 15
$C_f = 1.2$ Table 13
$A_f = 7.67' \times 3.75' = 28.8$ ft²

$F = 524.16$ lbs ⌀ 525 lbs

∴ Force acts at mid-height of Panel.

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DESIGN ANALYSIS

Client WHC
WO/Job No. ER4289 / W-320
Subject Distribution Panel Skid & Pad Design
Date 4-20-94 By JR Booth
Checked 5/4/94 By MLC
Location 200 E
Revised By

Snow: $p_g = 20$ psf (SDC 4.1 pg. 9)

Seismic: $F_p = Z I C_p W_p$ (UBC 1991)

where $Z = 0.2$

$I = 1.25$ (SDC 4.1)

$C_p = 0.75(2) = 1.5$

$W_p = 1200$ lb

∴ Apply force at CM.

$F_p = (0.2)(1.25)(1.5)(1200 \text{ lb}) = 450$ lb

Dead Loads: (Skid material sizes assumed)

1/4" STEEL PL = 11.26 psf (LRFD pg. 1-122)

Distribution Panel = 1200 lbs

C 4 x 7.25 = 7.25 lbs/ft

W 6 x 9 = 9 lb/ft

Two directional Seismic effects per UCRL 15910 pg. 4-30.

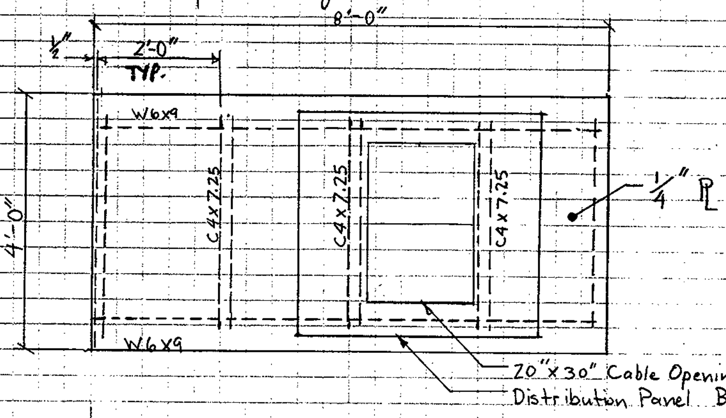
$F_p = 450$ lb

$F_p(90°) = 450 \text{ lb}(0.3) = 135$ lb

$F_T = (450^2 + 135^2)^{1/2} = 470$ lb (SRSS)

Client WHC
WO/Job No. ER4289 / W-320
Subject Distribution Panel Skid and Pad Design
Date 4-20-94 By JR Booth
Checked 5-4-94 By MRC
Location 200E
Revised By

Skid Conceptual Design: (See H-2-820756 for Final design)



PLAN
Scale: 1/2" = 1'-0"

Size Channels:

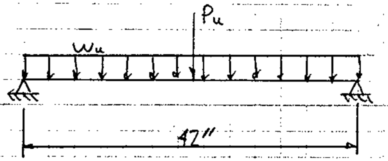
Apply 1200 lbs concentrated load to center of simply supported stringer. (Conserv)

Dead Load: $11.26(2) + 7.25 = 30$ #/ft

Live Load: 60 psf $\times 2 = 120$ #/ft

Snow Load: 20 psf $(2') = 40$ #/ft

$w_u = 1.2(30) + 1.6(120) + 0.5(40) = 248$ #/ft
$P_u = 1.4(1200) = 1680$ lbs



$$M_u = \frac{P_u L}{4} + \frac{w_u L^2}{8}$$

$$= \frac{(1680)(4)}{4} + \frac{(248)(4)^2}{8}$$

$$= 2176 \text{ \#}\cdot\text{ft}$$

KAISER ENGINEERS HANFORD

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DESIGN ANALYSIS

Client: WHC	WO/Job No. ER 4289 / W-320		
Subject: Distribution Panel Skid & Pad Design	Date 4-20-94	By J R Booth	
Location: 200 E	Checked 5/4/94	By MCC	
	Revised	By	

$M_u = 2176\ ^{\#}\cdot ft = 26.1$ in•Kips (LRFD pg. 3-5)

$M_u \le \phi M_n$

See pg. 3-5 of AISC-LRLD for design method.

$\phi M_n = \phi Z_x\ 36$

$Z_x = \dfrac{26.1}{(0.9)(36)} = 0.8\ in^3$, $Z_{x\,req} = 0.8\ in^3$

$Z_x = 2.81\ in^3$ for C 4 × 7.25

C 4 × 7.25 OK

Check Shear: $V_u = 1.3$ Kips

$\phi_v V_n \ge V_u$

$\phi_v V_n = \phi 0.6\ F_y\ A_w$ $A_w = (4.0 \times 0.321) = 1.28\ in^2$

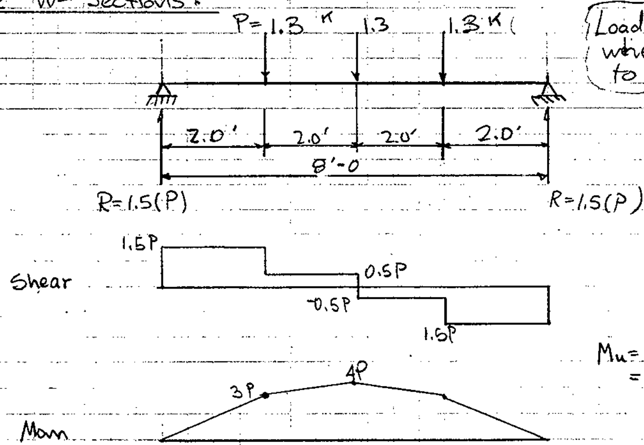
$= (0.9)(0.6)(36)(1.28)$

$= 24$ kips $> 1.3^K$

OK for shear

Size W- Sections:

Load case is conserv. when 1.3^K is applied to 3 locations.



$M_u = 4P + 9\ ^{\#}/ft (1.2)(8)$
$= 5.3\ K\cdot ft$

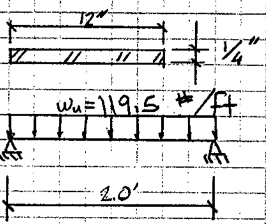
$M_u = 5.3^{k \cdot ft}$ Try W 6x9
$L_b = 2.0$ $L_p = 3.8$ Compact Section

$C_b \, \phi_b M_n \leq \phi M_p$ where $C_b = 1.13$ – (LRFD Pg. 3-7)
$1.13(5.3) = 5.99^{k \cdot ft} \leq \phi M_p = 16.8^{\, k \cdot ft}$ (LRFD Pg. 3-17)

Check Shear: $\phi V_n = (0.9)(0.6)(36)(5.90 \times 0.17) = 19.5$ Kips

$19.5 > 1.95$ OK

Check Steel PL



$S = \dfrac{[(1/12)(12)(1/4)^3]}{1/8} = 0.125 \ in^3/ft$

$w_u = 1.2(11.26 \times 1.0) + 1.6(60 \times 1.0) + 0.5(20 \times 1.0)$
$= 119.5$ #/ft
$P_u = 1.4\left(\dfrac{1200}{3}\right) = 560$ #

$M_u = \dfrac{119.5(2)^2}{8} + \dfrac{560(2)}{4} = 340$ #·ft $= 4.1$ k·in

$f_b = \dfrac{4.1}{0.125} = 32.8$ ksi $< F_b = 36$ ksi OK

Note: All four corners of Distribution Panel are supported by the W-shapes. Assume 1/3 of panel wt. & distributed load.

