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ENGINEERING DATA TRANSMITTAL

5

Page 1 of 1

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2	I	Cog. Eng.	SE Grever	[Signature]	SZ-48						
2	I	Cog. Mgr	JW Bailey	7/20/98	SZ-48						
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20. <i>J.W. Bailey</i> 3/24/98 J.W. Bailey [Signature] 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
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Abstract: This supporting document has been prepared to make the FDNW
civil/structural calculations for Project W-320, readily retrievable.

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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 1 of 11Date 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. 0Dwg. No. H-2-818426 (2 SH) Rev. No. 0

Other (Study, CDR) _____ Rev. No. _____

The status of these calculations is:

☐ Preliminary Calculations☒ Final Calculations☐ Check Calculations (On Calculation Dated _____)☐ Void Calculation (Reason Voided _____)

Incorporated in Final Drawings?

☒ Yes☐ No

This calculation verified by independent "check" calculations?

☐ Yes☒ No

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	<u>John R. Smith 2/19/94</u>		
Checked by	<u>John R. Smith 2/10/94</u>		
Approved by	<u>John R. Smith 2/29/94</u>		
Checked Against Approved Vendor Data	<u>John R. Smith 2/29/94</u>		

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Description

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11-15 GRAPHS, CHARTS AND DRAINAGE RUNOFF CRITERIA FROM SEELY'S
Attach A RAINFALL INPUT FROM BATTELLE
Attach B DRAINAGE AREA (IES 4319 C.14)

Subject Calculation No. W320-21-001

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[illegible]

A-2

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?

Assigned Lead Engineer

4/29/94

Date

Responsible Discipline Manager

4/29/94

Date

Original Design Package Distribution:

Project Manager

Design Verification Officer

Engineering Document Control

Design Change Distribution:

Attach to Engineering Change Notice

DESIGN ANALYSIS

Client WESTINGHOUSE

WO/Job No. ER 4319

Subject DRAINAGE RUNOFF - SIZE CULVERTS

Date 1/24/94

By PB

DRG. NO. 155439C14

Checked

By

Location 200E - INTERAEM TRANS. SYSTEM

Revised

By PRB

OBJECTIVE:

1) TO CALCULATE THE AMOUNT OF RUNOFF FROM THE DRAINAGE AREAS ADJACENT 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:

SEELEY'S DESIGN HANDBOOK FOR ENGINEERS
BATTELLE'S ATMOSPHERIC DATA REPORT

CONCLUSIONS:

THE DRAINAGE RUNOFF QUANTITIES AND SIZES OF CULVERTS ARE BASED UPON CONSERVATIVE FIGURES USING SEELEY'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 INITIALLY REQUIRED. TWO SIZES OF CULVERTS WERE CHECKED AND BOTH FOUND TO BE ADEQUATELY SIZE TO HANDLE THE AMOUNT OF RAINFALL CALCULATED. FINAL CULVERT SIZE WAS BASED ON SELECTION OF THE MOST ECONOMICAL ONE. USE 2-12" Ø CULVERTS TO DRAIN SITE.

**KAISER ENGINEERS
HANFORD****DESIGN ANALYSIS**Calc. No. W320-21-001Revision 0Page No. 2 of 15Client WESTINGHOUSEWO/Job No. ER4319Subject DRAINAGE RUNOFF - SIZE CULVERTSDate 1.24.94By P. BRINKMANDWG. NO. IES4319C14Checked 2/7/94By JR BoothLocation 200E - INTERFARM TRANS. SYSTEM

Revised

By

1) CALCULATE DRAINAGE AREAS:**THERE ARE 2 - DRAINAGE AREAS****DRAINAGE AREA 1:****BOUNDARIES -**

NORTH - $\frac{1}{2}$ OF ACCESS RD. TO TK. FARM 241-AZ
 EAST - FENCE LINE OF TK. FARM 241-AZ
 SOUTH - FENCE LINE BETWEEN TK. FARM 241-AZ
 & WO30 SITE
 WEST - $\frac{1}{2}$ OF BERM FOR SLUICING LINE

AREA 1 (WO30 JOB. & WEST
OF TK. FARM 241-AZ)AREA 2 (NORTH OF WO30
SITE AND WEST OF
TK. FARM 241-AN)**DRAINAGE AREA 2:****BOUNDARIES -**

NORTH - $\frac{1}{2}$ OF ACCESS RD. TO TK. FARM 241-AN
 EAST - FENCE LINE OF TK. FARM 241-AN
 SOUTH - $\frac{1}{2}$ OF ACCESS RD. TO TK. FARM 241-AZ
 WEST - $\frac{1}{2}$ OF BERM FOR SLUICING LINE

NOTE: SEE DWG.
IES4319C14 FOR
OUTLINE OF
DRAINAGE AREAS

$$\begin{aligned} \text{SIZE OF DRAINAGE AREA 1} &= \frac{235' \times 15'}{2} + 30' \times 80' + 205' \times 332' + 20' \times 200' \\ &= 17625 \text{ FT}^2 + 2400 \text{ FT}^2 + 68060 \text{ FT}^2 + 4000 \text{ FT}^2 \\ &= \frac{76225 \text{ FT}^2}{43560 \text{ FT}^2/\text{ACRE}} = \boxed{1.75 \text{ ACRES}} \end{aligned}$$

$$\begin{aligned} \text{SIZE OF DRAINAGE AREA 2} &= 60' \times 15' + 163' \times 280' + 121' \times 15' + 115' \times 15' \\ &+ \frac{235' \times 15'}{2} = 900 \text{ FT}^2 + 45640 \text{ FT}^2 + 1815 \text{ FT}^2 \\ &+ 1725 \text{ FT}^2 + 1762.50 \text{ FT}^2 = \frac{51,842.50 \text{ FT}^2}{43560 \text{ FT}^2/\text{ACRE}} \\ &= \boxed{1.19 \text{ ACRES}} \end{aligned}$$

2) "C" VALUE:

FROM SEELEY'S 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)

**KAISER ENGINEERS
HANFORD**Calc. No. W320-21-001Revision 0Page No. 3 of 15**DESIGN ANALYSIS**Client WESTINGHOUSEWO/Job No. ER4319Subject DRAINAGE RUNOFF - SIZE CULVERTSDate 1-24-94By P. BRINKMANDWG. NO. 1ES4319C14Checked 2/7/94By JR. BOOTHLocation 200 E. INTERARM TRANS. SYSTEM

Revised

By

3) CALCULATE RAINFALL INTENSITY FOR A CALCULATED TIME OF CONCENTRATION (T_c) (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 (T_c) 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 THROUGH 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 THAN 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.

KAISER ENGINEERS
HANFORD**DESIGN ANALYSIS**Calc. No. W320-21-001Revision 0Page No. 4 of 15Client WESTINGHOUSEWO/Job No. ER4319Subject DRAINAGE RUNOFF - SIZE CULVERTS Date 1-26-94 By P. BRINKMANDWG. No. IES4319C14Checked 2/7/94 By JR BoothLocation 200E-INTERFARM TRANS. SYSTEM

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CALCULATE TOTAL TIME OF CONCENTRATION (T_C):
(FOR AREA 1)IN DRAINAGE AREA 1, THERE ARE THREE (3) TIMES OF CONCENTRATION T_{C1} , T_{C2} & T_{C3} TO BE CONSIDERED IN DETERMINING THE TOTAL

TIME OF CONCENTRATION. T_{C1} 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_{C2} IS THE TIME THAT WATER FLOWS OVERLAND FROM EL. 672.00 TO H.P. SWALE EL. 671.50'. T_{C3} 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 SEELEY'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_{C1} : 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 CALCULATED TO BE 2.0 MIN ± = T_{C1}

 T_{C2} : OVERLAND FLOW

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

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

**KAISER ENGINEERS
HANFORD****DESIGN ANALYSIS**Calc. No. W320-21-001Revision 9Page No. 5 of 15Client WESTINGHOUSEWO/Job No. ER 4319Subject DRAINAGE RUNOFF - SIZE CULVERTDate 1-27-94By P. PRINKMANDWG. NO. 1ES4319C14Checked 2/8/94By JR BoothLocation 200B - INTERFARM TRANS. 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 = TC_2

TC_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 SEELEY'S PAGE 18-05 "DRAINAGE-DITCHES-COMMON SECTIONS" USE D-1 "SEGMENTAL" FOR TYPE OF SWALE FOR DRAINAGE AREA 1. FROM SEELEY'S PAGE 18-06 "DRAINAGE-DITCHES-COMMON SECTIONS-2" FOR A DITCH SLOPE OF 0.0054 AND DITCH TYPE D1, $V = 1.89 \text{ FT/SEC.}$

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

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

$$S = 0.0054$$

TOTAL TIME OF CONC. (TC_{TOTAL}) = $TC_1 + TC_2 + TC_3 = 2.0 + 12.0 + 2.42$

$TC_{\text{TOTAL}} = 16.42 \text{ MINUTES}$ USE 16.50 MIN. FROM CHART

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

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

$I = 0.62 \text{ INCHES PER HOUR}$ (25YR 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, $L = 1.65$

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

$$Q = A C i$$

$$A = 1.75 \text{ ACRES}$$

$$C = 0.65$$

$$= 1.75 \times 0.65 \times 1.65$$

$$i = 1.65 \text{ IN/HR.}$$

$$= 1.88 \text{ CFS} = 843.74 \text{ GPM/MIN.}$$

DESIGN CULVERT USING A Q OF 2.0 CFS.

VELOCITY IN CULVERT SHOULD BE A MIN. OF 2.50-3.0 FT/SEC. FOR CLEANOUT PURPOSES.

**KAISER ENGINEERS
HANFORD****DESIGN ANALYSIS**Calc. No. W320-21-001Revision 0Page No. 6 of 15Client WESTINGHOUSEWO/Job No. ER 4319Subject DRAINAGE RUNOFF - SIZE CULVERT Date 1-27-94 By P. ABINKMANDWG. NO. 154319 C14Checked 2/8/94 By JR BoothLocation 200 E - INTERAIRM TRANS. SYSTEM

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

CULVERT MATERIAL = CMP

"n" VALUE = UNPAVED ASPHALT COATED OR NON-COATED = 0.024

$$Q = AV$$

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

$$Q = 2.0 \text{ C.F.S.}$$

$$V = 2.5 \text{ FT/SEC}$$

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

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

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

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

A 12" CMP HAS AN
AREA OF .785 FT²TO BE CONSERVATIVE USE A 15" CMP
CALCULATE SLOPE FOR A V = 2.50 FT/SECA 15" CMP HAS AN
AREA OF 1.23 FT²

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

$$2.50 = \frac{1.486}{0.024} \times (3.0)^{2/3} \times S^{1/2}$$

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

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

$$R = \frac{A}{P} = \frac{1.23}{3.93} = 0.31$$

$$2.50 = S^{1/2}$$

$$61.92 \times .458$$

USE A 15" CMP @ S = 0.0078

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

$$0.088154 = S^{1/2}$$

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

$$S = .0078 = S$$

CAPACITY OF CULVERT = Q = AV

$$= 1.23 \times 2.50$$

$$= 3.075 \text{ CFS}$$

$$> 2.0 \text{ CFS OK}$$

NOTE:15" CMP IS MORE
CONSERVATIVE, WHILE
A 12" CMP IS MORE
ECONOMICALCOULD ALSO USE A 12" CMP @
S = 0.010 V = 2.5 FT/SEC.

$$\text{CAPACITY} = Q = AV$$

$$= .785 \times 2.50$$

$$= 1.962 \text{ CFS} > 1.92 \text{ CFS OK}$$

**7) CALCULATE TOTAL TIME OF CONCENTRATION (T_C)
(FOR DRAINAGE AREA 2)**

KAISER ENGINEERS
HANFORD**DESIGN ANALYSIS**Calc. No. W320-21-001Revision φPage No. 7 of 15Client WESTINGHOUSEWO/Job No. ER4319Subject DRAINAGE RUNOFF - SIZE CULVERTDate 1-27-94 By P. BRINKMANDWG. NO. 1854319C14Checked 2/7/94 By JR BoothLocation 200 E - INTERARM TRNGE. SYSTEM

Revised

By

IN DRAINAGE AREA 2, THERE 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. 665.00). 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 CONC. 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 LOCATION AT A NEW CULVERT.

 $TC_1 = \text{OVERLAND FLOW}$

$L = 115.00'$ (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

 $TC_2 = \text{OVERLAND FLOW}$

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

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

FROM FIG. 4 - OVERLAND FLOW TIME, BARE SOIL & A GROUND SLOPE OF 20%, $TC_2 = 1.0 \text{ MIN (ESTIMATED)}$

 $TC_3 = \text{OVERLAND FLOW}$

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

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

KAISER ENGINEERS
HANFORD**DESIGN ANALYSIS**Calc. No. W320-21-001Revision 0Page No. 8 of 15Client WESTINGHOUSEWO/Job No. ER 4319Subject DRAINAGE RUNOFF - SIZE CULVERTDate 1-27-94 By P. BRINKMANDWG. NO. 1854319C14Checked 2/8/94 By J.R. BoothLocation 200 E - INTERFARM TRANS. SYSTEM

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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

$$\text{TOTAL TIME OF CONC. } (TC_{\text{TOTAL}}) = TC_1 + TC_2 + TC_3 + TC_4 = 7.40 + 1.0 + 7.78$$

$$+ 8.30 = 24.48 \text{ MINUTES USE } 24.50 \text{ FROM CHART}$$

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

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

$$I = 0.62 \text{ INCHES/HOUR (25YR STORM - 1 HOUR RAINFALL)}$$

FOR A I VALUE OF 0.60 & A TC OF 24.50 MINUTES, $\lambda = 1.25$

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

$$Q = A \cdot i$$

$$A = 1.19 \text{ ACRES}$$

$$C = 0.65$$

$$\lambda = 1.25$$

$$= 1.19 \times 0.65 \times 1.25$$

$$= 0.97 \text{ CFS.}$$

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

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

Client <u>WESTINGHOUSE</u>	WO/Job No. <u>ER 4319</u>
Subject <u>DRAINAGE RUNOFF - SIZE CULVERT</u>	Date <u>1-27-94</u>
DWG. NO. <u>1554319C14</u>	Checked <u>2/8/94</u>
Location <u>200 E - INTERFARM TRANS. SYSTEM</u>	Revised

By P. BRINKMANBy JR Booth

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'

$$T_c = \frac{55.0'}{2.50 \text{ ft/sec}} = \frac{22 \text{ sec}}{60} = .37 \text{ MINUTES}$$

TIME OF CONCENTRATION (T_{C_3}) = TIME IT TAKES FOR WATER TO FLOW FROM DISCHARGE OF CULVERT NO. 1 TO ELEV. 660.00

T_{C_3} = 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 PARE SOIL & A GROUND SLOPE OF 4.00%, $T_{C_4} = 7.10$ MINUTES

INLET TIME OF CONCENTRATION (T_{C_6}) FROM EL. 660.00 TO L.P. EL. 658.00 = INLET TIME OF CONCENTRATION (T_{C_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 T_c OF 32.0 MINUTES TO CALCULATE NEW i VALUE.

FOR A i VALUE OF 0.60 & A T_c OF 32.0 MINUTES, $i_c = 1.10$

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

$$\begin{aligned} Q &= ACi \\ &= 3.0 \times 0.65 \times 1.10 \\ &= 2.145 \text{ CFS} \end{aligned}$$

$$\begin{aligned} A &= 3.0 \text{ ACRES} \\ C &= 0.65 \\ i &= 1.10 \end{aligned}$$

**KAISER ENGINEERS
HANFORD****DESIGN ANALYSIS**Calc. No. W32021-001Revision 0Page No. 10 of 15Client WESTINGHOUSEWO/Job No. ER4319Subject DRAINAGE RUNOFF - SIZE CULVERTDate 1-27-94By P. BRINKMANDWG. NO. 1554319C14Checked 2/8/94By J.R. BoothLocation 200 E - INTERFARM TRANS. SYSTEM

Revised

By

DESIGN CULVERT NO 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. NO 5 OF 9 FOR CULVERT DESIGN.

