AUG 07 1998

STATION 4 (25)

ENGINEERING DATA TRANSMITTAL

Page 1 of 1

1. EDT 622245

2. To: (Receiving Organization) Distribution	3. From: (Originating Organization) TWRS Projects/SST Retrieval	4. Related EDT No.: n/a
5. Proj./Prog./Dept./Div.: W-320 TWRS/TCPN # ~~D2MA1~~ D2991	6. Design Authority/ Design Agent/Cog. Engr.: JW Bailey, NHC	7. Purchase Order No.: n/a
8. Originator Remarks: For approval and release of a new supporting document. This document has been generated to ensure retrievability of the Project W-320 "Electrical Calculations, Vol. 1".		9. Equip./Component No.: n/a
		10. System/Bldg./Facility: 241-C-106
11. Receiver Remarks: 11A. Design Baseline Document? [X] Yes [] No		12. Major Assm. Dwg. No.: n/a
		13. Permit/Permit Application No.: n/a
		14. Required Response Date:

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	HNF-2487	-	0	Project W-320, 241-C-106 Sluicing, Electrical Calculations, Vol. 1	NA			-

16. KEY

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

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

(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN
2	1	Design Authority	JW Bailey	7/25/98	S2-48						
		Design Agent	MC Davenport	7/25/98							
2	1	Cog.Eng.	~~CE Graves~~		S2-48						
2	1	Cog. Mgr.	JW Bailey	7/25/98	S2-48						
		QA									
		Safety									
		Env.									

18.	19.	20.	21. DOE APPROVAL (if required) Ctrl. No.
MC Davenport ~~CE Graves~~ ~~7/24/98~~ 7/25/98		J.W. Bailey 7/25/98	[] Approved [] Approved w/comments [] Disapproved w/comments
Signature of EDT Originator Date	Authorized Representative for Receiving Organization Date	Design Authority/ Cognizant Manager Date	

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

BD-7400-172-1

Project W-320, 241-C-106 Sluicing Electrical Calculations, Vol. 1

John W. Bailey
Numatec Hanford Co., Richland, WA 99352
U.S. Department of Energy Contract DE-AC09-96RL13200

EDT/ECN: 622245 UC: 506
Org Code: 8C452 Charge Code: D2991/HANA0600
B&R Code: EW3130010 Total Pages: 300

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

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

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Karen J Broz 8/7/98
Release Approval Date Release Stamp

Coversheet page 1 of 2

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Project W-320, 241-C-106 Sluicing Electrical Calculations, Vol. 1

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W320-31-017	Tank AY-102 Load Determination, Feeder/Protection Sizing, Voltage Drop, Lighting and Conduit Sizing Calculations	G-i

W320-31-001

Fault Current Analysis

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CALCULATION IDENTIFICATION AND INDEX

Page i of iii
Date 2/25/94

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

Discipline: ELECTRICAL WO/Job No. W320 / ER4289 Calculation No. W320-31-001

Project No. & Name: W320 EQUIPMENT REMOVAL SYSTEM

Calculation Item: FAULT CURRENT ANALYSIS

These calculations apply to:

Dwg. No. H-2-820748 SH1 Rev. No. 0

Dwg. No. H-2-820749 SH1, SH2 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	J Abdel Rosario 2/25/94		
Checked by	Dan Larson 5/27/94		
Approved by	T Kranik 8/31/94		
Checked Against Approved Vendor Data	T Kranik 7/24/98		

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2	FEEDER CABLES, TRANSFORMER BANK MVA
3, 4, 5	METHOD OF CALC., FORMULAS, CALCULATIONS
6	ONE LINE DIAGRAM, PER UNIT IMPEDANCE DIAGRAM
7, 8	FAULT IMPEDANCE Z_{FX}, FAULT MVA_{FX}, FAULT CURRENT I_{FX}
9, 10	SUMMARY OF Z_{FX}, MVA_{FX}, I_{FX}, CB CLEARING TIME, MT, TDT; FINDINGS & CONCLUSIONS
~~APPENDICES~~ A-1 THRU A-7	3Ø FAULT CALC. BY UTILITIES, COND. MELTING CURVE, INS. THERMAL DAMAGE CURVE BREAKER TIME CURRENT CURVES.