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DESIGN ANALYSIS

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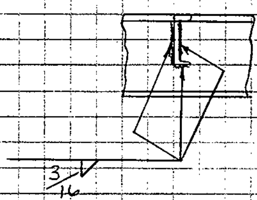
Client WHC | WO/Job No. ER4289 / W-320
Subject Distribution Panel Skid & Pad Design | Date 4-20-94 By JR Booth
Checked 5/4/94 By MRC
Location 200E | Revised By

Check Welds:



Check welds for shear.

(LRFD PG 6-65)

$\phi R_{nw} = (0.75)(0.132)(0.6)(70) = 4.16$ Kip/in ← controls

or

$\phi R_{nw} = (0.75)(0.19)(0.6)(58) = 4.96$ kip/in

Verticle Load = 1.3 K (from pg. 6)

Horizontal Load = 0.525 K (from pg. 3)

Length of weld: Web C4x7.25 = 4 − 0.6875 + 4 − (2 × .6875) = 5.94"
Flange C4x7.25 = 1.75"

Weld Capacity = (1.75 + 5.94) 4.16 K/in = 32 Kips

$\sqrt{(1.3)^2 + (.525)^2} = 1.4$ Kips **OK**

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DESIGN ANALYSIS

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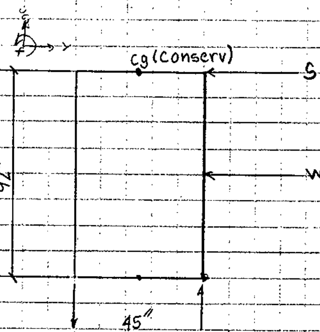
Client WHC		WO/Job No. ER4289 / W-320	
Subject Distribution Panel Skid & Pad Design		Date 4-20-94	By JRBooth
		Checked 5/4/94	By MRC
Location 200E		Revised	By

Determine Required Bolt Sizes:



F(wind) = 525 lbs ← governing shear
F(seismic) = 470 lbs

$M_{OT(WIND)} = (525)(46) - (45)T = 0$

$T = 537$ lbs

$M_{OT(seismic)} = (470)(92) - (45)T = 0$

$T = 960$ lbs ← Governs

$T = 960/2 = 480$ #/bolt $V = 525/2 = 262.5$ lbs/bolt

$\phi R_n = 0.65(0.60\,F_u^b)A_b$ Shear   (LRFD pg. 5-6)
$\phi R_n = 0.75(0.75\,F_u^b)A_b$ Tension   (LRFD pg. 5-3)

Try ½" Dia. A307 bolts

$\phi R_n = 0.65(27)(0.129) = 2.3$ Kips/bolt
$\phi R_n = 0.75(45)(0.129) = 4.4$ Kips/bolt

∴ 4-½"φ A307 bolts OK to secure Distribution Panel to ¼" PL.

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

Client WHC
WO/Job No. ER4289 / W-320
Subject Distribution Panel Skid & Pad Design
Date 4-20-94 By JR Booth
Checked 5-5-94 By MRC
Location 200E
Revised By

Design Lifting Lugs:

Determine total wt. of skid: Distribution Panel = 1200 #

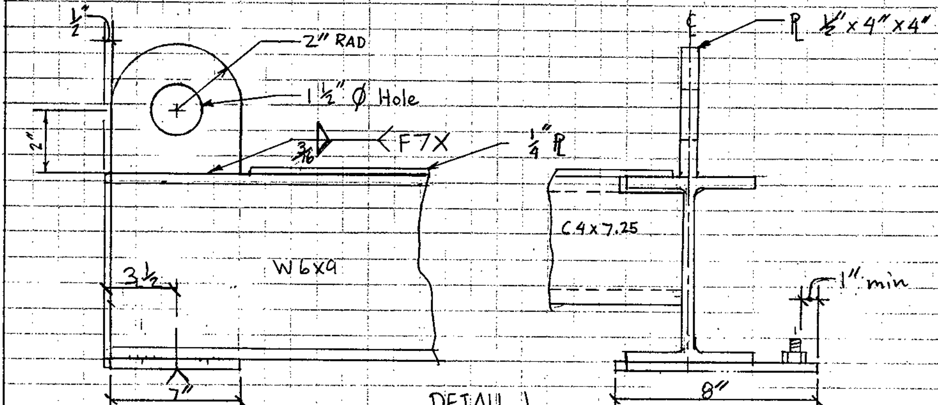
1/4 PL = (11.26)(4x8) = 361

5 - C4 x 7.25 x 3.5 = 127

2 - W6x9 = 144

1832 #

Scale: 3" = 1'-0"



DETAIL 1

Assume a load case as shown in (LRFD PG. 5-93)

$P_u = 1.4(1832) = 2565$ lb (Assume each lug take $\frac{1}{2} P_u$)

$P_{u_1} = 1282.5$ lb $= 1.3$ Kips

$l = 4$ in D = 3 K = 0 (Special Case) $C_1 = 1.0$

$a l = 2''$ $a = 0.5$ $C = 1.299$ (Assume worst case of C)

$P_u = (1.299)(1.0)(3)(4) = 15.6$ Kips $> P_{u_1}$

3/16" Fillet weld OK

KAISER ENGINEERS
HANFORD

Calc. No. W320-24-006
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DESIGN ANALYSIS

Client WHC	WO/Job No. ER4289 / W-320		
Subject Distribution Panel Skid & Pad Design	Date 4-20-94	By	JR Booth
	Checked 5-5-94	By	MRC
Location 200E	Revised	By	

Check Lug for design strength: (LRFD Pg. 6-37)

Design tensile strength:

$\phi P_n = \phi\, 2 t\, b_{eff}\, F_u$
$= (0.75)(2)(0.5)(1.25)(58) = 54.4$ kips

Design shear strength:

$\phi P_n = \phi\, 0.6\, A_{sf}\, F_u$ $\quad A_{sf} = 2(0.5)(1.25) = 1.25 in^2$
$= (0.75)\,0.6\,(1.25)(58)$
$= 32.63$ Kips

Check weak axis bending of lifting lug:

$S = \frac{bd^2}{6} = \frac{4(.5)^2}{6} = 0.17 in^3$

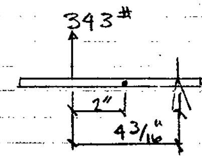
$M_u = (1.3^{kips})(2 in) = 2.6$ kip·in

$f_b = \frac{2.6}{0.17} = 15.3$ ksi $< F_b = 36$ Ksi OK

∴ Lifting Lug OK

Check Anchor PL's for Bending:

PL 1/4" × 7" × 8"
Pg. 12
$M_u = 343^{\#}(2) = 0.7$ K·in



$S = \frac{(7)(.25)^2}{6} = 0.07 in^3$

$f_b = \frac{0.7}{0.07} = 10$ ksi $< F_b = 36$ ksi OK

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

KAISER ENGINEERS HANFORD

Calc. No. W320-24-006
Revision 0
Page No. 12 of 14

DESIGN ANALYSIS

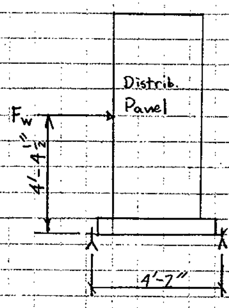
Client WHC		WO/Job No. ER 4289 / W-320	
Subject Distribution Panel Skid & Pad Design		Date 4-20-94	By J R Booth
		Checked 5-4-94	By MRC
Location 200 E		Revised	By

Anchor Bolt Requirement:

$M_{OT} = F_S(8.21')$, $F_W = 525$

$M_{OT} = 3859$ #·ft

Neglect moment from self weight.



$T = \dfrac{3859 \text{ \#·ft}}{4.17' \text{ (2 bolts)}} = 343$ #/bolts

$V = \dfrac{525 \text{ \#}}{2 \text{ bolts}} = 262.5$ #/bolts

$T_{ALLOW} = 1.2^K$
$V_{ALLOW} = 1.42^K$ } Minimum embedment. (12¼") (SDC 4.2, Table 18)

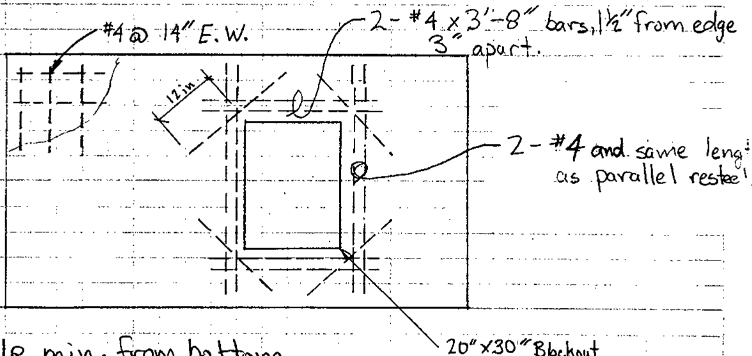
Maintain 6¾" min. between bolt and edge of slab.

∴ Use 4-½" HKB II @ Min Embedment of 2¼" to anchor skid

Design Concrete Pad (See H-2-820755 sh. 1 for final design)

Try a 9'-0 x 5'-6" x 6" slab.

Assume $f'_c = 4000$ psi
$f_y = 60$ ksi



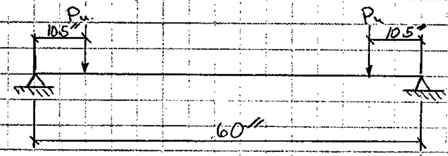
Maintain 3" clr min. from bottom & 1½" clr on sides.

Determine Temperature Resteel:

Minimum reinforcement is that required for control of skrinage and temperature cracking: (ρ_{min}, ACI 10.5.3)

$A_s = 0.0018 \times 12 \times 6 = 0.13\ in^2/ft$.

Check Required Resteel for Flexure:



$P_u = 1.95$ kips, from pg. 6 of calc.

$M_{DL} = 150\ psf \times 1' \times 0.5 = 75\ plf$

$M_u = \frac{1.4(75)(5.5)^2}{8} + (1950)(\frac{10.5}{12}) = 2103\ ft\text{-}\# = 25.2\ in\text{-}kip$

$\phi M_n \geq M_u$

$A_s = \frac{M_u}{\phi f_y (d - a/2)}$, $a = \frac{A_s f_y}{0.85 f'_c b}$

$A_s = \frac{25.2}{0.9(60)(2.75 - 0.5/2)} = 0.18\ in^2$

$a = \frac{0.18(60)}{0.85(4)(12)} = 0.26\ in$

$A_s = \frac{24.4}{0.9 \times 60 \times (2.75 - 0.26/2)} = 0.17\ in^2 > 0.13\ in^2$

$a = \frac{(0.17)(60)}{0.85(4)(12)} = 0.25\ in$

Assume #4 bars used.

Spacing $= 0.20\left(\frac{12}{0.17}\right) = 14\ in$

∴ Go with #4 bars spaced 14" O.C both ways minimum.

Client WHC | WO/Job No. ER4289 / W-320
Subject Distribution Panel Skid & Pad Design | Date 4-20-94 By JR Booth
Checked 5-5-99 By MRC
Location 200E | Revised By

Check Shear:

pg. 10, wt. for Pu for lifting lug

V_u @ support = 1.3 K x 1.15 = 1495 lbs (ACI sec. 11.3.1.1)

V_u @ d away = 1495 - 75 (1.4)($\frac{2.75}{12}$) = 1471 lbs

$\phi V_n = \phi\, 2\sqrt{f'_c}\, bd = (0.85)(2)\sqrt{4000}\,(12)(2.75) = 3548$ lb

$\phi V_n > V_u$ OK

Check Over Turning Moment of Skid & Pad:

$M_{OT} = 525(58) = 30.5$ in.k

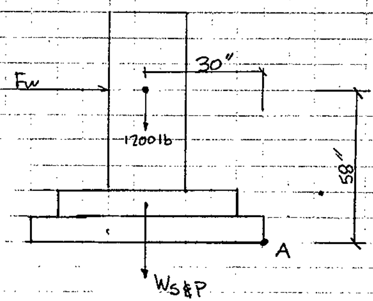
Pg. 10

$W_{S\&P} = 1832 + (150\text{pcf})(0.5 \times 5 \times 9)$
$= 5207$ lbs

$M_R = 5207\ (30) = 156.2$ in.k

$\frac{M_{OT}}{M_R} = \frac{30.5}{156.2} = 0.19 < 2/3$ OK

(per UBC sec. 2317)

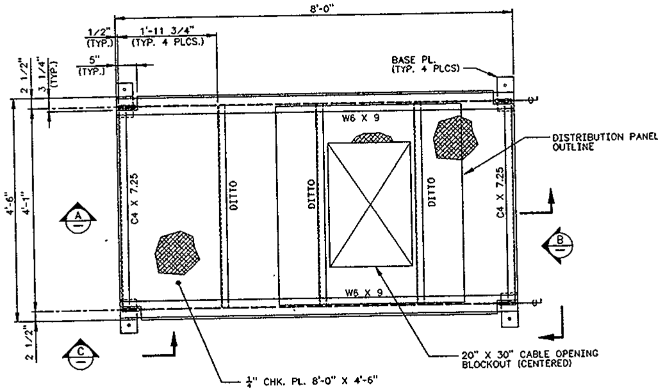


Determine Development Length for Diagonal Bars @ Opening:

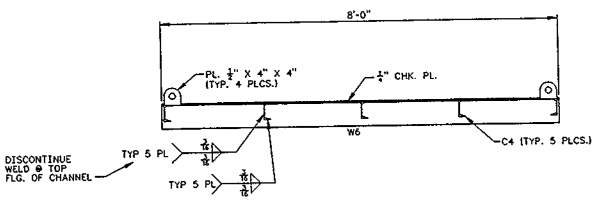
$l_{db} = 0.04\, A_b f_y / \sqrt{f'_c}$

$= \frac{0.04\,(0.2\text{in}^2)(60000\text{psi})}{\sqrt{4000\text{psi}}} = 7.59 \approx 8$ in

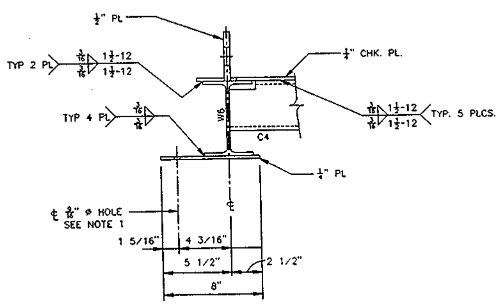
l_{db} cannot be less than 12 in. (ACI sec. 12.2.1)



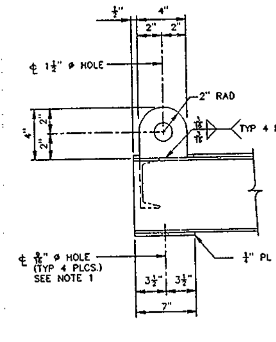
PLAN - DISTRIBUTION PANEL SKID
SCALE: 1" = 1'-0"



SECTION A
SCALE: 1" = 1'-0"
(TYP. 2 PLCS.)



SECTION B
SCALE: 3" = 1'-0"
(TYP. 4 PLCS.)



SECTION C
SCALE: 3" = 1'-0"
(TYP. 4 PLCS.)

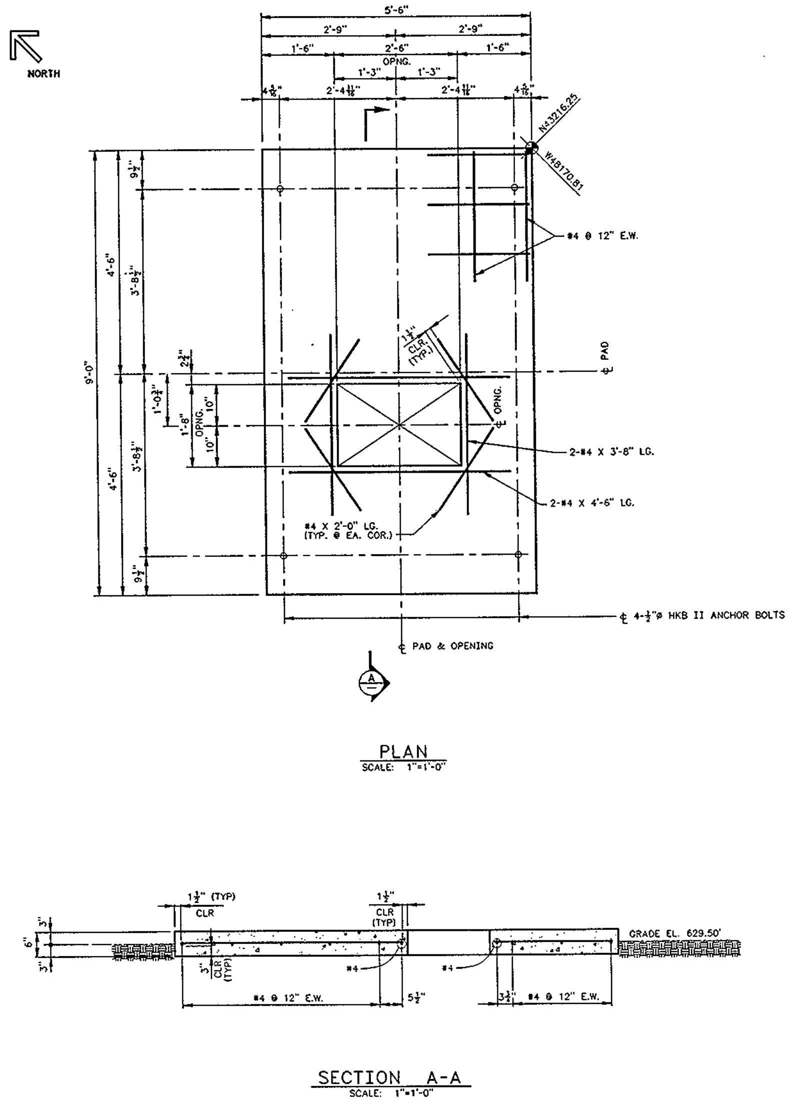
NOTES:

1. FIELD TO LOCATE & INSTALL 4-½" ⌀ HKB II ANCHOR BOLTS.
2. SECURE DISTRIBUTION PANEL TO SKID WITH ½" ⌀ ASTM A307 BOLTS. MATCH LOCATION OF BOLT HOLES WITH BOLT HOLES IN DISTRIBUTION PANEL.

R.W. DAVIDSON, P.E.

DESIGNED	JR BOOTH
SAFETY	SEE DR/AT FORM
QUALITY	SEE DR/AT FORM
ENG. CHECK	SEE DR/AT FORM
REVIEW NO.	4
FOR	WHC

PRELIMINARY
SAFETY CLASS 3
U.S. DEPARTMENT OF ENERGY
RICHLAND OPERATIONS OFFICE
ICF KAISER HANFORD COMPANY
STRUCTURAL
ELECTRICAL SKIDS
PLANS AND DETAILS
W-320 EQUIPMENT REMOVAL SYSTEM
F 241-C 241-AY 1001 H-2-820756 0
SCALE SHOWN JOB NO. ER-4289 SHEET 1 OF 1
CAD FILE B820756A CAD CODE 2B:IBM:ACD2:12.0:NN
2 PLOT SCALE: 1=12 KEMCAD