A 15" ϕ CMP @ $S = 0.078$ WILL CARRY A CAPACITY OF 3.076 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.

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

$$V = \frac{1.486}{0.024} \times (0.750)^{2/3} \times (0.010)^{1/2}$$

$$= 61.9167 \times 0.397 \times 0.10$$

$$= 2.45 \text{ FT/SEC.}$$

NOTE:

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

HNF-2461, Rev. 0

C-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	INCRE- MENT	TOTAL	C	TO INLET	IN CHAN- NEL	TIME OF CONC.	L *	Q C.F.S.	CHAN- NEL OR PIPE SIZE	SLOPE ft. per ft.	n	CAPA- CITY 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 $C = \frac{\text{RUNOFF}}{\text{RAINFALL}}$

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

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. K. H. Kuchling, Report, Back Bay Sewerage District, Boston, 1909.
2. Metcalf and Eddy, American Sewerage Practice, 1928. M^c Graw-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. M^c Graw-Hill.

RAINFALL INTENSITY IN INCHES PER HOUR - i $I = \text{in./hr.}$

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.

$$\therefore \text{Ditch time} = \frac{150}{1.7 \times 60} = 1.5$$

$$\text{Concentration time} = 16.5 \text{ Min.}$$

Enter 1.75 Curve from Fig. D above, find $i = 3.8$.

Concentration time in Example.

DRAINAGE- DITCHES - COMMON SECTIONS - I

D-1 SEGMENTAL

D-1A TRIANGULAR
Unequal side slopes

D-1B BITUMINOUS 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

SODDED GUTTER

COBBLED GUTTER

Base required same as for concrete pavement.

CONCRETE GUTTER

TABLE A - PROPERTIES OF DITCHES

NO.	DIMENSIONS				HYDRAULICS			
	SIDE SLOPES	B	H	W	a	p	R	R ^{2/3}
D-1	—	—	6'	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	1/2 to 1'-0"	—	4.5'	10'-0"	1.68	10.38	0.162	0.297
D-2A	1 1/2:1	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	1 1/2:1	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	1 1/2:1	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	1 1/2:1	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

HNF-2461, Rev. 0

Battelle

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COMMENTS:

The facsimile number listed above is for the Atmospheric Sciences Department only. Materials for any other group should be sent to the main facsimile office (509) 375-2718 or FTS 444-3876; verify (509) 375-2580.

THIS TRANSMISSION CONSISTS OF 3 PAGES EXCLUDING COVER PAGE.

Attach A-2

XI-8

A-20

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)							INTENSITY (INCHES PER HOUR)						
	TIME PERIOD							TIME PERIOD						
	20 MIN	60 MIN	2 HRS	3 HRS	6 HRS	12 HRS	24 HRS	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 P ST. AN ADDITIONAL 0.04 INCH OCCURRED BETWEEN 1855 AND 1910 TO ACCOUNT FOR THE RECORD 60-MINUTE AMOUNT OF 0.59 INCH.

Attach A-3

XI-7

A-21

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

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

DRAINAGE AREA 1
A = 1.79 ACRES
C = 0.65
Tc = 16.42 MIN.
Q = 1.92 CFS
EL. 675.94

DRAINAGE AREA 2
A = 1.19 ACRES
C = 0.65
Tc = 24.50 MIN.
Q = 0.97 CFS
EL. 665.02

W320-21-002

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

B-i

CALCULATION IDENTIFICATION AND INDEX		Page i of ii
		Date 03/18/97
<p>This sheet shows the status and description of the attached Design Analysis sheets.</p> <p>Discipline: CIVIL WO/Job No.: E34262/ W-320 Calculation No.: W320-21-002</p> <p>Project No. & Name: PROJECT W-320, TANK 241-C-106 SLUICING</p> <p>Calculation Item: W-320 SITE DRAINAGE AT THE INTERFARM TRANSFER LINE AND C FARM</p>		
<p>These calculations apply to:</p> <p>Dwg. No. H-2-818424 Sh 1, H-2-818426 Sh 1 Rev. No. 1/1</p> <p>Dwg. No. H-2-818428 Sh 1, H-2-818431 Sh 1 Rev. No. 1/1</p> <p>Other (Study, CDR): None Rev. No. N/A</p>		
<p>The status of these calculations is:</p> <p>☐ Preliminary Calculations</p> <p>☒ Final Calculations</p> <p>☐ Check Calculations (On Calculation Dated)</p> <p>☐ Void Calculation (Reason Voided)</p> <p>Incorporated in Final Drawings? ☒ Yes ☐ No</p> <p>This calculation verified by independent "check" calculations? ☐ Yes ☒ No</p>		
Original and Revised Calculation Approvals:		
	Rev. 0 Signature/Date	Rev. 1 Signature/Date
Originator	<i>Michael R. Custer</i> <i>3/27/97</i>	
Checked by	<i>[Signature]</i> <i>4/1/97</i>	
Approved by	<i>[Signature]</i> <i>4/1/97</i>	
Checked Against Approved Vendor Data	<i>N/A</i>	
<u>INDEX</u>		
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

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HNF-2461, Rev. 0

Calc. No.: W320-21-002

Revision: 0

Page No.: 1 of 6

DESIGN ANALYSIS

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: *Red*

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 Interfarm Transfer line berm and along the north fence of Tank 241-C-106. Recent rainfall has resulted in a breach in the berm of the Interfarm Transfer 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

Page No.: 2 of 6

DESIGN ANALYSIS

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: R.D.

Location: TANK 241-C-106, 200E

Revised:

By:

CALCULATIONS:

Refer to the DESIGN/ ANALYSIS 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

Page No. 3 of 6

DESIGN ANALYSIS

Client: NUMATEC HANFORD CORPORATION
 Subject: W320 SITE DRAINAGE AT THE INTERFARM
 TRANSFER LINE AND C FARMS
 Location: 241-C-106, 200E AREA

WO/Job No. E34262/ W-320

Date: 03/18/97

By: M.R. Custer

Checked: 4/1/97

By: *RC*

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-farm Transfer 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

$$\text{AREA} = 0.5 (500 \text{ ft} \times 1000 \text{ ft}) = 250000 \text{ sq ft} = 5.7 \text{ acres}$$

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):

$$\begin{aligned} \text{Slope overland to ditch line along Buffalo Avenue} &= (678.23 \text{ ft} - 671.60 \text{ ft}) / 250 \text{ ft} = 0.027 \text{ ft/foot} \\ \text{Slope along Buffalo Avenue} &= (671.60 \text{ ft} - 660.90 \text{ ft}) / 400 \text{ ft} = 10.70 / 400 = 0.027 = 0.027 \text{ ft/foot} \end{aligned}$$

FLOW PATH (2):

$$\begin{aligned} \text{Slope overland to ditch line along Seventh Avenue} &= (678.23 \text{ ft} - 668.53 \text{ ft}) / 275 \text{ ft} = 0.035 \text{ ft/foot} \\ \text{Slope along Seventh Avenue} &= (674.54 \text{ ft} - 660.90 \text{ ft}) / 500 \text{ ft} = 13.64 / 500 = 0.027 = 0.027 \text{ ft/foot} \end{aligned}$$

FLOW PATH (3):

$$\text{Slope along Buffalo Avenue} = (685.78 \text{ ft} - 660.90 \text{ ft}) / 1000 \text{ ft} = 24.88 / 1000 = 0.025 = 0.025 \text{ ft/foot}$$

DESIGN ANALYSIS

Client: NUMATEC HANFORD CORPORATION
 Subject: W320 SITE DRAINAGE AT THE INTERFARM
 TRANSFER LINE AND C FARMS

Location: 241-C-106, 200E AREA

WO/Job No. E34262/ W-320

Date: 03/18/97

Checked: *tl/qr*

Revised:

By: M.R. Custer *MRC*

By: *tan*

By:

FLOW PATH (4):

Slope along Seventh Avenue = $(674.75 \text{ ft} - 660.90 \text{ ft}) / 500 \text{ ft} = 13.85 / 500 = 0.027 = 0.027 \text{ ft/ foot}$

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) = $1.486 / n \text{ (R)} \text{ (S)} = 1.486 / 0.040 (0.584)(0.027) =$

vb = 3.56 ft/sec, Ditch time = $400 \text{ ft} / 3.6 \text{ ft/sec (60)} = 1.85 \text{ minutes}$

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

v7 = 3.56 ft/sec, Ditch time = $500 \text{ ft} / 3.6 \text{ ft/sec (60)} = 2.3 \text{ minutes}$

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:

$Q = A \times C \times Ir$,

where A = 5.7 acres, Ir = 2.0

C = 0.50 (Runoff coefficient)

Q = 5.7 cu ft/ sec

DESIGN ANALYSIS

Client: NUMATEC HANFORD CORPORATION
 Subject: W320 SITE DRAINAGE AT THE INTERFARM
 TRANSFER LINE AND C FARMS
 Location: 241-C-106, 200E AREA

WO/Job No. E34262/ W-320

Date: 03/18/97

By: M.R. Custer *MLC*Checked: *4/1/97*By: *RCS*

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)

$$A = Q/v = 5.7/2.5 = 2.28 \text{ sq ft}, \text{ Area of (1)} = 2.28/2 = 1.14 \text{ sq ft}$$

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

- 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)

$$2-15" \text{ culvert} = 2.46 \text{ sq ft} > 2.28,$$

∴ 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 of the 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:

$$\text{Maximum } Q \text{ (total)} = 5.7 \text{ cu ft/sec} + 2.2 \text{ cu ft/sec} = 7.9 \text{ cu ft/sec (Required flow by design)}$$

$$v = 1.486 / n \text{ (R)} \text{ (S)}, \text{ where } n = 0.050 \text{ (riprapped ditch), } R = 0.584, S = 19.1 \text{ ft} / 322.0 \text{ ft} = 0.059$$

$$v = 4.22 \text{ ft/sec}, A \text{ (ditch type, D-6A)} = 2.0 \text{ sq ft}$$

$$\text{Per Attachment A, slope} = 0.059 \text{ and TYPE D-6A ditch, velocity} = 7.0 \text{ ft/sec}$$

$$Q \text{ (provided)} = 14.3 \text{ cu ft/sec} > Q \text{ (required)} = 7.9 \text{ cu ft/sec} \dots \text{ok}$$

PROVIDE Ditch Type D-6A.

(Attachment A, page 4)

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

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

$$A \text{ (req'd)} = Q/v = (14.3 \text{ cu ft/sec}) / (7.0 \text{ ft/sec}) = 2.04 \text{ sq ft.}$$

Calc. No. W320-21-002

Revision 0

Page No. 6 of 6

DESIGN ANALYSIS

Client: NUMATEC HANFORD CORPORATION
 Subject: W320 SITE DRAINAGE AT THE INTERFARM
 TRANSFER LINE AND C FARMS
 Location: 241-C-106, 200E AREA

WO/Job No. E34262/ W-320

Date: 03/18/97

By: M.R. Custer *MRC*Checked: *4/1/97*By: *[Signature]*

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).

$$A = 0.75 \times 2.04 \text{ sq ft} = 1.53 \text{ sq ft}, \quad A (2\text{-}12" \text{ dia.}) = 0.79 \text{ sq ft} (2) = 1.58 \text{ sq ft} > 1.53 \text{ sq ft} \dots \text{ok}$$

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:

$$A = 300 \text{ ft} \times 300 \text{ ft} = 90000 \text{ sq ft} / 43560 \text{ sq ft or approximately 2.1 acres}$$

- 2) Overland flow time,

Across the top of the tank:

- Estimated distance = 400 ft
- Time of Concentration, $T_c = 17 \text{ min.}$

(Attachment A, page 2)

Down the tank embankment):

- Estimated distance = 32 ft
- Time of Concentration, $T_c = 2 \text{ min.}$

- 4) Concentration Time (total), $17 \text{ min} + 2 \text{ min} = 19 \text{ min}$

- 5) Rainfall intensity, $I_r = 1.5 \text{ in/ hour}$

(Attachment A, page 3)

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

$$Q = A \times C \times I_r, \text{ where } A = 2.1 \text{ acres, } I_r = 1.5 \text{ in/ hr, } C = 0.65 \text{ (runoff coefficient)}$$

$$Q = 2.1 \text{ cu ft/ sec}$$

- 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

CALC. W320-21-002

 REV. 0
SHT. 1 OF 5

ACI RATIONAL FORMULA (Logical approach).

HNF-2461, Rev. 0

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	INCRE- MENT	TOTAL	C	TO INLET	IN CHAN- NEL	TIME OF CONC	L *	Q CFS.	CHAN- NEL OR PIPE SIZE	SLOPE ft. per ft.	n	CAPA- CITY FULL CFS.	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	165	0.3	165	3.8	30	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	168	3.7	68	D-2	.011	.030	12.0	2.8	420	4.62	0	81.52	76.90
"	"	C	2.0	5.7	.50		1.8	193	3.5	100	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 = $\frac{\text{RUNOFF}}{\text{RAINFALL}}$

SURFACES		MIN.	MAX.	MIN.	MAX.	
ROOFS, slag to metal.		0.90	1.00	0.70	0.95	
PAVEMENTS	Concrete or Asphalt.	0.90	1.00	0.95	1.00	
	Bituminous Macadam, open and closed type.	0.70	0.90	0.70	0.90	
	Gravel, from clean and loose to clayey and compact.	0.25	0.70	0.15	0.30	
R.R. YARDS		0.10	0.30	0.10	0.30	
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
		Light Vegetation	0.10	0.40	0.01	0.35
		Dense Vegetation	0.05	0.30	0.01	0.55
	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
		Light Vegetation	0.20	0.60	0.10	0.70
		Dense Vegetation	0.15	0.50	0.10	0.70
COMPOSITE AREAS	City, business areas.	0.60	0.75	0.60	0.95	
	City, dense residential areas, vary as to soil and vegetation.	0.50	0.65	0.30	0.60	
	Suburban residential areas.	0.35	0.55	0.25	0.40	
	Rural Districts.	0.10	0.25	0.10	0.25	
	Parks, Golf Courses, etc.,	0.10	0.35	0.05	0.25	

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. Kent & Kuichling, Report, Back Bay Sewerage District, Boston, 1909.

2. Metcalf and Eddy, American Sewerage Practice, 1928. M^c Graw-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. M^c Graw-Hill.

ATTACHMENT A
CALC. W310-21-002
REV. 0
SHT. 2 OF 5

$TC_{100} = 1.0$ min
(AREA 1)

$TC_{100} = 2.0$ min
(AREA 2)

Concentration time in Example.

DRAINAGE-DITCHES-COMMON SECTIONS-I

D-1 SEGMENTAL

D-1A TRIANGULAR
Unequal side slopes

D-1B BITUMINOUS 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 ditchesATTACHMENT A
CALC. W320-21-C02, REV. 0
SHT. 4 OF 5

SODDED GUTTER

COBBLED GUTTER

Base required same as for concrete pavement.

CONCRETE GUTTER

TABLE A - PROPERTIES OF DITCHES

NO.	DIMENSIONS				HYDRAULICS			
	SIDE SLOPES	B	H	W	a	p	R	R ^{3/4}
D-1	—	—	6 1/2	5' 0"	1.84	5.16	0.356	0.502
D-1A	12:1 & 2:1	—	6"	7' 0"	1.75	7.04	0.245	0.392
D-1B	12:1 & 2:1	—	5 1/2	7' 0"	1.64	7.08	0.232	0.377
D-1C	1/2 to 1' 0"	—	4.5	10' 0"	1.68	10.38	0.162	0.297
D-2A	1 1/2:1	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	1 1/2:1	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	1 1/2:1	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	1 1/2:1	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

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☒ 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	<i>James A. Rupert 2/3/94</i>	<i>James A. Rupert 6/22/94</i>	
Checked by	<i>Michael R. Curtis 4/1/94</i>	<i>Michael R. Curtis 6/6/94</i>	
Approved by	<i>R. W. Davidson 2-11-94</i>	<i>R. W. Davidson 6/29/94</i>	
Checked Against Approved Vendor Data		<i>Ann Shampine 4/7/98</i>	

INDEXDesign Analysis
Page No.

Description

1,2	OBJECTIVES; CRITERIA; DATA; ASSUMPTIONS; METHODS; REFERENCES; CALCULATION; CONCLUSIONS.
3-1420	Body of Calculation & SUMMARY SKETCHES (CR: 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

Subject Calculation No. W320-24-001 REV, 0

Page ii of iii

90156

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

<u> </u>	<u> X </u>	1. Does the design or design change involved meet the established criteria to be considered Safety Class 1 or 2?
<u> </u>	<u> X </u>	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?
<u> </u>	<u> X </u>	3. Does this design or design change significantly affect the nuclear safety consequences of a malfunction or failure of the structure, system, or component?
<u> </u>	<u> X </u>	4. Does this design or design change involve or change design that has previously undergone formal design verification?

M. VanAtay

Assigned Lead Engineer

2. 10. 94

Date

R. W. Dornier

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

KAISER ENGINEERS
HANFORD

Calc. No. W320-24-001

Revision 01

Page No. 1 of 20

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 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.D. 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.

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 CalculationsREFERENCES

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

Revision 0

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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 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-320-24-001Revision 0Page No. 3 of 20Client WHLWO/Job No. ER 4289Subject COLD TEST FACILITY: MOCK-UPS FORDate 1/4/94 By J. S. RupertTANK PITS 241-CR-06A,B AND 241-AY-02BChecked 2/7/94 By MRLLocation CAISSON W-106

Revised By

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

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Subject <u>COLD TEST FACILITY: MOCK-UPS FOR</u>	Date <u>1/4/94</u> By <u>J. M. Rupert</u>
<u>TANK PITS 241-CR-06A,B AND 241-AY-02B</u>	Checked <u>2/7/94</u> By <u>MRC</u>
Location <u>CAISSON W-106</u>	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 #	3560	
		<u>33166</u>
241-CR-06B HEEL JET PUMP	3152	
" SPOOL PIECE	886	
" MOCK RISER #	983	
		<u>5021</u>
241-AY-02B AGITATOR PUMP	2780	
" SPOOL PIECE	1633	
" MOCK RISER #	929	
		<u>5242</u>

X WTS. OF MOCK RISERS:
241-CR-06A

2" IR FLANGE (81.6 psf - REF. 1, p. 1-111)
 $1.7' \times 1.7' \times 1.17' \text{ ID} \times 81.6 \text{ psf}$
 $\pi/4 (1.7^2 - 1.17^2) \text{ ft}^2 \times 81.6 \text{ psf} = 109 \text{ lb}$

$3/8" \text{ IR} \times 6' \times 1.17' = 8.29 \text{ psf}$
 $\pi \text{ ID} = \pi (1.17')^2 \times 8.29 \text{ psf} = 30.5 \text{ lb}$

12" SCH 40 PIPE (50 psf, REF. 1, p. 1-93)
 $7.46' (\text{to psf}) = 372.9 \text{ lb}$

DOWELS (REF. 1, p. 1-103)
 $2" \phi \text{ @ } 10.7 \text{ psf (DOWELS)}$
 $(15" + 18")/12 \times 10.7 \text{ psf} = 29.4 \text{ lb}$
 $1 1/4" \phi \text{ @ } 4.18 \text{ psf}$
 $(4 \text{ STUDS}) \times 9 1/2' \times 4.18 \text{ psf} = 12.5 \text{ lb}$

TOTAL RISER WT. = $109 + 30.5 + 372.9 + 29.4 + 12.5 + 4.3 = 558.6 \text{ lb}$ SAY 560 lb

$3/8" \text{ IR } 14" \text{ OD} \times 12.0' \text{ ID} \times 15.3 \text{ psf}$
 $\pi/4 (1.17^2 - 1.0^2) \text{ ft}^2 \times 15.3 \text{ psf} = 4.3 \text{ lb}$

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 By J.A. Rupert

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 Checked 2/7/94

 By MLC

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241-CR-06B

* 2" IR FLANGE (REF. 1, I-111)

3' OD x 1'-6" ID

$$\pi (3^2 - 1.5^2) \text{ ft}^2 \times 81.6 \text{ psf} = 433$$

Lb

* 18" SCH 40 PIPE (REF. 7)

$$32''/12 \times 104.7 \text{ pcf} = 279 \text{ Lb}$$

* 18" x 12" REDUCER - STD. (REF. 7)

90 Lb

* 12" SCH 40 PIPE (REF. 1, I-93)

$$32''/12 \times 50 \text{ pcf} = 133 \text{ Lb}$$

 * DOWELS - 2" ϕ (REF. 1, I-108)

$$(15'' + 18'') \text{ ft} \times 10.7 \text{ pcf} = 29.4 \text{ Lb}$$

12

 STUDS - 1/4" ϕ

$$6 \text{ STUDS} \times 9''/12 \text{ ft} \times 4.18 \text{ pcf} = 18.8 \text{ Lb}$$

$$\text{TOTAL RISER WT.} = 433 + 279 + 90 + 133 + 29.4 + 18.8 \approx \underline{983 \text{ Lb}}$$

241-AY-02B

* 2" IR FLANGE (REF. 1, I-111)

43" OD x 34" ID

$$\pi (3.5^2 - 2.83^2) \text{ ft}^2 \times 81.6 \text{ psf} = 308 \text{ Lb}$$

4

* 3/8" IR PIPE

91 D. H. x 15.3 pcf

$$\pi (3.4'' (5.7'')) 15.3 \text{ pcf} = 579 \text{ Lb}$$

144

 * DOWELS - 2" ϕ (REF. 1, I-108)

$$(15'' + 18'') \text{ ft} \times 10.7 \text{ pcf} = 29.4 \text{ Lb}$$

12

 STUDS - 1/4" ϕ

$$4 \text{ STUDS} \times 9''/12 \text{ ft} \times 4.18 \text{ pcf} = 12.5 \text{ Lb}$$

$$\text{TOTAL RISER WT.} = 308 + 488 + 29.4 + 12.5 \approx \underline{929 \text{ Lb}}$$

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

DETERMINE PLATFORM LOADING (CONT.)
DEAD LOADS: $\frac{1}{2}" \text{ R @ } 20.4 \text{ psf (REF. 1, 1-111)}, L \times 4 \times \frac{1}{2} \text{ @ } 16.2 \text{ psf (REF. 1, 1-47)}$

$$a) \frac{1}{2}" \text{ R: } 10' \times 10' \times 20.4 \text{ psf} = 2040 \text{ Lb}$$

$$b) L \times 4 \times \frac{1}{2}: 2(120' + 45')/12 \times 16.2 \text{ psf} = 446 \text{ Lb}$$

$$\text{TOTAL: } (2040 + 446) \text{ Lb} = 2486 \text{ Lb} \quad \text{ASSUME L.WT. IS DIST. WITH PLATE}$$

$$\Rightarrow 2486 \text{ Lb} / 100 \text{ ft}^2 = 24.86 \text{ psf OR } \pm 0.173 \text{ psi}$$

LIVE LOADS:

$$a) \text{ HEAVIEST MOCK RISER/POOL/PUMP ASS'Y. (241-AY-02B)} = (2780 + 1633 + 929) \text{ Lb} = 5342 \text{ Lb}$$

$$b) \text{ VACUUM LOAD: MAX. -VE. PRESSURE IS } 6" \text{ H}_2\text{O, DESIGN ASS'Y FOR } 6" \text{ H}_2\text{O -VE. PRESSURE}$$

$$= 6.24 \text{ Lb}/\text{ft}^2 \times \frac{8"}{12} = 0.290 \text{ psi} \quad \text{SEE APP. A OF CALCS.}$$

SIZE PLATFORM STRONGBACKS (USE $F_y = 36 \text{ ksi}$ FOR ALL STRUCTURAL STEEL)
TRIBUTARY LOADING (DISTRIBUTED)

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

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

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

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

$$M_x = P a = 1336 \text{ Lb} (37.5") = 50100 \text{ in-Lb (REF. 1, 2-298)}$$

$$M_{\text{MAX}} = (34380 + 50100) \text{ in-Lb} = 84480 \text{ in-Lb}$$

$$F_{\text{MAX}} = 0.66 F_y \text{ (REF. 1, p. 5-312, SECT. 5.6.2 \& C5.1.2)}$$

$$S_x = \frac{M_{\text{MAX}}}{F_{\text{MAX}}} = \frac{84480 \text{ in-Lb}}{0.66 (36000) \text{ psi}} = 3.56 \text{ in}^3 \text{ REQ'D}$$

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Client <u>WHC</u>	WO/Job No. <u>ERA289</u>
Subject <u>COLD TEST FACILITY: MOCK-UPS FOR</u>	Date <u>1/1/94</u> By <u>J.D. Rupert</u>
<u>TANK PITS 241-CR-06A,B AND 241-AV-02B</u>	Checked <u>2/7/94</u> By <u>MRC</u>
Location <u>CAISCO W-106</u>	Revised _____ By _____

STRONG BACKS (CONTINUED)

$$S_x = 3.56 \text{ in}^3 \text{ REF. 1}$$

$$\text{USE } L 6 \times 4 \times 1/2, S_x = 4.33 \text{ in}^3 \text{ (REF. 1, p. 1-47)}$$

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 $1/2"$ PL - STRESS IN THE FIELD OF THE PL

MODEL A $1"$ WIDE STRIP $\times 45"$ LONG (WREST CASE) SIMPLY SUPPORTED
 LOADING: $1/2"$ PL 20.4 psf ($1 \text{ ft}^2 / 144 \text{ in}^2$) = 0.142 psi
 VACUUM: 0.290 psi

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

$$f_b = \frac{M_x}{S_x} = \frac{M_x}{b d^2/6} = \frac{109 \text{ in-lb}}{1" (0.500")^2/6} = 2616 \text{ psi} < 0.75 F_y = 27000 \text{ psi OK} \quad (\text{REF. 1, p. 5-146})$$

DESIGN LEDGER ANGLE SUPPORT FOR PLATFORM

(TYP. 2 SUPPORT, 4 PLCS)

DESIGN ANALYSIS

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 WO/Job No. ER4289

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 Date 1/4/94

 By J. M. Rupert
TANK PITS 241-CR-06A,B AND 241-AV-02B

 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 HDIS IN CASE OF REBAR INTERFERENCE.

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

LOADS: $L 5 \times 3 \times 3/8$, $S_x = 2.24 \text{ in}^3$ (REF. 1, 1-4B)

PUMP + MOCK-UP RISER = 5342 Lb

1/2" R = 2040 Lb

VACUUM = $0.29 \text{ psi} (120")^2 = 4176 \text{ Lb}$

TOTAL = 11558 Lb

$$w = \frac{11558 \text{ Lb}}{4 \times 120"} = 24.1 \text{ plf}$$

$$M_x = \frac{wL^2}{8} = \frac{24.1 \text{ plf} (29")^2}{8} = 2534 \text{ in-Lb}$$

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

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

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

$$f_b = \frac{M_x}{S_x} = \frac{72.3 \text{ in-Lb}}{1" (0.375")^2 / 6 \text{ in}^3} = 308.5 \text{ psi} < 0.75 F_y \text{ OK}$$

USE $L 5 \times 3 \times 3/8$ FOR LEDGER ANGLE SUPPORT

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WO/Job No. ER4289

Subject COLD TEST FACILITY: MOCK-UPS FOR

Date 1/4/94 By J. S. Rupert

TANK PITS 241-CR-06A,B AND 241-AY-02B

Checked 2/7/94 By MRC

Location CAISSON W-106

Revised 6/22/94 By J. S. Rupert

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

THERE ARE 4 SUPPORT POINTS WHERE THE $L \times 4 \times \frac{1}{2}$ STRONGBACKS TRANSFER THE LOAD THROUGH THE $\frac{1}{2}$ " R PLATFORM TO THE $L \times 3 \times \frac{3}{8}$ LEDGER ANGLE.

DETERMINE LOAD TRANSFERRED

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

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

TOTAL LOAD @ SUPPORT: $(1146 + 1336) \text{ Lb} = 2482 \text{ Lb} / \text{SUPPORT POINT}$

LOADS ON ANCHORS (RET. 1, P. 6 OF CALCS.)

• SHEAR: $2482 \text{ Lb} / 2 \text{ ANCHORS} = 1241 \text{ Lb} / \text{ANCHOR}$

• TENSION: SEE BELOW

$\Sigma M_A = 2482 \text{ Lb} \times 2" - T \times \frac{2}{3}(5 - 1.75 - 1)"$

$T = 3309 \text{ Lb}$ (THE 1" ALLOWS FOR RELOCATION OF THE HOI UP TO 1" IN CASE OF REBAR INTERFERENCE)

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

$f_u' = 4000 \text{ PSI}$ (REF. DWG. H-6-10602, VI, REV. 2 & SPEC. W-106-CL, SECT. 320, P. 3)

$\frac{5}{8}" \text{ HDI:}$

$T_{MAX} = 2.440 \text{ K} \Rightarrow 2 \times 2.440 = 4.88 \text{ K} > 3.31 \text{ K} \text{ OK}$

$V_{MAX} = 3.070 \text{ K} \Rightarrow 2 \times 3.070 = 6.14 \text{ K} > 4.88 \text{ K} \text{ OK}$

MRC
6/29/94

$\Delta \quad \frac{V}{V_{ALLOW}} + \frac{T}{T_{ALLOW}} = \frac{6.14 \text{ K}}{6.14 \text{ K}} + \frac{4.88 \text{ K}}{4.88 \text{ K}} = 0.88 < 1.0 \text{ OK}$

• USE $\frac{5}{8}" \text{ HDI'S @ 9" MIN. SPACING AND 11" MAX. SPACING TO SUPPORT THE CONCENTRATED LOADS (4 PLCS) OF THE PLATFORM ON THE LEDGER ANGLE.}$

DESIGN ANALYSIS

Client 12HC

WO/Job No. ER 4289

Subject COLD TEST FACILITY; MOCK-UPS FOR

Date 1/4/94

By P.S. Rupert

TANK PITS 241-CR-01A,B AND 241-AY-02B

Checked 2/7/94

By MRC

Location CAISSON W-106

Revised

By

SIZE STIFFENER PLATES @ SUPPORTS

$$F_H = 36 \text{ ksi}$$

$$R = 2482 \text{ lb}$$

$$e_s = 3" - 0.375" = 2.625"$$

$$L_h = 2.625"$$

$$\theta = \phi = 59.04^\circ$$

$$t = 0.375"$$

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

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

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

USE TWO 3/8" ID (A36) STIFFENERS @ EACH OF 4 SUPPORT POINTS TO STRENGTHEN 5" x 3" 3/8" LEDGER ANGLE.

DESIGN ANALYSIS

 Client WHC

 WO/Job No. ER4289

 Subject COLD TEST FACILITY: MOCK UPS FOR

 Date 1/4/94 By J. M. Rupert

 TANK DITS 241-CR-06A,B AND 241-AY-02B

 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 $L \times 4 \times 1/2$ STIFFENERS TRANSFER TRIBUTARY LOAD TO THE $L \times 3 \times 3/8$ LEDGER, THROUGH THE $1/2"$ IR.