PRELIMINARY

DESIGNED PC BRINKMAN

SAFETY CLASS 3

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

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

STRUCTURAL
MISCELLANEOUS PADS
PLAN, SECTIONS & DETAILS

W320 EQUIPMENT REMOVAL SYSTEM

F 200E 0901 H-2-820755 0

SCALE SHOWN ER4289 SHEET 1 OF 1

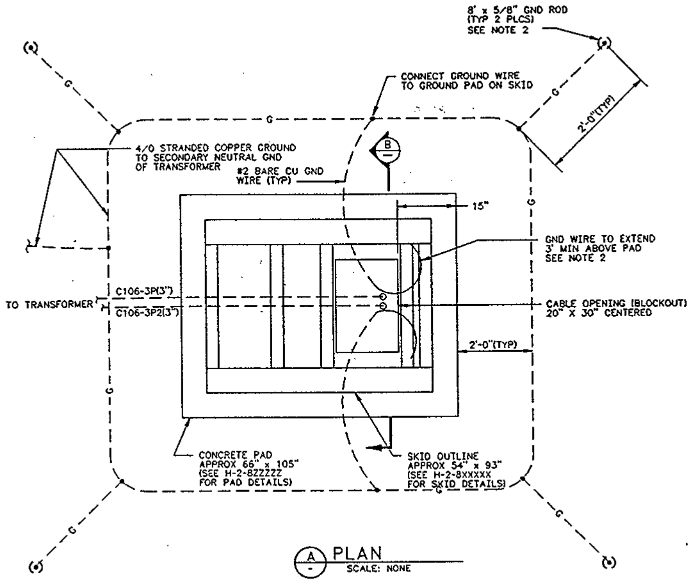
WHC

B820755A 28:IBM:ACD2:12.0:NN

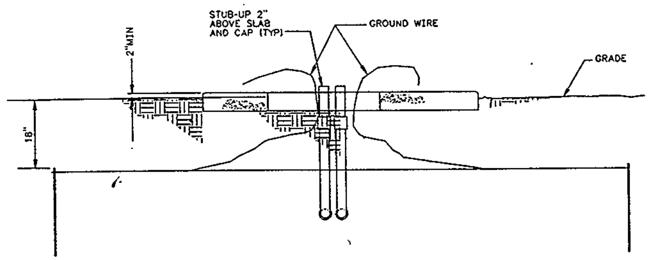
PLOT SCALE: 1=12 KEHCAD

E-19

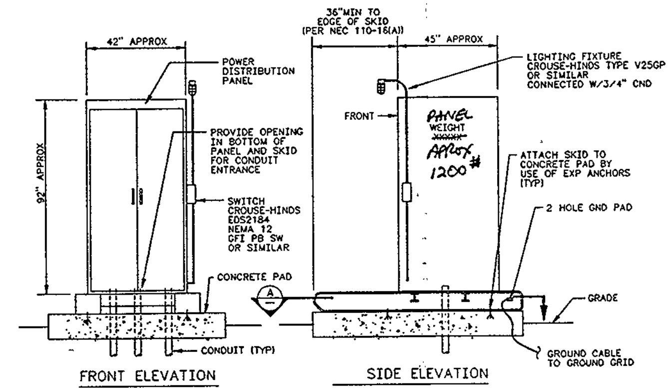
Attach 2-1



A PLAN
SCALE: NONE



B ELEVATION
SCALE: NONE



DISTRIBUTION PANEL SKID

3 DETAIL
SHT 1 SCALE:NONE

CONDUIT NUMBERING LEGEND
(ONLY FOR PERMANENT CNDS ON THIS DWG)

AY101-3P14
- CONDUIT NUMBER SUFFIX
- P = POWER, C = CONTROL, S = SIGNAL, T = TELEPHONE, X = DATA LINK
- SAFETY CLASS 2 OR 3
- BUILDING OR AREA DESIGNATOR

GENERAL NOTES:

1. SYMBOLS PER ANSI Y14.15 AND/OR Y32.2
2. INSTALL 8' X 5/8" GROUND RODS AS SHOWN. GROUND RODS SHALL BE COPPER PLATED. GROUND ROD SHALL BE SUITABLY CONNECTED TO #2 BARE SOFT DRAWN COPPER GROUND WIRE WHICH SHALL EXTEND BELOW THE PAD AND BE TRAINED UP THRU CABLE OPENING AND SHALL HAVE A TAIL OF AT LEAST THREE FEET. CONNECT GROUND TO DISTRIBUTION PANEL NEUTRAL BUS.

GP McDONALD PE

PRELIMINARY	
KB KNOWLES	U.S. DEPARTMENT OF ENERGY RICHLAND OPERATIONS OFFICE ICF KAISER HANFORD COMPANY
HD COMISH	ELECTRICAL C-FARM PLANS AND DETAILS
SEE DR/AT FORM	W-320 EQUIPMENT REMOVAL SYSTEM
SEE DR/AT FORM	F 241-C 7201 H-2-820749 0
SEE DR/AT FORM	SCALE SHOWN ER-289 SHEET 5 OF 5
2	
WHC	

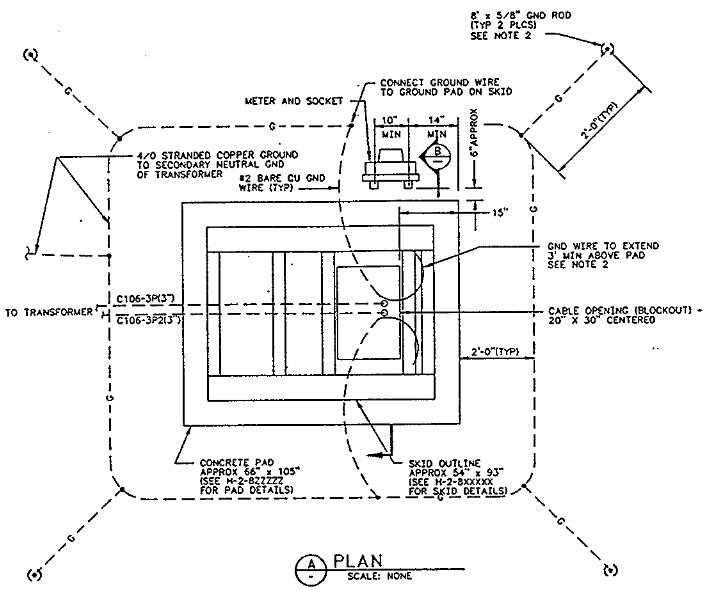
H-2-818423 DRAWING LIST

B820749E 2J-IBM-ACD2:12.0-NN

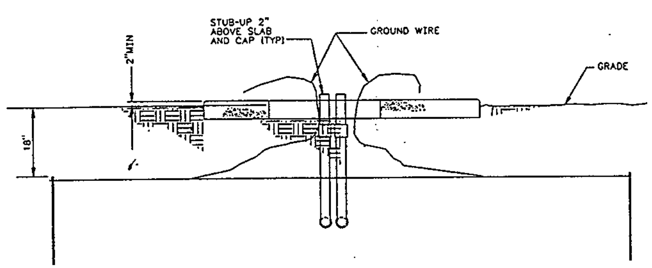
2 PLOT SCALE: 1=1 KEHCAD 1

HNF-2461, Rev. 0

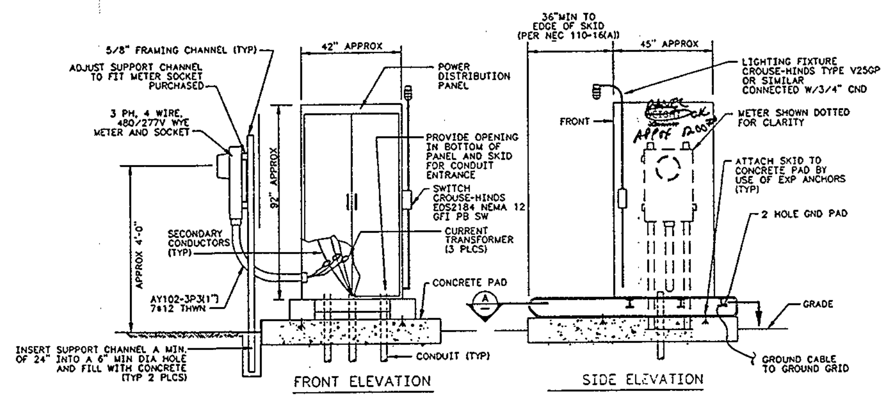
ATTACH 2-2



A PLAN
SCALE: NONE



B ELEVATION
SCALE: NONE

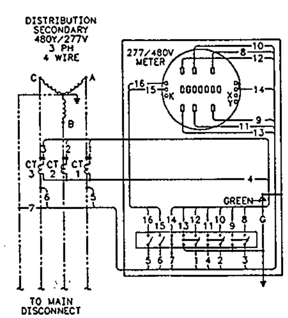


DISTRIBUTION PANEL SKID

3 DETAIL
SHT 1
SCALE:NONE

GENERAL NOTES:

1. SYMBOLS PER ANSI Y14.15 AND/OR Y32.2
2. INSTALL 8' X 5/8" GROUND RODS AS SHOWN. GROUND RODS SHALL BE COPPER PLATED. GROUND ROD SHALL BE SUITABLY CONNECTED TO #2 BARE SOFT DRAWN COPPER GROUND WIRE WHICH SHALL EXTEND BELOW THE PAD AND BE TRAINED UP THRU CABLE OPENING AND SHALL HAVE A TAIL OF AT LEAST 3 FT. CONNECT GROUND TO DISTRIBUTION PANEL NEUTRAL BUS.
3. ALL WIRE AND CABLE SHALL BE COPPER RATED 600V INSULATED EXCEPT WHERE OTHERWISE NOTED.



WIRE SCHEDULE:

NUMBER	COLOR
1	ORANGE
2	YELLOW
3	BLACK
4	GREEN
5	RED
6	BLUE
7	WHITE
8	BLACK
9	GREEN
10	YELLOW
11	GREEN
12	ORANGE
13	GREEN
14	WHITE
15	BLUE
16	RED
17	WHITE

WIRING DIAGRAM - METER CONNECTIONS

GP McDONALD PE

PRELIMINARY

KB KNOWLES
JOEL ROSARIO
SEE DR/AT FORM
SEE DR/AT FORM
SEE DR/AT FORM

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

ELECTRICAL
AY-FARM
PLANS AND DETAILS
W-320 EQUIPMENT REMOVAL SYSTEM

F 2005 7201 H-2-820752 0

SHOWN ER4289 SHEET 3 OF 3

H-2-818423 DRAWING LIST

BS18696C 2J-18M-ACD2-12.0-NN

WHC

2 PLOT SCALE: 1=1 KEMCAD

W320-24-007

Design Bracket That Clamps to a Crane
Boom to Support a Camera Pan/Tilt

KAISER ENGINEERS HANFORD	CALCULATION IDENTIFICATION AND INDEX	Page i of iii Date 06/27/94

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

Discipline STRUCTURAL WO/Job No. ER5735 Calculation No. W320-24-007

Project No. & Name PROJECT W-320; EQUIPMENT REMOVAL SYSTEM

Calculation Item DESIGN BRACKET THAT CLAMPS TO A CRANE BOOM TO SUPPORT A CAMERA PAN/TILT.

These calculations apply to:

Dwg. No. H-2-820726 SHT 1/1 Rev. No. 0

Dwg. No. N/A Rev. No. N/A

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	J.A. Rupert 06/28/94		
Checked by	Rodney C Campbell 7-14-94		
Approved by	RW Davidson 7-18-94		
Checked Against Approved Vendor Data	Ann Shangevin 4/7/98		

INDEX

Design Analysis Page No.	Description
1	OBJECTIVES; CRITERIA; DATA; METHODS; REFERENCES; CALCULATION; CONCLUSIONS.
2 - 4	Body of Calculation
APP. A 4 pages	1) Marked-up sketch of equipment weights. 2) EG&G. Idaho, Internal Tech. Report - Design Aid: Fasteners, 09/21/82. 3) Dwg. H-2-820726 Rev 0.

RONALD W. DAVIDSON
STATE OF WASHINGTON
24180
REGISTERED PROFESSIONAL ENGINEER
7/18/94
EXPIRES 03-03-96

KEH 0378.00 (06/92) KEF072

CALCULATION CROSS INDEX (Typical)

Subject Calculation No. W320-24-007

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		H-2-820722	0	H-2-820726			X			7-18-

KEH 1975.00 (12/

DESIGN VERIFICATION SCREENING CRITERIA

Project/Document No. CALC. NO. W320-24-007 REV. 0
p. iii OF iii

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?
	X	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?
	X	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?
	X	4. Does this design or design change involve or change design that has previously undergone formal design verification?

[signature] 7/18/94
Assigned Lead Engineer Date

[signature] 7/18/94
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

DESIGN ANALYSIS

Client WHC	WO/Job No. ER5735	Calc. No. W320-24-007
Subject W320 EQUIPMENT REMOVAL SYSTEM	Date 06/27/94	By J.G. RUPERT *JGR 6/27/94*
	Checked *7-14-94*	By *Rodney C. Campbell*
Location 241-C, 241-AY TANK FARMS	Revised	By

Revision 0

Page No. 1 of 4

OBJECTIVE

Design a clamp and bracket to mount a camera pan/tilt to a crane boom.

CRITERIA

DOE ORDER 6430.1A, 04/06/89
FUNCTIONAL DESIGN CRITERIA: WHC-SD-W320-FDC-001 REV. 2

DATA

See marked-up sketch of PELCO drawing from Bob Skamser (WHC) showing 15 lb total equipment weight (Appendix A).

METHODS:

Hand Calculations

REFERENCES

1. AISC MANUAL OF STEEL CONSTRUCTION; 9th ed., 1989
2. SDC 4.1, REV. 11
3. ANSI/ASCE 7-88
4. UBC-91
5. DESIGN OF WELDED STRUCTURES; Blodgett, O., 03/82
6. INTERNAL TECHNICAL REPORT: DESIGN AID - FASTENERS
   EG&G IDAHO, INC., REPORT NO. ED-E4-82-009, 09/21/82

CALCULATION

See attached calculation

CONCLUSIONS

Fabricate the clamp from a pair of angle irons and mount the pan/tilt to a structural channel bracket welded to the clamp. Drill clearance holes in the bracket to match the bolt pattern of the pan/tilt.

KAISER ENGINEERS HANFORD

Calc. No. W320-24-007
Revision 0
Page No. 2 of 4

DESIGN ANALYSIS

Client WHC		WO/Job No. ER 5735	
Subject W320 EQUIPMENT REMOVAL SYSTEM		Date 06/27/94	By J. A. Rupert
		Checked 7-14-94	By Rodney C. Campbell
Location 241-C AND 241-AY TANK FARMS		Revised	By

DESIGN A BRACKET TO SUPPORT A CAMERA PAN/TILT AND MOUNT IT TO A CRANE BOOM / JIB.