 SEE "SECTION" SKETCH, P. 7 OF CALCS. $F_y = 36 \text{ ksi}$

$$f_{bx} = \frac{M_x}{S_x} = \frac{R \times L}{S_x} = \frac{2482 \text{ Lb} \times 2"}{5.83/6} = 2382 \text{ psi} < 0.75 F_y$$

OR REFER TO REF. 3, P. 6-6-2.
 $e = \frac{\sqrt{L_s \times r_c}}{2}$; $t_s = 0.500"$ } $e \leq 12 t_s = 6"$ HERE.
 $r_c = 00$

CHECK PLATFORM DEFLECTIONS

 1. $L \times 4 \times 1/2$: $I_x = 17.4 \text{ in}^4$ (REF. 1, p. 1-47)

 $P = 1336 \text{ Lb}$
 $a = 37.5"$
 $w = 19.1 \text{ pli}$
 $x = 60"$ (CTR.)

53424/4

$$\delta = \frac{5 w a^2}{384 EI} + \frac{P a}{24 EI} \left(\frac{3L^2 - 4a^2}{2} \right) \quad (\text{REF. 1, p. 2-296 \& 2-298})$$

$$\delta = \frac{5(19.1 \text{ pli})(120")^4}{384(2986 \text{ psi})(17.4 \text{ in}^4)} + \frac{1336 \text{ Lb}(37.5")}{24(2986 \text{ psi})(17.4 \text{ in}^4)} = 0.10 + 0.116$$

$$\delta = 0.26" < L/240 = 120/240 = 0.50 \text{ OK}$$

2. PLATE CANTILEVER @ SUPPORT
 $1/2"$ IR; $b = 5"$; $d = 0.500"$

$$I_x \text{ IR} = \frac{b d^3}{12} = \frac{5"(0.500")^3}{12} = 0.052 \text{ in}^4$$

 $P = 2482 \text{ Lb}$ (P. 8 OF CALCS.)
 (CONSERVATIVE)

$$\delta_R = \frac{P R^3}{3 EI} = \frac{2482 \text{ Lb} (2.0")^3}{3 \times 2986 \times 0.052 \text{ in}^4} = 0.004" < L/240 = 2"/240 = 0.008 \text{ OK}$$

USE $1/2"$ IR AND $L \times 4 \times 3/8$ TO CONSTRUCT PLATFORM.

DESIGN ANALYSIS

 Client WHL

 WO/Job No. ER4289

 Subject COLD TEST FACILITY: MOCK-UPS FOR

 Date 1/4/94

 By J. A. Rupert

TASK: PITS 241-CR-06A, B AND 241-AV-02B

 Checked 2/7/94

 By MHC

 Location CAISSON W-106

Revised

By

SIZE PLATFORM WELDS

INTERMITTENT WELDS WILL BE USED TO PROVIDE LATERAL-TORSIONAL RESTRAINT. (REF. 1, p. 4-312, SECT. 4.2) FOR THE 1" (COMPRESSION) LEG OF THE $L 6 \times 4 \times \frac{1}{2}$.

WELDS AT THE ENDS OF THE $L 6 \times 4 \times \frac{1}{2}$ TRANSFER THE REACTION LOAD OF 2482 Lb. THESE WELDS ARE ANALYZED BELOW.

TREAT $\frac{1}{4}$ " SKIP WELDS AS LINES: (REF. 3, p. 7.4, TABLE 5)

$$P = 2482 \text{ Lb}$$

NO CREDIT TAKEN FOR 1" RETURNS

$$l = (1.5" + 1" + 3") = 5.5"$$

$$M_x = P \cdot l = 2482 \text{ Lb} \times 5.5" = 13691 \text{ IN-Lb}$$

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

$d = 6"$
 $b = 4"$

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

$$f_v = \frac{M_x}{S_w} = \frac{13691 \text{ IN-Lb}}{12.0 \text{ IN}^2} = 1138 \text{ psi}$$

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

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

USE $\frac{1}{4}$ " FILLET SKIP WELDS, 2" @ 12" O/C, TO ATTACH $L 6 \times 4 \times \frac{1}{2}$ TO $\frac{3}{8}$ " R PLATFORM. AND 6" LENGTH OF WELD @ ENDS W/ 1" RETURN.

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Client WHC

WO/Job No. ER4289

Subject COAL TEST FACILITY: MOC-VPS FOR

Date 1/4/94 By J. A. Rupert

TANK PTS 241-CR-06A & B AND 241-AY-02B

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" R PLATFORM.

 $F_y = 36,000 \text{ psi}$

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

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

FOR 241-CR-06A RISER ASS'Y TOTAL WT: 3366 lb + 431 lb VACUUM LOAD = 3797 lb

3/8" R ADAPTER: 3'-7" OD X 1'-4" ID $\Rightarrow r_o = b = 8"$, $a = 21.5"$

$b/a = 8/21.5 \approx 0.4 \Rightarrow K_{mr} = 0.404$ (INTERPOLATE)

$w = \text{TOTAL ASS'Y WT} / \pi \times \text{PD OF RISER FLANGE (CONSERVATIVE)}$
 $= 3797 \text{ lb} / \pi \times 21.0 = 57.6 \text{ pli}$

$$f_b = \frac{M_{max}}{S_x} = \frac{K_m \times w \times a}{b^2/6} = \frac{0.404 \times 57.6 \times 21.5}{1^3 (0.375)^2/6} = 21,347 \text{ psi} < 0.75 F_y \quad \text{OK}$$

(REF. 1, p. 5-48)

FOR 241-CR-06B RISER ASS'Y TOTAL WT: 5021 lb + 431 lb VACUUM LOAD = 5452 lb

3/8" R ADAPTER: 3'-7" OD X 2'-6" ID $\Rightarrow r_o = b = 15"$, $a = 21.5"$

$b/a = 15/21.5 = 0.70 \Rightarrow K_{mr} = 0.274$

$w = 5452 \text{ lb} / \pi \times \text{OD OF RISER FLANGE} = 5452 \text{ lb} / \pi \times 36" = 48.2 \text{ pli}$

$$f_b = \frac{K_m \times w \times a}{b^2/6} = \frac{0.274 \times 48.2 \times 21.5}{1^3 (0.375)^2/6} = 12,115 \text{ psi} < 0.75 F_y \quad \text{OK}$$

CHECK SHEAR ON 3/8" R ADAPTER

ID OF 1/2" R RETAINER = 3.9"

$A_v = \pi \times \text{DIA} \times t$

$$F_v = \frac{5773 \text{ lb}}{\pi \times 3.9" \times 0.375"} = 125 \text{ psi} < 0.4 F_y \quad \text{OK}$$

CHECK STRESS ON WELDS CONNECTING 1/2" R RETAINER TO 1/2" R PLATFORM

TRY 3/16" FILLET; TAKE CREDIT FOR INSIDE WELD (43.5" DIA.) ONLY

$F_w = t_e \times 0.3 \times 70 \text{ ksi} \times l = 0.7071 (3/16) (0.3) (70) (\pi \times 43.5") = 380 \text{ lb}$ CAPACITY

$\times V = (5452 + 431) = 5773 \text{ lb} < 380 \text{ lb} \quad \text{OK}$ FOR 241-AY-02B ASS'Y (HEAVIEST)

$\times \text{VACUUM LOAD} = 0.290 \text{ psi} \times \pi (43.5")^2/4 = 431 \text{ lb}$; @ 8" H2O, 2X OPERATING VACUUM

DESIGN ANALYSIS

Client WHL

WO/Job No. 1ER 4284

Subject COLD TEST FACILITY: MOCK-UPS

Date 2/1/94

By J. A. RUPEERT

FOR PITS 241-CR-06A, B AND 241-AV-02B

Checked 2/7/94

By MRC

Location CAISSON W-106

Revised

By

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

$$l = \frac{24"}{2} = 12.00"$$

$$S_R = \frac{bd^2}{6} = \frac{50.9"(0.5")^2}{6} = 2.12 \text{ in}^3$$

LOAD ON SWIVEL:

1/2" IR: 10' x 10'

2040 Lb

L 6x4 x 1/2" x 27.5'

446

SPOOL/PUMP/RISE ASS'Y

5342

7828 Lb

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

$$M_x = (1957 \text{ Lb}) \times (12.00") = 23484 \text{ in-Lb}$$

$$f_b = \frac{M_x}{S_R} = \frac{23484 \text{ in-Lb}}{2.12 \text{ in}^3} = 11077 \text{ psi} < 0.75 F_y = 27000 \text{ psi} \quad \text{OK}$$

SIZE LIFTING RINGS FOR PLATFORM.

TRY 1/2" SWIVEL HOIST RING (CROSS-BY # 1016909 OR APPROVED EQUAL)

@ SWL = 2500 Lb EACH (ONE EA. CORNER OF 1/2" IR PLATFORM)

$$4 \text{ SWIVELS} \times 2500 \text{ Lb/SWIVEL} = 10,000 \text{ Lb} > 7828 \text{ Lb LOAD} \quad \text{OK}$$

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

Calc. No. W-320-24-001

Revision 0

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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.G. RUPERT *JGR*

Checked 2/7/94

By *MRC*

Location CAISSON W-106

Revised

By

SUMMARY SKETCHES

Calc. No. W-320-24-001

Revision 0

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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

Checked **2/7/94**

Revised

By J.G. RUPERT

By *MRC*

By

SUMMARY SKETCHES

Calc. No. W-320-24-001

Revision 0

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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.G. RUPERT *JGR*

Checked 2/7/94

By MRC

Location CAISSON W-106

Revised

By

SUMMARY SKETCHES

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.G. RUPERT *JGR*

Checked 2/7/94

By *MRC*

Location CAISSON W-106

Revised

By

SUMMARY SKETCHES **DETAIL**STIFFENED SUPPORT
TYP FOUR PLACES

Calc. No. W-320-24-001

Revision 0

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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.G. RUPERT *fm*

Checked 2/1/94

By *MRC*

Location CAISSON W-106

Revised

By

SUMMARY SKETCHES

Calc. No. W-320-24-001

Revision 0

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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.G. RUPERT *JGR*Checked *2/7/94*By *MRC*

Revised

By

Location CAISSON W-106

SUMMARY SKETCHES

DON'T SAY IT --- Write It!

DATE: December 6, 1993

TO: James G Rupert

FROM: Rodney C. Campbell

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 referenced numbers are so that you can create your cross index.

HNF-2461, Rev. 0

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

<u>Variable</u>	<u>Specification Limit</u>
-----------------	----------------------------

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

C-25

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 ≥ -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.	Immediately AND Each 8 hours thereafter
	AND A.2 Restore primary tank vapor space pressure to within limit.	Immediately

SURVEILLANCE REQUIREMENTS

	SURVEILLANCE	FREQUENCY
SR 3.3.2.1	VERIFY primary tank vapor space pressure is ≥ -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

440

Lifting Eyes, Nuts, & Swivels

Lif

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 models; II-cad plating; and metric sizes. Specify requirements and 3052T1999. Prices on request.

SAFETY NOTE: Some loosening may develop through 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 Sale Radius	Dimensions				D	Alloy Steel Work Load Limit, Lbs.	No.	NET EACH
			B	C	1/2"	3/4"				
3/8"-16	12	7/16"	15/16"	9/16"	3/8"	1/2"	800	3052T55	\$85.01	
1/2"-13	28	1 1/16"	2 1/16"	1 1/16"	1/2"	3/4"	1,000	3052T57	82.31	
3/4"-10	28	1 1/8"	3 1/4"	3/4"	3/4"	1"	2,500	3052T58	79.61	
1"-8	60	1 1/2"	3 1/4"	1 1/4"	3/4"	1 1/4"	2,500	3052T61	79.72	
1 1/4"-7	60	1 3/4"	3 1/4"	1 1/4"	3/4"	1 1/2"	4,000	3052T61	79.98	
1 1/2"-6	100	2"	3 1/4"	1 1/4"	3/4"	1 3/4"	4,000	3052T62	79.98	
2"-4 1/2"	800	2 1/4"	8"	3 3/8"	1 3/4"	2"	5,000	3052T63	79.98	
2 1/2"-4"	800	2 1/2"	8"	3 3/8"	1 3/4"	2 1/4"	7,000	3052T64	171.43	
3"-3 1/2"	100	2 3/4"	8"	3 3/8"	1 3/4"	2 1/2"	7,000	3052T62	173.86	
3 1/2"-3"	100	3"	8"	3 3/8"	1 3/4"	2 3/4"	10,000	3052T65	171.43	
4"-2 1/2"	100	3 1/4"	8"	3 3/8"	1 3/4"	3"	10,000	3052T66	178.28	
4 1/2"-2"	100	3 1/2"	8"	3 3/8"	1 3/4"	3 1/4"	10,000	3052T67	193.25	
5"-1 3/4"	100	3 3/4"	8"	3 3/8"	1 3/4"	3 1/2"	10,000	3052T68	197.34	
5 1/2"-1 1/2"	100	3 1/2"	8"	3 3/8"	1 3/4"	3 3/4"	15,000	3052T68	324.66	
6"-1 1/4"	100	3 1/2"	8"	3 3/8"	1 3/4"	4"	30,000	3052T69	462.68	

Bolt Size	Thread Torque Ft. Lbs.	Inside Sale Radius	Dimensions				D	Alloy Steel Work Load Limit, Lbs.	No.	NET EACH
			B	C	1/2"	3/4"				
3/8"-16	12	7/16"	15/16"	9/16"	3/8"	1/2"	800	3052T55	\$85.01	
1/2"-13	28	1 1/16"	2 1/16"	1 1/16"	1/2"	3/4"	1,000	3052T57	82.31	
3/4"-10	28	1 1/8"	3 1/4"	3/4"	3/4"	1"	2,500	3052T58	79.61	
1"-8	60	1 1/2"	3 1/4"	1 1/4"	3/4"	1 1/4"	2,500	3052T61	79.72	
1 1/4"-7	60	1 3/4"	3 1/4"	1 1/4"	3/4"	1 1/2"	4,000	3052T61	79.98	
1 1/2"-6	100	2"	3 1/4"	1 1/4"	3/4"	1 3/4"	4,000	3052T62	79.98	
2"-4 1/2"	800	2 1/4"	8"	3 3/8"	1 3/4"	2"	5,000	3052T63	79.98	
2 1/2"-4"	800	2 1/2"	8"	3 3/8"	1 3/4"	2 1/4"	7,000	3052T64	171.43	
3"-3 1/2"	100	2 3/4"	8"	3 3/8"	1 3/4"	2 1/2"	7,000	3052T62	173.86	
3 1/2"-3"	100	3"	8"	3 3/8"	1 3/4"	2 3/4"	10,000	3052T65	171.43	
4"-2 1/2"	100	3 1/4"	8"	3 3/8"	1 3/4"	3"	10,000	3052T66	178.28	
4 1/2"-2"	100	3 1/2"	8"	3 3/8"	1 3/4"	3 1/4"	10,000	3052T67	193.25	
5"-1 3/4"	100	3 3/4"	8"	3 3/8"	1 3/4"	3 1/2"	10,000	3052T68	197.34	
5 1/2"-1 1/2"	100	3 1/2"	8"	3 3/8"	1 3/4"	3 3/4"	15,000	3052T68	324.66	
6"-1 1/4"	100	3 1/2"	8"	3 3/8"	1 3/4"	4"	30,000	3052T69	462.68	