1. LOADS (SC-3)

PAN/TILT: PELCO MODEL PT 270-24P; WT. 15 Lb

CAMERA: 15 Lb, INCL. WEATHERPROOF ENCLOSURE.

WIND:

SPEED (BASIC) = 70 mph
I = 1.07
EXP. = C
} REF. 2, p. 8

$F = q_z G_h C_f A_f$ (REF. 3, TABLE 4)

$q_z = 0.00256\, K_z (IV)^2 = 0.00256\,(0.8)(1.07 * 70)^2 = 11.5$ psf

$G_h = 1.32$ (REF. 3, TABLE 8) $K_z = 0.80$ (REF. 3, TABLE 6)

$C_f = 2.0$ (REF. 3, TABLE 13)

$A_f = 16" * 20" = 320\ IN^2$ OR $2.2\ FT^2$

$F = 11.5$ psf$(1.32)(2.0)(2.2\ FT^2) = 67$ # CONTROLS

NOTE: THIS WIND FORCE IS VERY CONSERVATIVE SINCE THE EQUIPMENT REMOVAL OPERATION WILL NOT TAKE PLACE AT WIND SPEEDS > 10 mph.

SEISMIC: SC-3

$I = 1.25$ (REF. 2, p. 9) $W_p = 30$ Lb

$Z = 0.20$ (REF. 4, TABLE 23 I)

$C_p = 2.0 * 0.75 = 1.50$ (REF. 4, TABLE 23 P & SECT. 2336)

$F_p = Z\, I\, C_p\, W_p = 0.2\,(1.25)(1.5)(30\text{ Lb}) = 11.25$ Lb

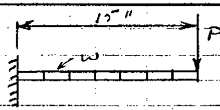
KAISER ENGINEERS HANFORD

DESIGN ANALYSIS

Calc. No. W320-24-007
Revision 0
Page No. 3 of 4

Client WHC	WO/Job No. ER 5735		
Subject W320 EQUIPMENT REMOVAL SYSTEM	Date 06/27/94	By J. A. Rupert	
	Checked 7-14-94	By Rodney C. Campbell	
Location 241-C AND 241-AY TANK FARMS	Revised	By	

2. CHECK STRESS ON 3" CHANNEL BRACKET



=> $P = 30$ Lb (ASSUME 2X 15 Lb EQUIP. LOAD, CONSERV.)

$w = \frac{F}{15"} = \frac{67 \text{ Lb}}{15"} = 4.5$ pli   F = WIND LOAD

$M_x = PL + \frac{wL^2}{2} = 30 \times 15 + \frac{4.5(15)^2}{2} = 956$ "-#

TRY C3x4.1 $F_y = 36{,}000$ psi

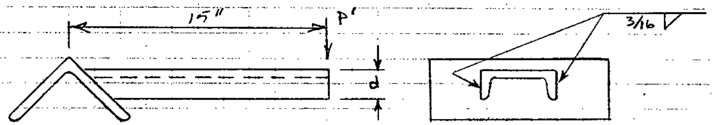
$S_y = 0.202 \text{ IN}^3$ $t_f = 0.273"$ (REF. 1, p. 1-41)

$b_f = 1.41"$ $t_w = 0.170"$

$f_{by} = \frac{M_y}{S_y} = \frac{956 \text{"-\#}}{0.202 \text{ IN}^3} = 4734$ "-# $< 0.6 F_y$ OK (REF. 1, p. 5-48)

∴ USE C3 x 4.1 FOR PAN/TILT SUPPORT BRACKET

3. SIZE WELDS THAT ATTACH C3x4.1 TO L 2½ x 2½ x ¼



LET $P' = w + P$ LOAD $= 67 + 30 = 97$ Lb (CONSERVATIVE)

$d = 1.41"$

$S_w = \frac{d^2}{3} = \frac{(1.41")^2}{3} = 0.66 \text{ IN}^2$ (TREAT WELD AS A LINE, REF. 5, p. 7.4)

$M_w = PL = 97 \times 15" = 1455$ "-#   (WIND + D.L. TAKEN @ END OF CANTILEVER)

$f_w = \frac{M_w}{S_w} = \frac{1455 \text{"-\#}}{0.66 \text{ IN}^2} = 2204$ pli

$F_w = 0.1875" \times 0.7071 \times 0.3 \times 70000 \text{ psi} \times 1" = 2784 \text{ pli} > f_w$ OK

∴ TWO 3/16" FILLET WELDS x 1.41" LONG ARE SUFFICIENT

KAISER ENGINEERS
HANFORD

Calc. No. W320-24-007
Revision 0

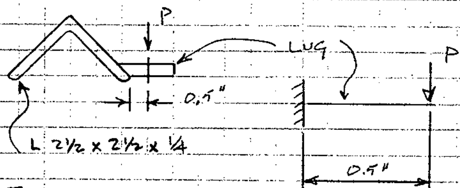
DESIGN ANALYSIS

Client WHC	WO/Job No. ER 5735		
Subject W320 EQUIPMENT REMOVAL SYSTEM	Date 06/27/94	By J. A. Rupert	
	Checked 7-14-94	By Rodney C. Campbell	
Location 241-C AND 241-AY TANK FARMS	Revised	By	

4. CHECK STRESS ON WELDS THAT ATTACH 3/8" LUGS TO ANGLE CLAMP

USE FULL PEN WELDS - TAKE CREDIT FOR 1/4" (THINNER OF THE 2 THICKNESSES JOINED)

LUG: 3/8" PL 1"x 1"
A36 MAT'L



$$f_b = \frac{PL}{bd^2/6}$$

$$\Rightarrow P_{MAX} = \frac{bd^2/6 * F_b}{L}$$

$F_y = 36\,000$ psi

$$= \frac{1''(0.25)^2/6 * 0.75 F_Y}{0.5''} = 562 \text{ Lb}$$

USE AN ALLOWABLE W = 280 Lb (ALLOWS 100% F.S. FOR K FACTOR)
FULL PEN. WELD OK

T = KDW (REF. 6, p. 9)

K = 0.20 (FRICTION FACTOR FOR UNPLATED BOLT, DRY THREAD)
D = BOLT DIAMETER (IN.) = 3/8"
T = TORQUE (IN-Lb)
W = AXIAL LOAD (Lb) = 280 Lb

$T = 0.2 * 0.375'' * 280 \text{ Lb} = 21$ IN-Lb

FOR ASTM A307 BOLTS $F_t = 20\,000$ psi (REF. 1, p. 4-3)

$$f_t = \frac{W}{A} = \frac{280 \text{ Lb}}{0.11 \text{ IN}^2} = 2545 \text{ psi} < 20\,000 \text{ psi} \quad \text{ok}$$