Bolt Size	Thread Torque Ft. Lbs.	Inside Sale Radius	Dimensions				D	Alloy Steel Work Load Limit, Lbs.	No.	NET EACH
			B	C	1/2"	3/4"				
3/8"-16	12	7/16"	15/16"	9/16"	3/8"	1/2"	800	3052T55	\$85.01	
1/2"-13	28	1 1/16"	2 1/16"	1 1/16"	1/2"	3/4"	1,000	3052T57	82.31	
3/4"-10	28	1 1/8"	3 1/4"	3/4"	3/4"	1"	2,500	3052T58	79.61	
1"-8	60	1 1/2"	3 1/4"	1 1/4"	3/4"	1 1/4"	2,500	3052T61	79.72	
1 1/4"-7	60	1 3/4"	3 1/4"	1 1/4"	3/4"	1 1/2"	4,000	3052T61	79.98	
1 1/2"-6	100	2"	3 1/4"	1 1/4"	3/4"	1 3/4"	4,000	3052T62	79.98	
2"-4 1/2"	800	2 1/4"	8"	3 3/8"	1 3/4"	2"	5,000	3052T63	79.98	
2 1/2"-4"	800	2 1/2"	8"	3 3/8"	1 3/4"	2 1/4"	7,000	3052T64	171.43	
3"-3 1/2"	100	2 3/4"	8"	3 3/8"	1 3/4"	2 1/2"	7,000	3052T62	173.86	
3 1/2"-3"	100	3"	8"	3 3/8"	1 3/4"	2 3/4"	10,000	3052T65	171.43	
4"-2 1/2"	100	3 1/4"	8"	3 3/8"	1 3/4"	3"	10,000	3052T66	178.28	
4 1/2"-2"	100	3 1/2"	8"	3 3/8"	1 3/4"	3 1/4"	10,000	3052T67	193.25	
5"-1 3/4"	100	3 3/4"	8"	3 3/8"	1 3/4"	3 1/2"	10,000	3052T68	197.34	
5 1/2"-1 1/2"	100	3 1/2"	8"	3 3/8"	1 3/4"	3 3/4"	15,000	3052T68	324.66	
6"-1 1/4"	100	3 1/2"	8"	3 3/8"	1 3/4"	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 1/2 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)	B	C	D	E	Work Load Limit, Lbs.	No.	NET EACH
1/2"	3/4"	1 1/4"	1 1/8"	1/4"	520	3019T14	\$2.92 \$2.63
3/8"	1"	1 1/2"	1 1/4"	3/8"	840	3019T15	2.92 2.63
1/4"	1 1/4"	2"	1 1/2"	1/2"	1240	3019T16	2.95 2.66
1/2"	1 1/2"	2 1/4"	1 3/4"	3/4"	1700	3019T17	2.97 2.68
3/4"	1 3/4"	2 3/4"	2"	1"	2240	3019T18	2.97 2.68
1"	2"	3"	2 1/2"	1 1/2"	3600	3019T19	3.68 3.32
1 1/4"	2 1/4"	3 1/4"	2 3/4"	1 3/4"	5200	3019T21	\$6.83 \$6.16
1 1/2"	2 1/2"	3 1/2"	2 3/4"	1 3/4"	7200	3019T22	9.06 8.10
1 3/4"	2 3/4"	3 3/4"	3"	1 3/4"	10000	3019T23	13.33 12.02
2"	3"	4"	3 1/2"	2"	12300	3019T24	16.00 14.30
2 1/4"	3 1/4"	4 1/4"	3 3/4"	2 1/4"	15500	3019T25	20.38 18.19
2 1/2"	3 1/2"	4 1/2"	3 3/4"	2 1/2"	22500	3019T27	35.69 35.47

HEAVY-DUTY SELF-COLORED

Thread Dia. (A)	B	C	D	E	Work Load Limit, Lbs.	No.	NET EACH
3/8"	1"	1 1/2"	1 1/4"	3/8"	1800	3274T41	\$4.14 \$3.79
1/2"	1 1/4"	2"	1 3/4"	1/2"	3600	3274T42	5.19 4.81
3/4"	1 3/4"	2 1/4"	1 3/4"	3/4"	5160	3274T43	8.74 8.17
1"	2"	3"	2 1/2"	1"	10600	3274T44	\$12.55 \$11.39
1 1/4"	2 1/4"	3 1/4"	2 3/4"	1 1/4"	16800	3274T46	23.22 20.81
1 1/2"	2 1/2"	3 1/2"	2 3/4"	1 1/2"	22500	3061T14	\$16.53 \$14.91

Large Opening Swivel Hoist Rings

Same as the 3052T series (Heavy-Duty Swivel Hoist Rings) listed above, except swivel eye which is forged from one piece of steel. Provides working load with four times factor of safety in all directions. Inside bore radius is .645" for 2994T148, .880" for 149-155. The swivels with 3/8"-16 coarse thread meet Military Spec. MSS-1937. 12 thread work ft. lbs. for all hoist rings.

Thread Dia. (A)	B	C	Work Load Limit, Lbs.	No.	NET EACH
1/2"	3/4"	1 1/4"	800	7	2994T61 \$6.87
3/8"	1"	1 1/2"	800	7	2994T62 \$6.87
1/2"	1 1/4"	2"	1200	12	2994T63 \$13.19
3/4"	1 3/4"	2 1/4"	1200	12	2994T64 \$13.19
1"	2"	3"	2500	28	2994T65 \$21.39
1 1/4"	2 1/4"	3 1/4"	2500	28	2994T66 \$21.39
1 1/2"	2 1/2"	3 1/2"	2500	28	2994T67 \$21.39

Use these pad machinery, equip Eye Shou I.O. O.D. DI CARBON STEEL

Lift

For temporary and construction machine bolt, and ed to heavy steel b on a line through ed minimum bolt le 123 and T27; and Bolt Hole. TR SINGLE SWIVEL DOUBLE SWIVEL

NOTE: ALL HOOK

Steel and Screw H

Standard ceiling hooks. Select for steel and solid bra Nos. 9587T13, 9587T11, and 9588 and 9588T78 come others come 100 ps

A	B	C
1080	1 1/2"	1 3/4"
105	1 1/4"	1 1/2"
102	1 1/4"	1 1/2"
100	1 1/4"	1 1/2"
98	1 1/4"	1 1/2"
96	1 1/4"	1 1/2"
94	1 1/4"	1 1/2"
92	1 1/4"	1 1/2"
90	1 1/4"	1 1/2"
88	1 1/4"	1 1/2"
86	1 1/4"	1 1/2"
84	1 1/4"	1 1/2"
82	1 1/4"	1 1/2"
80	1 1/4"	1 1/2"

Solid B Shoulder

Supplied 100 per for 9586T6, 9586T7 which are 50 per bolt Wire Dia. 072 060 090 120

W320-24-005

Design Two Electrical Equipment Skids
and One Concrete Slab

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?

☒ 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	<i>J. S. Eupert</i> 06/23/94		
Checked by	<i>R. W. Davidson</i> 6/30/94		
Approved by	<i>R. W. Davidson</i> 7/14/94		
Checked Against Approved Vendor Data	<i>Ananthangiri</i> 7/1/98		

Design Analysis
Page No.

INDEX

Description

[illegible]

CALCULATION CROSS INDEX (Typical)

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

Page ii of iii[illegible]

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?

R. D. Douch
Assigned Lead Engineer

6/30/94
Date

R. D. Douch
Responsible Discipline Manager

6/14/94
Date

Original Design Package Distribution:

Project Manager

Design Verification Officer

Engineering Document Control

Design Change Distribution:

Attach to Engineering Change Notice

DESIGN ANALYSIS

Client WHC

Subject W320 EQUIPMENT REMOVAL SYSTEM

Location 241-C, 241-AY TANK FARMS

WO/Job No. ER5735

Date 06/15/94

Checked *u30194*

Revised

By J.G. RUPERT

By *R.D. Dasher*

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.

DESIGN ANALYSIS

Client WHL
Subject W320 EQUIPMENT REMOVAL SYSTEM
Location 241-C, 241-4Y TANK FARMS

WO/Job No. ER 5735
Date 06/15/94 By J. A. Rupert
Checked 06/30/94 By W. J. Anderson
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"

DESIGN ANALYSIS

Client <u>WHL</u>	WO/Job No. <u>EP-5735</u>
Subject <u>W320 EQUIPMENT REMOVAL SYSTEM</u>	Date <u>06/16/94</u> By <u>A. M. Rupert</u>
	Checked <u>6/30/94</u> By <u>R. M. Dowd</u>
Location <u>241-C, 241-AV TANK FARMS</u>	Revised _____ By _____

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

LOADS

X.FMR: 500 Lb

1'-3" RACK: EQUIP. = 60 Lb

UNISTRUT - P1000 @ 1.9 pcf } REF. 2, p. 23

P1001 @ 3.8 pcf }
(2x4') 3.8 pcf + (2x1.25') 1.9 pcf = 35 #

TOTAL: (60 + 35) Lb = 95 Lb

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

UNISTRUT (3x4.67') 1.9 pcf + (2x4') 3.8 pcf = 57 Lb

TOTAL: (310 + 57) Lb = 367 Lb

NEGLECT W6X15 SELF-WEIGHT.

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

W6 X 15: $S_x = 9.72 \text{ in}^3$, $b_f = 5.99"$, $I = 29.1 \text{ in}^4$ (REF. 1, p. 1-32)

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

NOTE: W6X15 IS NONCOMPACT (REF. 1, p. 2-73)

$L_u = 12.0'$

$L_c = 6.3'$

THE W6X15 IS BRACED @ 4'-8" MAX. (ϕ_b) < $\frac{F_b b_f}{\sqrt{F_y}} = \frac{F_b (5.99")}{\sqrt{36}} = 75.9"$ OK

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

$\therefore f_b = 2969 \text{ psi} < F_b = 0.6 \times 36000 \text{ psi} = 21,600 \text{ psi}$ OK

DESIGN ANALYSIS

Client	WHC	WO/Job No.	ER 5135
Subject	W320 EQUIPMENT REMOVAL SYSTEM	Date	06/15/94 By J.A. Rupeert
		Checked	W320/94 By R. J. J. J.
Location	241-C, 241-AV TANK FARMS	Revised	By

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

$$\Delta = \frac{PL^3}{48EI} = \frac{96266 (120")^3}{48 (2946 \text{ psi}) (29.1 \text{ in}^4)} = 0.04" < \frac{L}{240} = 0.5" \text{ OK}$$

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 $\Rightarrow$ THE W6 FRAME IS NOT SUBJECT TO FLEXURE.

WIND LOAD (SC-3)

SPEED: 70 mph

I: 1.07

EXP: C

REF. 3, p. 8

$$F = q_z G_h C_f A_f \quad (\text{REF. 4, TABLE 4})$$

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

$$G_h = 1.32 \quad (\text{REF. 4, TABLE 8})$$

$$C_f = 1.2; V \leq 3 \quad (\text{REF. 4, TABLE 13})$$

$$A_f = \text{VARIES BY SITUATION/COMPONENT}$$

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

DESIGN ANALYSIS

Client <u>W.H.C.</u>	WO/Job No. <u>ER 4725</u>
Subject <u>W320 EQUIPMENT REMOVAL SYSTEM</u>	Date <u>06/15/94</u> By <u>J.A. Rupert</u>
	Checked <u>4/30/94</u> By <u>P. (W) [signature]</u>
Location <u>241-C, 241-AV TANK FARMS</u>	Revised By

SEISMIC LOAD (SC-3)

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

$Z = 0.20$ (REF. 5, TABLE 23.1)

$W_p = \text{VARIES BY SITUATION/COMPONENT}$

HORIZONTAL FORCE FACTOR, $C_p = 2.0 \times 0.75 = 1.50$ (REF. 5, TABLE 23.6 & SECT. 2336)

$F_p = Z I C_p W_p$
 $= 0.2 \times 1.25 \times 1.50 C_p = 0.375 C_p$

3. DETERMINE OVERTURNING STABILITY OF SKID.

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

$P = 150 + 160 + 100 = 370 \text{ lb}$ (EQUIP. WT.)

$W_{tr} = 35 + 57 = 92 \text{ lb}$ (UNISTRUT WT; SEE p. 3)

$W_{6 \times 15} = 15 \text{ psf} (2 \times 10 + 4 \times 1.25)' = 375 \text{ lb}$

$W_{XFMR} = 500 \text{ lb}$

$F = 18.2 \text{ psf} (4.5' \times 10') = 819 \text{ lb}$

SIDE VIEW

SUM ABOUT POINT A TO FIND

$M_{OT} = 819 \text{ lb} \times 27" = 22,113 \text{ in.-lb}$

$M_R = 370 \text{ lb} \times 6" + (375 + 92 + 500) 13.5" = 15,274 \text{ in.-lb}$

$\frac{M_{OT}}{M_R} = \frac{22,113 \text{ in.-lb}}{15,274 \text{ in.-lb}} = 1.4 > 2/3 \Rightarrow \text{NEED ANCHORS (REF. 4, 6.1.2)}$

DESIGN ANALYSIS

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Client WHL
Subject W320 EQUIPMENT REMOVAL SYSTEM
Location 241-C, 241-AV TANK FARMS

WO/Job No. ER 5735

Date 06/15/94 By A. S. Rupert
Checked W320/94 By R. J. Davidson
Revised By

SEISMIC:

$$M_R = 15.274 \text{ k-in} \quad (\text{SEE P. 5})$$

$$W'_{XFMR} = 0.375 (500 \text{ Lb}) = 188 \text{ Lb}$$

$$W'_u = 0.375 (92 \text{ Lb}) = 35 \text{ Lb}$$

$$P' = 0.375 (370 \text{ Lb}) = 139 \text{ Lb}$$

$$W'_{6x15} = 0.375 (379 \text{ Lb}) = 141 \text{ Lb}$$

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

ONLY SEISMIC
LOADS SHOWN

MOT FOR WIND (22113 in-lb) CONTROLS

1. DESIGN ANCHORS FOR SKID

ALLOW ANCHORS TO RESIST FULL MOT. WIND. (CONSERVATIVE)

W6X15 FRAME PLAN

TRY 1/2" HKB II, $f_c = 4000 \text{ psi}$

$$E M_A = T \times 25.75" - M_{OT} = 0$$

$$T = 22113 \text{ in-lb} = 429 \text{ Lb/BOLT}$$

$$25.75" \times 2 \text{ BOLTS}$$

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

$$T_{ALLOW} = 1200 \text{ Lb/BOLT}, 2\frac{1}{4}" \text{ EMBED} > 429 \text{ Lb OK}$$

$$V_{ALLOW} = 1420 \text{ Lb/BOLT}, 2\frac{1}{4}" \text{ EMBED} > 205 \text{ Lb OK} \quad (\text{REF. 6, TABLE 13})$$

(FOR MIN. EDGE DISTANCE FOR HKB II SEE REF. 6, TABLE 10)

DESIGN ANALYSIS

Client	WHL	WO/Job No.	ER 5735
Subject	W320 EQUIPMENT REMOVAL SYSTEM	Date	06/15/94
		By	J. A. Rupert
		Checked	03/09/94
		By	W. Davidson
Location	241-C, 241-A/TANK FARMS	Revised	
		By	

$$\frac{V}{V_{allow}} + \frac{T}{T_{allow}} = \frac{205}{1420} + \frac{129}{1200} = 0.50 \leq 1.0 \quad \text{OK}$$

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

5. SIZE UNISTRUT COLUMNS & BEAMS USED FOR 4'-6" WIDE EQUIPMENT RACK (MEMBER SIZES ARE ALSO SUFFICIENT FOR THE 1'-3" WIDE RACK)

SEISMIC LOAD ON RACK:

$$W_p = \text{WT PANELS} + \text{WT WIREWAY} + \text{WT UNISTRUT} \quad (\text{SEE P. 3})$$

$$= 160 + 150 + 57 = 367 \text{ Lb}$$

$$F_p = Z I C_p W_p = 0.375 \times 367 \text{ Lb} = 138 \text{ Lb}$$

$$M_p = 138 \text{ Lb} (42" - 15") = 3726 \text{ Lb-in} \quad (W_p \text{ TAKEN @ 42" ABOVE BASE})$$

(CONTROLS) => CONSERVATIVE

WIND LOAD ON RACK:

$$F = 10.2 \text{ psf} \times A_f = 10.2 \text{ psf} (4' \times 4.67') = 340 \text{ Lb}$$

$$M_f = 340 \text{ Lb} (24" - 15") = 3060 \text{ Lb-in} \quad (F \text{ TAKEN @ COLUMN MID HT.})$$

TRY P1001 UNISTRUT FOR COLUMNS

MODEL COLUMN AS FLAGPOLE $\Rightarrow K=2.1$ (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)

INPUTE MAX. ALLOW MOMENT

$$M_x = 5690 \text{ Lb} \times \frac{3.25"}{2} = 9246 \text{ Lb-in} / \text{P1001 COLUMN}$$

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

$$M_x = (150 + 160) \text{ Lb} \times 6" + 3726 \text{ Lb-in} = 5586 \text{ Lb-in}$$

$$\frac{M_x}{2 \text{ COLS}} = \frac{5586 \text{ Lb-in}}{2} = 2793 \text{ Lb-in} / \text{COL} < 9246 \text{ Lb-in} \text{ ALLOWED} \quad \text{OK}$$

CHECK: $S_x = 0.572 \text{ in}^3$ $F_y = 33 \text{ ksi}$ (REF. 2, p. 20, 25)

$$f_b = \frac{M_x}{S_x} = \frac{2793 \text{ Lb-in}}{0.572 \text{ in}^3} = 4883 \text{ psi} < 0.6 (33,000) = 19,800 \text{ psi} \quad \text{OK}$$

DESIGN ANALYSIS

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Client <u>WHL</u>	WO/Job No. <u>ER6735</u>
Subject <u>W320-EQUIPMENT REMOVAL SYSTEM</u>	Date <u>06/15/94</u> By <u>J. A. Rupert</u>
Location <u>241-C, 241-AY TANK FARMS</u>	Checked <u>06/30/94</u> By <u>W. J. Davidson</u>
	Revised By

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

$P = \text{PANEL + WIREWAY}$
 $160 + 150 = 310 \text{ Lb OR } P/2 = 155 \text{ Lb}$

UNIFORM LOAD MAX: SEE P.2 OF CACS
 $60/56 \times 600 = 729 \text{ Lb} > 150 \text{ Lb (REF. 2, p. 24)}$
(WIREWAY OK)

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

$P_{MAX} = 0.5 \times 600 \text{ Lb} \times 60/56 = 364 \text{ Lb} > P/2 \text{ COLS} = 182 \text{ Lb OK}$

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

6. SIZE WELDS FOR P1001 CONNECTION TO 16" X 15" SKID BASE.

$F = 340 \text{ Lb (WIND)}$

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

$R = \frac{340 \text{ Lb} \times 9" + 1860 \text{ Lb-in}}{15" \times 2 \text{ COLS}} = 164 \text{ Lb/COLUMN}$

DETAIL 1

SECTION X-X

DESIGN ANALYSIS

Client	WHL	WO/Job No.	ER 5735
Subject	W320 - EQUIPMENT REMOVAL SYSTEM	Date	06/15/94
		By	J. M. Rupert
		Checked	W. J. D. S. (W. J. D. S.)
Location	241-C, 241-AY TANK FARMS	Revised	By

CAPACITY OF $2 \times 3" = 6"$ OF $\frac{1}{8}"$ FILLET WELD

$$F_v = 0.125" \times 0.7071 \times 0.3 \times 70,000 \text{ psi} \times 6" = 11,156 \text{ Lb} \gg R/2 = 164 \text{ Lb}$$

 $\therefore$ USE $\frac{1}{8}"$ MIN. FILLET WELD $\times 6"$ TO ATTACH P1001 UNISTRUT COLS. TO BASE7. SIZE WELD FOR MOUNTING XEMR TO W6X15 SKID BASE

$$F_w = 18.2 \text{ psf} \times 2'-2" \times 4' = 158 \text{ Lb}$$

$$F_p = 0.375 \times 500 \text{ Lb} = 188 \text{ Lb} \quad \text{CONTROLS}$$

TRY 4 ANGLE CLIPS, ONE @ EACH CORNER OF XEMR. CLIPS ARE SAME AS FOR MOUNTING UNISTRUT COLUMNS (P.B.); $\frac{3}{16}"$ FILLET WELDS4 CLIPS $\times 3"$ WELD/CLIP = $12"$ OF $\frac{3}{16}"$ FILLET WELD. FROM P.B. OF CALCS; CAPACITY = $2 \times 16,705 \text{ Lbs} = 33,410 \text{ Lbs} \gg F_p$ $\therefore$ USE 4 ANGLE CLIPS (2 $2\frac{1}{2} \times 1\frac{1}{2} \times \frac{1}{4} \times 3"$ LONG) AND MOUNT TO SKID BASE w/ $\frac{3}{16}"$ FILLET WELDS $\times 3"$ LONG.B. SIZE FORGED STEEL (F.S.) EYEBOLTS FOR LIFTING SKID #1

TOTAL SKID WT.

XEMR: 500 Lb

W6X15: $27' \times 15 \text{ pcf} = 405 \text{ Lb}$ P1001 UNISTRUT: $(4 \times 4'-8" + 3 \times 1'-6") 1.9 \text{ pcf} = 44 \text{ Lb}$ P1001 UNISTRUT: $4 \times 4' \times 3.8 \text{ pcf} = 61 \text{ Lb}$

MISC. CLIPS/STIFFENERS: 15 Lb

PANELS: $(1 \times 60 \text{ Lb} + 4 \times 40 \text{ Lb} + 1 \times 150 \text{ Lb}) = 370 \text{ Lb}$ TOTAL: $(500 + 405 + 44 + 61 + 15 + 370) \text{ Lb} = 1395 \text{ Lb}$ SAY 1400 LbDIRECT TENSION LOAD (USE 4 EYEBOLTS) = $\frac{1400 \text{ Lb}}{4} = 350 \text{ Lb/BOLT}$ RATED SWL FOR A $\frac{1}{2}"$ F.S. EYEBOLT IS 2600 Lb $\gg 350 \text{ Lb}$ USE ARMSTRONG # 89024, $\frac{1}{2}"$ LIFTING EYE, F.S. (OR EQUAL)
CAPACITY: 2600# STRAIGHT LIFT (0°), 1200# @ 30° FROM VERTICAL

DESIGN ANALYSIS

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Client WHL

WO/Job No. ER 5735

Subject W320 - EQUIPMENT REMOVAL SYSTEM

Date 06/15/94 By J. A. Rupert

Checked 06/30/94

By P. J. D. [Signature]

Location 241-C, 241-AV TANK FARMS

Revised

By

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 = $\sqrt{14^2 + 7.75^2} = 16"$, $\theta = \tan^{-1}(14/7.75) = 61^\circ$

END CONDITION: ASSUME PIN-PIN $\Rightarrow K=1.0$
LOAD IS APPLIED C.C.G. BY DESIGN OF ADJUSTABLE BRACES

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

$P = (1160 + 150) Lb = 310 Lb$

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.

$F = 18.2 \text{ psf} \times 4.67' \times 4' = 340 Lb$ (SEE p. 4)

$\Sigma M_A = 0 = 340 Lb \times 24" - R \times 14" = 0$ (NOTE: 14" IS CONSERVATIVE)

$R = \frac{340 \times 24}{14} = 291 Lb / \text{STRUT}$
 $14 \times 2 \text{ STRUT}$

$C_s = \frac{R}{C_{RS}(61^\circ)} = \frac{291 Lb}{C_{RS}(61^\circ)} = 600 Lb / \text{STRUT} < 9320 Lb$

DESIGN ANALYSIS

Client WHL

WO/Job No. ER5735

Subject W320-EQUIPMENT REMOVAL SYSTEM

Date 06/15/94

By J. D. Ruppert

Checked 06/24/94

By W. D. Dinkelman

Location 241-C, 241-AY TANK FARMS

Revised

By

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

$$\Sigma M_A = 0 = 310 \text{ LB} \times 6" + 340 \text{ LB} \times 24" - R' \times 14" = 0$$

$$R' = \frac{310 \times 6 + 340 \times 24}{14 \times 2 \text{ STRUTS}} = 358 \text{ LB}$$

$$T = \frac{R'}{\cos(\theta)} = \frac{358 \text{ LB}}{\cos(61^\circ)} = 738 \text{ LB} < 9320 \text{ LB} *$$

MATERIAL: UNISTRUT IS ASTM A570 GR 33, 12 GA.; $E_t = 33,000 \text{ psi}$
 $A = 0.556 \text{ in}^2$ (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- $\frac{1}{2}$ " 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)

$\frac{1}{2}$ -13 FOR P1000

PULL-OUT STRENGTH: 2000 LB

SLIP RESISTANCE: 1500 LB

TORQUE: 50 FT-LB

DESIGN ANALYSIS

Client	WHL	WO/Job No.	ER 5735
Subject	W320-EQUIPMENT REMOVAL SYSTEM	Date	06/15/94
		By	R. A. Rupert
		Checked	06/30/94
		By	W. J. [Signature]
Location	241-C, 241-AV 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

$$\rho_s = \frac{12/4 \times 0.20 \text{ in}^2}{6" \times 12"} = 0.0037 > 0.0018 \text{ (REF. 6, 7.12.2.1)}$$

TOTAL SKID WT. IS 1400 LBS. $\Rightarrow$ VERY SMALL STRESS ON SLAB

$\therefore$ USE 6" CONCRETE ($f'_c = 4000$ PSI) SLAB W/ #4 @ 9" E.W. - ASTM A615, GR 60

WO/Job No. ER 5735

Date 06/15/94 By S. N. Rupert

Checked 6/30/94 By *[Signature]*

Revised By

A diagram of a horizontal beam of length $13\frac{1}{8}$ ft. A triangular load starts at 0 at the left end and increases linearly to $1\frac{1}{2}$ ft/lb at the right end. The load is represented by a triangle with a height of $1\frac{1}{2}$ ft/lb and a base of $13\frac{1}{8}$ ft. A point load P is applied vertically downwards at the right end of the beam. The beam is supported by a roller support at the left end and a pin support at the right end.

SECTION Y-Y

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

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

DESIGN ANALYSIS

Client WHC

WO/Job No. ER 5135

Subject W320 - EQUIPMENT REMOVAL SYSTEM

Date 06/15/94 By J. A. Rupert

Checked 6/30/94 By [Signature]

Location 241-C, 241-AV TANK FARMS

Revised By

1. CHECK STRESS ON W6X15 SKID BASE

[FOR W6X15 PROPERTIES SEE P. 3 OF CALCS.]

LOADS: SEE SKETCH IN APP. A OF CALCS.

PANELS/BEAMS: 340 LB, WIREWAY: 150 LB

UNISTRUT: P1001 - 3 * 5.5' (3.8 pft) = 63 LB

P1000 - 4 * 9.0' (1.9 pft) = 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 LOADS: MAX. WHEN PERPENDICULAR TO PANEL FRONT

SEE P. 4 OF CALCS.

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

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

$$F_p = 0.375 W_p$$

DESIGN ANALYSIS

Client WHC WO/Job No. ER 5735
Subject W320 - EQUIPMENT REMOVAL SYSTEM Date 06/15/94 By J.O. Ruppert
Checked 6/30/94 By W.D. Dore
Location 241-C, 241-A4 TANK FARMS Revised By

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

$$F = 18.2 \text{ psf} \times A_r \\ = 18.2 \text{ psf} (6' \times 9') = 983 \text{ lb}$$

$$W = W_{ER} + W_B + W_L$$

$$W_{ER} = \frac{\text{EQUIP WT}}{2} = \frac{621 \text{ lb}}{2} = 310 \text{ lb} \quad (\text{SEE p.H. OF CALCS.})$$

$$W_B = \text{WT. 6'x15' SKID BASE} = (2 \times 10' + 3 \times 3') 15 \text{ psf} = 435 \text{ lb}$$

$$W_L = 9' \times 3' \times 0.5' \times 150 \text{ psf} = 2025 \text{ lb}$$

$$M_R = 310 \text{ lb} \times 6" + 435 \text{ lb} \times 21" + 2025 \text{ lb} \times 21" = 53520 \text{ in-lb}$$

$$M_{OT} = F \times 36" = 18.2 \text{ psf} (9' \times 6') \times 36" = 35380 \text{ in-lb}$$

$$FS_{OT} = 1.5, \quad 1.5 \times M_{OT} = 53071 \text{ in-lb} < M_R = 53520 \text{ in-lb} \quad \text{OK}$$

SEISMIC

SEE p. 14 OF CALCS FOR LOADS

$$M_{OT} = 0.375 [150 \text{ lb} \times 54" + 471 \times 39" \times 2025 \times 3] \\ = 12204 \text{ in-lb} < \text{WIND } M_{OT} = 35380 \text{ in-lb}$$

$\Rightarrow$ WIND CONTROLS

$\therefore$ SKID #2 IS STABLE AS DESIGNED. FILL SKID BASE WITH CONCRETE

DESIGN ANALYSIS

Calc. No. W320-24-005
Revision 0
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Client <u>WHL</u>	WO/Job No. <u>ER 5735</u>
Subject <u>W320 EQUIPMENT REMOVAL SYSTEM</u>	Date <u>06/15/94</u> By <u>A. J. Rupert</u>
Location <u>241-C, 241-AV TANK FARMS</u>	Checked <u>06/30/94</u> By <u>John D. Doughton</u>
	Revised By

A. SIZE UNISTRUT COLUMNS & BEAMS USED FOR EQUIPMENT RACK

UNSUPPORTED COL. HT. = $60" - 6" - 24" = 36"$

SEISMIC LOADING - ON $\frac{1}{2}$ RACK

$W_p = \text{WT PANELS} + \text{WT WIREWAY} + \text{WT UNISTRUT}$
 $= 240 \text{ Lb} + 150 \text{ Lb} + (131/2) \text{ Lb} = 496 \text{ Lb}$ (ASSUME SAME LOADING ON BOTH HALVES OF RACK; CONSERV.)