∴ USE 4 - 3/8" A307 BOLTS TORQUED TO 21 IN-Lb TO CLAMP BRACKET TO CRANE

Al
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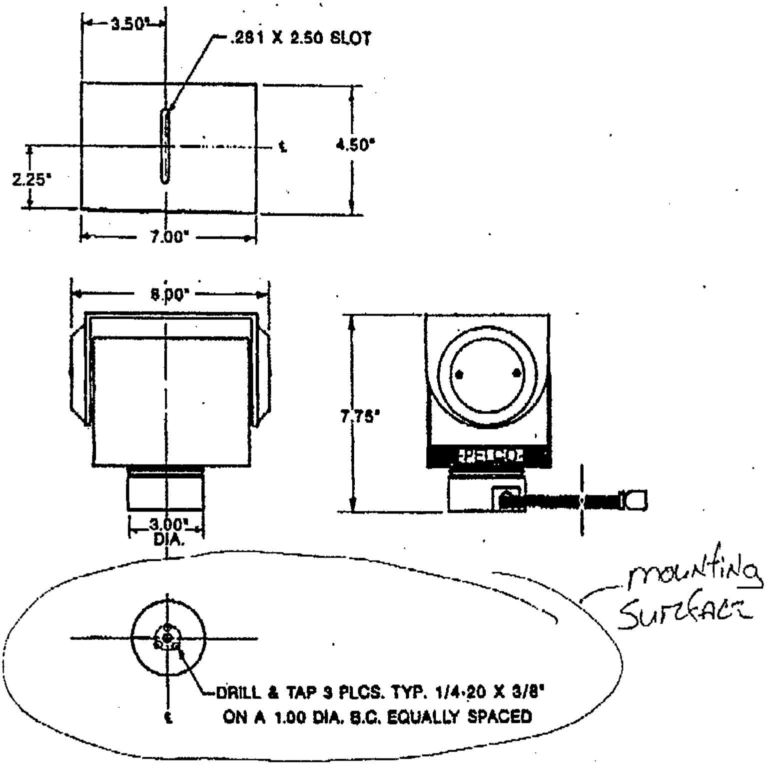
tilt

Total weight of
CAMERA, CABLE AND
Pan + Tilt
~ 15 lbs



Rtn to D.L. Evans

EG&G Idaho, Inc.

Report No. ED-E4-82-009

Date: September 21, 1982

Bob

cy 1

For further information see ASTM A193 & A194

INTERNAL TECHNICAL REPORT

Master Copy

Title: DESIGN AID - FASTENERS

...nization: Mechanical Engineering Division

Author: J. P. Sekot

Checked By: ______________________ Approved By: C. E. Friedrich

TORQUE

A well accepted equation for computing torque-tension relationship in bolted joints is:

$$T = \frac{KDW}{12}$$

Where T = torque (lb-ft)

K = friction factor

W = bolt tension (lb)

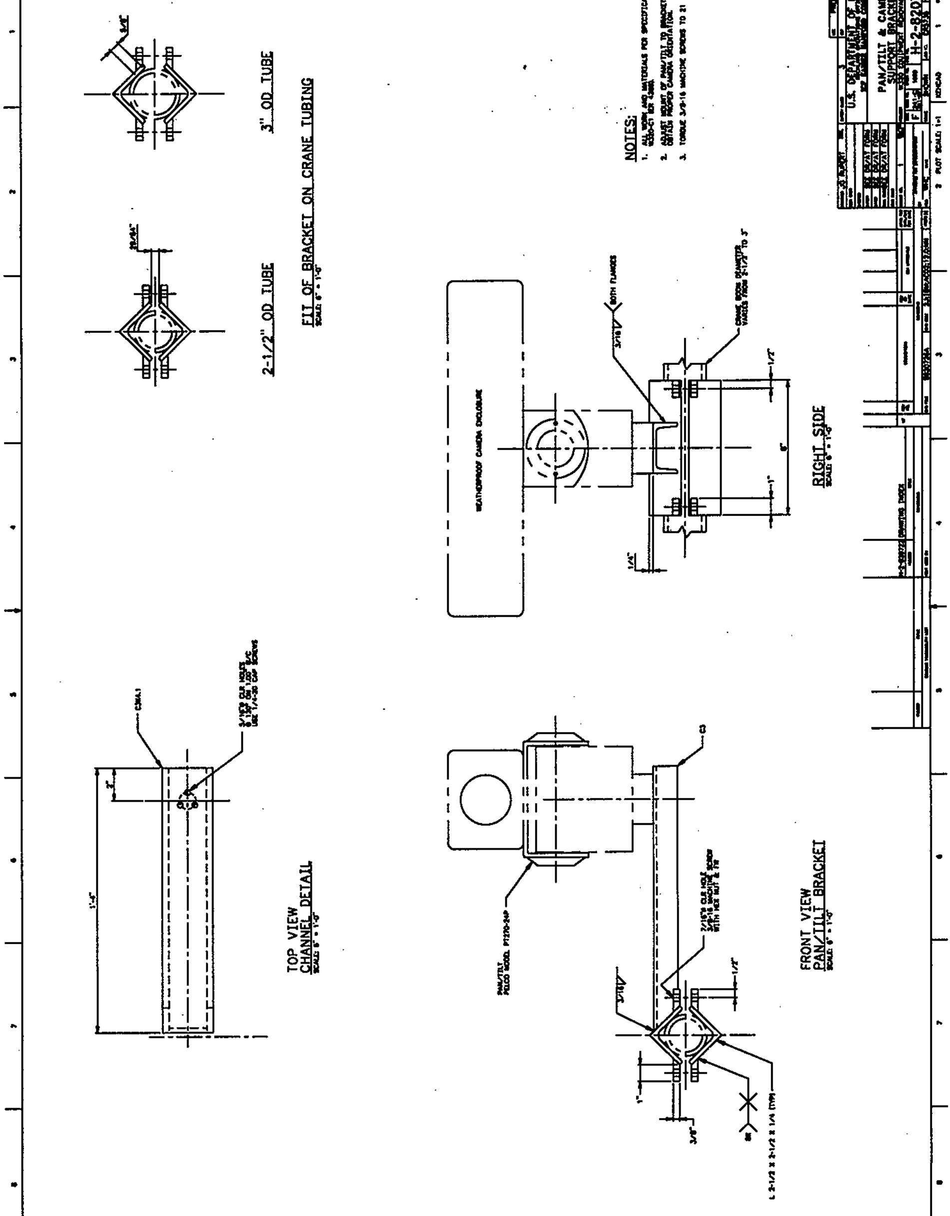
D = bolt diameter (in.)

Typical values of K are:

Material	K
Lubricated Steel	0.11
Cadmium Plated Steel	0.15
Unplated Steel	0.20
Stainless Steel	0.30

for average conditions (represented by unplated alloy steel bolts and nuts with dry threads) a friction factor of K = 0.20 is generally used.

CALC NO. W320-24-007, REV 0
APPENDIX "A", p. 4 OF 4



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Project W-320 Tank 106-C, HNF-2461, Civil/Structural Calculations, Vol. 1		ECN No. n/a

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