$F_p = ZIC_p W_p = 0.375 * 496 \text{ Lb} = 171 \text{ Lb}$

$M_p = 171 \text{ Lb} * 36" = 6156 \text{ Lb-in}$ CENTER COL. CONTROLS

WIND LOADING - ON $\frac{1}{2}$ RACK

$F = 983 \text{ Lb}$ TOTAL; $\frac{1}{2}$ TO CTR COL. = 492 Lb

$M_F = 492 \text{ Lb} (36" - 24") = 5904 \text{ Lb-in}$

TRY P1001 UNISTRUT FOR COLUMNS

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

MAX. ALLOWABLE C SLOT FACE = $(60/13) 5960 = 5676 \text{ Lb}$

IMPUTE MAX ALLOWABLE MOMENT: $5676 * 1.625 = 9224 \text{ Lb-in}$ / P1001 COLUMN

COMBINE LOADS (D + W OR E, REF. 1, 2.3)

$M_x = (150 + 240) \text{ Lb} * 6" + 6156 \text{ Lb-in} = 8496 \text{ Lb-in} < 9224 \text{ Lb-in}$

CHECK: $S_x = 0.572 \text{ in}^3$ $F_y = 33 \text{ KSI}$ (REF. 2, p. 20, 25)

$f_b = \frac{M_x}{S_x} = \frac{8496 \text{ Lb-in}}{0.572 \text{ in}^3} = 14853 \text{ PSI} < 0.6 F_y = 19800 \text{ PSI}$ OK

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

DESIGN ANALYSIS

HNF-2481, Rev. U
Calc. No. W320-24-005
Revision 0
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Client <u>WHL</u>	WO/Job No. <u>ER 5735</u>
Subject <u>W320-EQUIPMENT REMOVAL SYSTEM</u>	Date <u>06/15/94</u> By <u>J. J. Rupert</u>
	Checked <u>06/30/94</u> By <u>R. W. Davidson</u>
Location <u>241-C, 241-AV TANK FARMS</u>	Revised _____ By _____

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

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

UNIFORM LOAD MAX: (REF. 2, P. 24)

$$60/54 \times 680 \text{ Lb} = 756 \text{ Lb} > 150 \text{ Lb} \text{ UNIFORM LOAD OF WIREWAY}$$

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

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

∴ 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/ $K = 1.0$.

$$\Rightarrow \text{MAX ALLOWABLE COMPRESSIVE LOAD} \\ = 7000 \text{ Lb} \text{ (REF. 2, P. 25)}$$

$$\text{LET } C = 7000 \text{ Lb}$$

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

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

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

DESIGN ANALYSIS

Client <u>WHL</u>	WO/Job No. <u>ER 5735</u>
Subject <u>W320-EQUIPMENT REMOVAL SYSTEM</u>	Date <u>06/14/94</u> By <u>J. D. Ruppert</u>
	Checked <u>4/30/94</u> By <u>W. J. D. Ruppert</u>
Location <u>241-C, 241-AV TANK FARMS</u>	Revised By

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

TOTAL SKID #2 WT

PANELS/BRRP 1621 LB

W6X15 BASE 458 LB

WT CONCRETE 2025 LB

3104 LB 548 3200 LB

$$\text{LOAD / } 1/2" \text{ FS. EYEBOLT} = \frac{3200 \text{ LB}}{4 \text{ BOLTS}} = 800 \text{ LB/BOLT}$$

MODEL W6X15 TOP FLANGE AS ($F_y = 36 \text{ ksi}$)

1. A IR W/ EDGES FIXED, SIMPLE, SIMPLE, FREE
2. A IR W/ EDGES SIMPLE, SIMPLE, SIMPLE, FREE

1. REF. B, p. 413, CASE 7a (CONSERVATIVE)

$$a/b = 4/3 = 1.33$$

$$\beta_1 = 1.08$$

$$\beta_2 = 0.574$$

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

$$q = \frac{800 \text{ LB}}{(2.5")^2} = 128 \text{ psi (CONSERV.)}$$

3/8" WASHER SIZE

$$t_f = 0.26"$$

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

DESIGN ANALYSIS

Client	WHC	WO/Job No.	ER 5735
Subject	W320-EQUIPMENT REMOVAL SYSTEM	Date	06/15/94
		By	John Ruppert
		Checked	6/30/94
		By	(WJ) (signature)
Location	241-L, 241-AY TANK FARMS	Revised	
		By	

$$\sigma_2 = \frac{B_2 q b^2}{t^2} = \frac{0.674 (128) (3)^2}{(0.26)^2} = 11486 \text{ psi} < 0.75 F_y \quad \text{OK}$$

@ CTR OF FREE EDGE

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

$$a/b = 3/4 = 0.75$$

$$\beta = 0.50$$

$$q = \frac{800 \text{ LL}}{(2.5')^2} = 128 \text{ psi (CONSERV.)}$$

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

∴ USE 1/2" FS EYEBOLT @ END OF STIFFENED W6X15 SKID BASE

7. SIZE FS, EYEBOLTS FOR LIFTING SKID #2

$$\text{TOTAL SKID WT} = 3200 \text{ Lb (SEE P. 18)}$$

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

USE ARMSTRONG 1/2" F.S. EYEBOLT # B9025 (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 (2GA.).

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.

NOTES:

1. ALL WORK TO BE PERFORMED PER SPECIFICATION W320-C1 (ER-4288).
2. UNISTRUT BEAMS SHALL BE GALVANNEAL COATED.
3. UNISTRUT COLUMNS SHALL BE GALVANNEAL COATED.
4. UNISTRUT BEAMS SHALL BE GALVANNEAL COATED.
5. UNISTRUT COLUMNS SHALL BE GALVANNEAL COATED.
6. UNISTRUT BEAMS SHALL BE GALVANNEAL COATED.
7. UNISTRUT COLUMNS SHALL BE GALVANNEAL COATED.

U.S. DEPARTMENT OF ENERGY	PRELIMINARY
CONTRACT NO. W320-24-005	APPENDIX A
PROJECT NO. H-2-820756	10
DATE: 10/1/82	10
BY: R.W. DAVIDSON, P.E.	10
CHECKED BY: R.W. DAVIDSON, P.E.	10
APPROVED BY: R.W. DAVIDSON, P.E.	10

W320-24-006

Distribution Panel Skid & Pad Design

**KAISER ENGINEERS
HANFORD****CALCULATION IDENTIFICATION AND INDEX**Page 1 of LLDate 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

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 EXPIRES 3/3/94

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	<u>James R Booth</u> 4-20/94		
Checked by	<u>Michael R. Gentry</u> 5/5/94		
Approved by	<u>R. Davidson</u> 5/17/94		
Checked Against Approved Vendor Data	<u>Ann Hanger</u> 4/1/98		

INDEXDesign 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)

CALCULATION CROSS INDEX (Typical)

Subject Calculation No. W320-24-006

Page ii of iii[illegible]

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	
<u> </u>	<u> ✓ </u>	1. Does the design or design change involved meet the established criteria to be considered Safety Class 1 or 2?
<u> </u>	<u> ✓ </u>	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?
<u> </u>	<u> ✓ </u>	3. Does this design or design change significantly affect the nuclear safety consequences of a malfunction or failure of the structure, system, or component?
<u> </u>	<u> ✓ </u>	4. Does this design or design change involve or change design that has previously undergone formal design verification?

<u> </u>	<u>5/17/94</u>
Assigned Lead Engineer	Date

<u> </u>	<u>5/17/94</u>
Responsible Discipline Manager	Date

Original Design Package Distribution:

Project Manager
Design Verification Officer
Engineering Document Control

Design Change Distribution:

Attach to Engineering Change Notice

DESIGN ANALYSIS

Calc. No. W320-24-006

Revision 0

Page No. 1 of 14

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

Objective: To design the steel skid and concrete pad to support the Distribution Panels shown on H-2-82749 sh.5 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, Ry. II
- 3) UBC (1991 edition)

Data: See H-2-820749 sh.5 & H-2-820752 sh.3 for size and weight of Distribution Panel.
 $f'_c = 4000 \text{ psi}$ Resteel $f_y = 60000 \text{ psi}$
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. II
 - 3) UBC 91
 - 4) AISC - LRFD ; 1st ED
 - 5) SDC 4.2, Rev. 0
 - 6) ACI 318-89
 - 7) UCRL 15910

DESIGN ANALYSIS

Calc. No. W320-24-006
Revision 0
Page No. 2 of 14

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

- Conclusion:
1. See attachment 1-1 for steel skid design.
 2. Attach Distribution Panel to skid with 4 - $\frac{1}{2}$ " ϕ 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 Hasnick, Electrical Lead Engineer for project W-320. Also see attachment 2.
 6. See ATTACH 1-2 for Pad design.

DESIGN ANALYSIS

Calc. No. W320-24-006
Revision 0
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Client	WHC	WO/Job No.	ED4289 / W-320
Subject	Distribution Panel Skid & Pad	Date	4-20-94 By JR Booth
Design		Checked	5/4/94 MIC
Location	200E	Revised	By

Snow: $p_g = 20 \text{ psf}$ (SDC 4.1 pg. 9)

Seismic: $F_p = ZICpW_p$ (UBC 1991)
where $Z = 0.2$
 $I = 1.25$ (SDC 4.1) $\therefore$ Apply force at CM
 $C_p = 0.75(2) = 1.5$
 $W_p = 1200 \text{ lb}$
 $F_p = (0.2)(1.25)(1.5)(1200 \text{ lb}) = 450 \text{ lb}$

Dead Loads: (Skid material sizes assumed)

 $\frac{1}{4}'' \text{ STEEL PL} = 11.26 \text{ psf}$ (LRFD pg. 1-122)

Distribution Panel = 1200 lbs

C 4 x 7.25 = 7.25 lbs/ft

W 6 x 9 = 9 lbs/ft

Two directional seismic effects per UCL 15910 pg. 4-30.

 $F_p = 450 \text{ lb}$ $F_p(90^\circ) = 450 \text{ lb}(0.3) = 135 \text{ lb}$ $F_T = (450^2 + 135^2)^{1/2} = 470 \text{ lb}$ (SRSS)

DESIGN ANALYSIS

HNF-2461, Rev. 0
Calc. No. W320-24-006
Revision 0
Page No. 5 of 14

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

Skid Conceptual Design: (See H-2-B20756 for Final design)

PLAN
Scale: $\frac{1}{2}" = 1'-0"$

Size Channels:

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

$$\text{Dead Load: } 11.26(2) + 7.25 = 30 \text{ \#/ft}$$

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

$$\text{Snow Load: } 20 \text{ psf}(2') = 40 \text{ \#/ft}$$

$$w_u = 1.2(30) + 1.6(120) + 0.5(40) = 248 \text{ \#/ft}$$

$$P_u = 1.4(1200) = 1680 \text{ lbs}$$

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

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

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

DESIGN ANALYSIS

HNF-2461, Rev. 0
Calc. No. W320-24-006
Revision 0
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Client	W/H	WO/Job No.	ER 4289 / W-320
Subject	Distribution Panel Skid & Pad	Date	4-20-94
Design		By	JR Booth
Location	200 E	Checked	5/4/94 MLC
		Revised	
		By	

$$M_u = 21.76 \text{ k-ft} = 26.1 \text{ in-kips (LRFD pg. 3-5)}$$

$$M_u \leq \phi M_n$$

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

$$\phi M_n = \phi Z_x 36$$

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

$$Z_x = 2.81 \text{ in}^3 \text{ for } C4 \times 7.25$$

C4 x 7.25 OK

Check Shear: $V_u = 1.3 \text{ kips}$

$$\phi V_n \geq V_u$$

$$\begin{aligned} \phi V_n &= 0.6 F_y A_w \\ &= (0.9)(0.6)(36)(1.28) \\ &= 24 \text{ kips} > 1.3 \text{ k} \end{aligned}$$

$$A_w = (4.0 \times 0.321) = 1.28 \text{ in}^2$$

OK For shear

Size W-Sections:

Load case is conserv.
when 1.3k is applied
to 3 locations.

$$\begin{aligned} M_u &= 4P + 9 \text{ k} / (1.2)(8) \\ &= 5.3 \text{ k-ft} \end{aligned}$$

DESIGN ANALYSIS

Calc. No. W320-24-006
Revision 0
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Client WHC WO/Job No. ER 4789 / W-320
Subject Distribution Panel Skid & Pad Design Date 4-20-94 By JR Booth
Checked 5/4/94 By MRC
Location 200F Revised _____ By _____

$M_u = 5.3 \text{ k}\cdot\text{ft}$ Try W 6 x 9
 $L_b = 2.0$ $L_p = 3.8$ Compact Section

Check $\phi_b M_u \leq \phi M_p$ where $C_b = 1.13$ - (LRFD Pg. 3-7)
 $1.13(5.3) = 5.99 \text{ k}\cdot\text{ft} \leq \phi M_p = 16.8 \text{ k}\cdot\text{ft}$ (LRFD Pg. 3-17)

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

$19.5 > 1.95$ OK

Check Steel P

$s = \frac{(1/2)(12)(1/4)^3}{12} = 0.125 \text{ in}^3/\text{ft}$

$w_u = 1.2(11.26 \times 1.0) + 1.6(60 \times 1.0) + 25(20 \times 1.0)$
 $= 119.5 \text{ #/ft}$
 $P_u = 1.4\left(\frac{1200}{3}\right) = 560 \text{ #}$

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

$F_b = \frac{4.1}{0.125} = 32.8 \text{ ksi} < F_b = 36 \text{ ksi}$ OK

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

DESIGN ANALYSIS

Calc. No. W32D-24-006
Revision 0
Page No. 8 of 14

Client WHC
Subject Distribution Panel Skid & Pad
Design
Location 200E
WO/Job No. ER4289 / W-320
Date 4-20-94 By JR Booth
Checked 5/1/94 By MLC
Revised By

Check Webs:

Check welds for shear.

(LRFD PG. 6-65)

$$\phi R_{nw} = (0.75)(0.132)(0.6)(70) = 4.16 \text{ kip/in} \leftarrow \text{controls}$$

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

$$\text{Vertical Load} = 1.3 \text{ K (from pg. 6)}$$

$$\text{Horizontal Load} = 0.525 \text{ K (from pg. 3)}$$

$$\text{Length of weld: Web } C4 \times 7.25 = 4 - 0.6875 + 4 - (2 \times 0.6875) = 5.94"$$

$$\text{Flange } C4 \times 7.25 = 1.75"$$

$$\text{Weld Capacity} = (1.75 + 5.94) 4.16 \text{ K/in} = 32 \text{ Kips}$$

$$\sqrt{(1.3)^2 + (0.525)^2} = 1.4 \text{ Kips}$$

OK

DESIGN ANALYSIS

Calc. No. W320-24-006
Revision 0
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Client WHC
Subject Distribution Panel Skid & Pad
Design
Location 200E

WO/Job No. ER4289 / W-320
Date 4-20-94 By JR Booth
Checked 5/4/94 By MRC
Revised By

Determine Required Bolt Sizes:

$F(\text{wind}) = 525 \text{ lbs} \leftarrow \text{governing shear}$
 $F(\text{seismic}) = 470 \text{ lbs}$

$$M_{OT}(\text{wind}) = (525)(46) - (45)T = 0$$

$$T = 537 \text{ lbs}$$

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

$$T = 960 \text{ lbs} \leftarrow \text{Governs}$$

$$T = 960/2 = 480 \text{ \#/bolt} \quad V = 525/2 = 262.5 \text{ lbs/bolt}$$

$$\phi R_n = 0.65(0.60 F_u^b) A_b$$

$$\phi R_n = 0.75(0.75 F_u^b) A_b$$

Shear (LRFD pg. 5-6)
Tension (LRFD pg. 5-3)

$$\phi R_n = 0.65(27)$$

$$\phi R_n = 0.75(45)$$

$$(0.129) = 2.3 \text{ kips/bolt}$$

$$(0.129) = 4.4 \text{ kips/bolt}$$

Try $\frac{1}{2}$ " Dia. A307 bolts

$\therefore 4 - \frac{1}{2}" \phi \text{ A307 bolts } \underline{OK}$ to secure Distribution
Panel to $\frac{1}{4}" \text{ PL}$.

DESIGN ANALYSIS

Calc. No. W320-24-006
Revision 0
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Client	WHC	WO/Job No.	ER4289 / W-320
Subject	Distribution Panel Skid & Pad	Date	4-20-94 By J.R. Booth
Design		Checked	5-5-94 By MEC
Location	200E	Revised	

Design Lifting Lugs:

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

$$\begin{aligned} \frac{1}{4} P &= (11.26)(4 \times 8) = 361 \\ 5 - C4 \times 7.25 \times 3.5 &= 127 \\ 2 - W6 \times 9 &= 144 \\ \hline &= 1832 \# \end{aligned}$$

Scale: 3" = 1'-0"

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

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

$$P_{u1} = 1282.5 \text{ lb} = 1.3 \text{ kips}$$

$$l_f = 4 \text{ in} \quad D = 3 \quad K = 0 \text{ (Special Case)} \quad C_1 = 1.0$$

$$a/l = 2" \quad a = 0.5 \quad C = 1.299 \quad (\text{Assume worst case of C})$$

$$P_u = (1.299)(1.0)(3)(4) = 15.6 \text{ kips} > P_{u1}$$

3/16" Fillet weld OK

DESIGN ANALYSIS

Client	WHC
Subject	Distribution Panel Skid & Pad
Design	200E
Location	200E
W/O Job No.	ER4289 / W-320
Checked	5-5-94 BV
Revised	BV

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

Design tensile strength:

$$\phi P_n = 0.25 A_g F_u = (0.75)(2)(0.5)(58) = 54.4 \text{ kips}$$

Design shear strength:

$$\phi P_n = 0.6 A_g F_u = (0.75)(0.6)(1.25)(58) = 32.63 \text{ kips}$$

$$A_g = 2(0.5)(1.25) = 1.25 \text{ in}^2$$

Check weak axis bending of 1/1 Fitting Lug:

$$S = \frac{I}{y} = \frac{6}{4(1.5)^2} = 0.17 \text{ in}^3$$

$$M_u = (1.3 \text{ kips})(2 \text{ in}) = 2.6 \text{ kip-in}$$

$$f_b = \frac{M_u}{S} = \frac{2.6}{0.17} = 15.3 \text{ ksi} < F_b = 36 \text{ ksi} \quad \text{OK}$$

∴ 1/1 Fitting Lug OK

Check Anchor PL's for Bending:

$$M_u = 343(2) = 0.7 \text{ k-in}$$

$$S = (7)(1.25)^2 = 0.07 \text{ in}^3$$

$$f_b = \frac{M_u}{S} = \frac{0.7}{0.07} = 10 \text{ ksi} < F_b = 36 \text{ ksi} \quad \text{OK}$$

DESIGN ANALYSIS

HN-2401, Rev. 0
Calc. No. W320-24-006
Revision 0
Page No. 12 of 14

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

Anchor Bolt Requirement:

$$M_{OT} = F_s(8.2') , F_w = 525$$

$$M_{OT} = 3859 \text{ #.ft}$$

Neglect moment from self weight.

$$T = \frac{3859 \text{ #.ft}}{4.17' (26 \text{ bolts})} = 343 \text{ #/bolts}$$

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

$$\left. \begin{array}{l} T_{ALLOW} = 1.2 K \\ V_{ALLOW} = 1.42 K \end{array} \right\} \text{Minimum embedment. (SDC 4.2, Table 18)} \\ (2 \frac{1}{4} ")$$

Maintain $6 \frac{3}{4} "$ min. between bolt and edge of slab.

∴ Use $4 \frac{1}{2} "$ HKB II @ Min Embedment of $2 \frac{1}{4} "$ to anchor skid

Design Concrete Pad (See H-2-B20755 sh.1 for final design)

DESIGN ANALYSIS

Client <u>W/HC</u>	WO/Job No. <u>ER4289 / W-320</u>
Subject <u>Distribution Panel Skid & Pad Design</u>	Date <u>4-20-94</u> By <u>JR Smith</u>
Location <u>200 E</u>	Checked <u>5-4-94</u> By <u>MRC</u>
	Revised _____ By _____

Determine Temperature Resteel:

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

$$A_s = 0.0018 \times 12 \times 6 = 0.13 \text{ in}^2/\text{ft}$$

Check Required Resteel for Flexure:

$P_u = 1.95 \text{ kips}$, from pg. 6 of calc.

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

$$M_u = 1.4 (75)(5.5)^2 / 8 + (1.95)(10.5) = 2103 \text{ ft-lb} = 25.2 \text{ in-kip}$$

$$\phi M_n \geq M_u$$

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

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

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

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

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

Assume #4 bars used.

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

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

DESIGN ANALYSIS

Client	W/HC	WO/Job No.	ER 4289 / W-320
Subject	Distribution Panel Skid & Pad	Date	4-20-94 By JR Booth
Location	Design 200E	Checked	5-5-99 By MKC
		Revised	By

Check Shear:

pg. 10, wt. for P_u for lifting lug

$$V_u @ \text{support} = 1.3 \times 615 = 1495 \text{ lbs (ACI sec. 11.3.1.1)}$$

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

$$\phi V_n = \phi 2 \sqrt{f_c'} b d = (0.85)(2) \sqrt{4000} (12)(2.75) = 3548 \text{ lb}$$

$$\phi V_n > V_u \quad \underline{\underline{OK}}$$

Check Over Turning Moment of Skid & Pad:

$$M_{OT} = 525(58) = 30.5 \text{ in-k}$$

$$W_{s\&p} = 1832 + (150 \text{ pcF})(0.5 \times 5 \times 9) = 5207 \text{ lbs}$$

$$M_R = 5207(30) = 156.2 \text{ in-k}$$

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

(per VBC sec. 2317)

Determine Development Length for Diagonal Bars @ Opening:

$$l_{db} = 0.04 A_b f_y / \sqrt{f_c'}$$

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

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

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

- NOTES:
1. FIELD TO LOCATE & INSTALL 4- $\frac{1}{2}$ " ϕ HKB II ANCHOR BOLTS.
 2. SECURE DISTRIBUTION PANEL TO SKID WITH 4" ϕ ASTM A307 BOLTS. MATCH LOCATION OF BOLT HOLES WITH BOLT HOLES IN DISTRIBUTION PANEL.

R.W. DAVIDSON, P.E.

PRELIMINARY 10/1/78		DATE 10/1/78	
PROJECT JR BOOTH		DRAWING NO. 3	
SHEET NO. 1		U.S. DEPARTMENT OF ENERGY RICHLAND OPERATIONS OFFICE ICF KAISSER HANFORD COMPANY	
NOTES SEE DR/AT FORM		STRUCTURAL	
SEE DR/AT FORM		ELECTRICAL SKIDS	
SEE DR/AT FORM		PLANS AND DETAILS	
JOB NO. 4		W-320 EQUIPMENT REMOVAL SYSTEM	
APPROVED FOR CONSTRUCTION W/HC		H-2-820756	
2 PLOT SCALE: 1/12		KEYCAD	
1		1

NORTH

DESIGNED BY PC BRINDMAN		SAFETY CLASS 3		REV PRELIMINARY	
U.S. DEPARTMENT OF ENERGY RICHMOND OPERATIONS OFFICE ICF KAISER HANFORD COMPANY STRUCTURAL MISCELLANEOUS PADS PLAN, SECTIONS & DETAILS					
DRAWN BY SEE DR/AT FORM CHECKED BY SEE DR/AT FORM APPROVED BY SEE DR/AT FORM		PROJECT NO. W320 EQUIPMENT REMOVAL SYSTEM DRAWING NO. H-2-820755 SHEET NO. 10			
REVISIONS 1. 28/04/02 12.0/01 2. 28/07/55A		2. PLOT SCALE: 1"=12' REH/DAD			

[illegible]

GP McDONALD PE

1. SYMBOLS PER ANSI Y4.15 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 TIED UP TO THE CABLE OPENING AND SHALL HAVE A TAIL OF AT LEAST THREE FEET. CONNECT GROUND TO DISTRIBUTION PANEL NEUTRAL BUS.

GENERAL NOTES:

CONDUIT NUMBERING LEGEND

ONLY FOR PERMANENT CDS ON THIS DWG

AT101-SP1

CONDUIT NUMBER SUFFIX

P = POWER
C = CONTROL
S = SIGNAL
T = TELEPHONE
X = DATA LINK

SAFETY CLASS 2 OR 3

BUILDING OR AREA DESIGNATION

DISTRIBUTION PANEL SKID

3 DETAIL 1 SH 1 SCALE: NONE

8
ELEVATION
SCALE: NONE

PLAN

Attachment 2-1

W320-24-007

Design Bracket That Clamps to a Crane
Boom to Support a Camera Pan/Tilt

Subject Calculation No. W320-24-007

Page ii of iii[illegible]

HNF-2461, Rev. 0

F-2

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?

Assigned Lead Engineer

7/18/94

Date

Responsible Discipline Manager

7/18/94

Date

Original Design Package Distribution:

Project Manager
Design Verification Officer
Engineering Document Control

Design Change Distribution:

Attach to Engineering Change Notice

DESIGN ANALYSIS

Client WHC

Subject W320 EQUIPMENT REMOVAL SYSTEM

WO/Job No. ER5735

Date 06/27/94

By J.G. RUPERT

Checked 7-14-94

By *Robert C. Campbell*

Location 241-C, 241-AY TANK FARMS

Revised

By

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.

DESIGN ANALYSIS

Client	WHC	WO/Job No.	ER 5735
Subject	W320 EQUIPMENT REMOVAL SYSTEM	Date	06/27/94
		Checked	7-14-94
Location	241-C AND 241-AY TANK FARMS	By	J. A. Rupert
		Revised	By Johnny C. Campbell

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 210-24P, WT. 15 LB

CAMERA: 15 LB, INCL. WEATHERPROOF ENCLOSURE.

WIND:

SPEED (BASIC) = 70 mph

I = 1.07

EXP. = C

} REF. 2, p. 8

$$F = q_z G_h C_f A_f \quad (\text{REF. 3, TABLE 4})$$

$$q_z = 0.00256 K_z (IV)^2 = 0.00256 (0.8)(1.07 \times 70)^2 = 11.5 \text{ psf}$$

$$G_h = 1.32 \quad (\text{REF. 3, TABLE 8}) \quad K_z = 0.80 \quad (\text{REF. 3, TABLE 6})$$

$$C_f = 2.0 \quad (\text{REF. 3, TABLE 13})$$

$$A_f = 16" \times 20" = 320 \text{ in}^2 \text{ OR } 2.2 \text{ FT}^2$$

$$F = 11.5 \text{ psf} (1.32)(2.0)(2.2 \text{ FT}^2) = 67 \# \quad \text{CONTROLS}$$

NOTE: THIS WIND FORCE IS VERY CONSERVATIVE SINCE THE EQUIPMENT REMOVAL OPERATION WILL NOT TAKE PLACE AT WIND SPEEDS > 10 mph.

SEISMIC: SC-3

$$I = 1.25 \quad (\text{REF. 2, p. 9})$$

$$W_p = 30 \text{ LB}$$

$$Z = 0.20 \quad (\text{REF. 4, TABLE 23I})$$

$$C_p = 2.0 + 0.75 = 1.50 \quad (\text{REF. 4, TABLE 23P \& SECT. 2336})$$

$$F_p = Z I C_p W_p = 0.2 (1.25)(1.5)(30 \text{ LB}) = 11.25 \text{ LB}$$

DESIGN ANALYSIS

Client WHC

WO/Job No. ER 5735

Subject W320 EQUIPMENT REMOVAL SYSTEM

Date 06/27/94 By J. R. Rupert

Checked 7-14-94 By Kathy C. Campbell

Location 241-C AND 241-AV TANK FARMS

Revised By

2. CHECK STRESS ON 3" CHANNEL BRACKET

$\Rightarrow P = 30 \text{ Lb}$ (ASSUME 2X 15 Lb EQUIV. LOAD, CONSERV.)

$$W = \frac{F}{15"} = \frac{67 \text{ Lb}}{15"} = 4.5 \text{ pli} \quad F = \text{WIND LOAD}$$

$$M_x = PL + \frac{WL^2}{2} = 30 \times 15 + \frac{4.5 (15)^2}{2} = 956 \text{ in}^{\circ}$$

TRY C3x4.1 $F_y = 36,000 \text{ psi}$

$$S_y = 0.202 \text{ in}^3 \quad t_f = 0.273" \quad (\text{REF. 1, p. 1-41})$$

$$b_f = 1.41" \quad t_w = 0.170"$$

$$f_{by} = \frac{M_x}{S_y} = \frac{956 \text{ in}^{\circ}}{0.202 \text{ in}^3} = 4734 \text{ psi} < 0.6 F_y \quad \text{OK} \quad (\text{REF. 1, p. 5-48})$$

 $\therefore$ USE C3x4.1 FOR PAN/TILT SUPPORT BRACKET

3. SIZE WELDS THAT ATTACH C3x4.1 TO L 2 1/2 x 2 1/2 x 1/4

$$\text{LET } P' = W + P \text{ LOAD} = 67 + 30 = 97 \text{ Lb} \quad (\text{CONSERVATIVE})$$

$$d = 1.41"$$

$$S_w = \frac{d^2}{3} = \frac{(1.41")^2}{3} = 0.66 \text{ in}^2 \quad (\text{TREAT WELD AS A LINE, REF. 5, p. 7-4})$$

$$M_w = PL = 97 \times 15" = 1455 \text{ in}^{\circ} \quad (\text{WIND + D.L. TAKEN @ END OF CANTILEVER})$$

$$f_w = \frac{M_w}{S_w} = \frac{1455 \text{ in}^{\circ}}{0.66 \text{ in}^2} = 2204 \text{ pli}$$

$$F_w = 0.1875" \times 0.7071 \times 0.3 \times 70,000 \text{ psi} \times 1" = 2784 \text{ pli} > f_w \quad \text{OK}$$

 $\therefore$ TWO 3/16" FILLET WELDS X 1.41" LONG ARE SUFFICIENT

DESIGN ANALYSIS

HNF-2401, REV. 0
Calc. No. W320-24-007
Revision 0
Page No. 4 of 4

Client WHC

WO/Job No. ER 5735

Subject W320 EQUIPMENT REMOVAL SYSTEM

Date 06/27/94

By J. M. Rupert

Checked 7-14-94

By Robert C. Campbell

Location 241-C AND 241-AV 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" x 1" x 1"
A36 MAT'L

$$f_b = \frac{PL}{bd^2/6}$$

$$\Rightarrow P_{max} = \frac{bd^2/6 \times F_u}{L}$$

$$= \frac{1" (0.25")^2 / 6 \times 0.75 F_u}{0.5"} = 542 \text{ Lb}$$

$$F_u = 36,000 \text{ psi}$$

USE AN ALLOWABLE $W = 280 \text{ Lb}$

(ALLOWS 100% F.S. FOR K FACTOR)
FULL PEN WELD OK

$$T = KDW \text{ (REF. 6, p. 9)}$$

$K = 0.20$ (FRICTION FACTOR FOR UNPLATED BOLT, DRY THREAD)

$D = \text{BOLT DIAMETER (IN.)} = 3/8"$

$T = \text{TORQUE (IN-LB)}$

$W = \text{AXIAL LOAD (LB)} = 280 \text{ Lb}$

$$T = 0.2 \times 0.375 \times 280 \text{ Lb} = 21 \text{ IN-LB}$$

FOR ASTM A307 BOLTS $F_u = 20,000 \text{ psi}$ (REF. 1, p. 1-3)

$$f_t = \frac{W}{A} = \frac{280 \text{ Lb}}{0.11 \text{ in}^2} = 2545 \text{ psi} < 20,000 \text{ psi} \quad \text{OK}$$

USE 4- 3/8" A307 BOLTS TORQUED TO 21 IN-LB TO CLAMP BRACKET TO CRANE

HNF-2461, Rev. 0

F-8

Total weight of
camera, cable and
Paint Telt
~ 15 lbs

LOAN COPY
Return to
TECHNICAL LIBRARY

Bob

For further information see

ASTM
A193 & A194

cy1

INTERNAL TECHNICAL REPORT

Master Copy

Title: DESIGN AID - FASTENERS

Organization: Mechanical Engineering Division

Author: J. P. Sekot

Checked By: _____

Approved By:

C. E. Friedrich

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TORQUE

HNF-2461, Rev. 0

F-10

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.

TOP VIEW
CHANNEL DETAIL
SCALE 1/4\"/>

2-1/2" OD TUBE

3" OD TUBE

FIT OF BRACKET ON CRANE TUBING
SCALE 1/4\"/>

FRONT VIEW
BRACKET
SCALE 1/4\"/>

RIGHT SIDE
SCALE 1/4\"/>

NOTES:

1. ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED.
2. BRACKET SHALL BE WELDED TO CRANE TUBING.
3. TUBING SHALL BE WELDED TO CRANE TUBING.

U.S. GOVERNMENT PRINTING OFFICE	
1975 O-280-226	1975 O-280-226
PAN/TITLE & CAMERA	
SUBMITTAL SHEET	
PROJECT NO. H-2-80026	
DATE 11-1-75	
BY J. H. HARRIS	
CHECKED BY J. H. HARRIS	
APPROVED BY J. H. HARRIS	
SCALE 1/4\"/>	

DISTRIBUTION SHEET

To Distribution	From JW Bailey	Page 1 of 1				
		Date 20 July 1998				
Project Title/Work Order Project W-320 Tank 106-C, HNF-2461, Civil/Structural Calculations, Vol. 1		EDT No. 622219				
		ECN No. n/a				
Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only	
JW Bailey	S2-48					
W-320 Project Files	R1-29					