9/92

CALCULATION CROSS INDEX (Typical)

Subject Calculation No. W320-31-001

Subject Calculation Revision No.	Superceded by Calculation No.	These interfacing calculation/documents provide input to the subject calculation, and if revised may require revision of the subject calculation.		Results and conclusions of the subject calculation are used in these interfacing calculations and/or documents.		Does the output interface calculation/ documents require revision?		Has the output interface calculation/ documents been revised?		Discipline manager's signature and date indicating evaluation complete.
		Calculation/Document No.	Revision No.	Calculation/Document No.	Revision No.	Yes	No	Yes	No	
0	N/A			H-2-820748 SH.1	0		✓		✓	
				H-2-820749 SH.1 & 2	0		✓		✓	

SFS No. _____

DESIGN VERIFICATION SCREENING CRITERIA

Project/Document No. W320 / W320-31-001

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?

J Kosnik — Assigned Lead Engineer — Date: 7/19/94

Responsible Discipline Manager — Date

Original Design Package Distribution:

Project Manager

Design Verification Officer

Engineering Document Control

Design Change Distribution:

Attach to Engineering Change Notice

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DESIGN ANALYSIS

Calc. No. W320-31-001
Revision 0
Page No. 1 of 10

Client WHC
WO/Job No. ER 4285
Subject FAULT CURRENT ANALYSIS, FEEDER CABLE & CB SIZING
Date 2/25/94 By J.C. DEL ROSARIO
Checked 5/27/94 By D.E. Larson
Location TANK FARM C, 200 EAST AREA
Revised By

1. OBJECTIVE: THE PURPOSE OF THIS CALCULATIONS IS TO SUPPORT W320 TANK 241-C-106 IN-TANK EQUIPT. REMOVAL PHASE. THE MAXIMUM FAULT CURRENTS THAT THE CIRCUIT BREAKER WILL BE REQUIRED TO INTERRUPT WILL BE DETERMINED TO PROPERLY SELECT THE CIRCUIT BREAKERS THAT WILL PROTECT THE FEEDER CABLES.

2. REFERENCES:
   A. G.E. INDUSTRIAL POWER SYSTEM COORDINATION
   B. WEST. CATALOG 55-000 10TH ED. 1991-1992
   C. 1993 NEC
   D. 3ϕ FAULT CALC. AT TANK FARM - FROM ELECTRICAL UTILITIES ENG'G.
   E. INDUSTRIAL POWER SYSTEM HANDBOOK BY BEEMAN
   F. GE CB T-C CURVES G. CU COND MELTING TEMP. H. CABLE SC WITH STAND CURVE

3. DATA:

LOAD DATA

HPPT- HIGH PRESS. PUMP TRLR - (ELECT SYST BY WHC/VENDOR) INFO FURNISHED BY WHC

MAIN PUMP MOTOR -	100 HP, 3ϕ, 480V	- 124A	
BOOSTER PUMP -	2 HP, 3ϕ, 480V	- 3.4A	ONE USED AT A TIME
HOSE REEL MOTOR -	2 HP, 3ϕ, 480V	- 3.4A	
OTHER LOADS	3ϕ, 480V	- 0.5A	AMPACITIES FROM NEC
TOTAL CONNECTED LOAD		- 127.9A	

100 HP MAIN PUMP MOTOR HAS 150A BRANCH CB & 200A FUSES INSTALLED BY THE PUMP AND CONTROLLER VENDOR TO LIMIT THE STARTING & RUNNING CURRENT INPUT TO THE VARIABLE FREQUENCY CONTROLLER.
THE 100 HP INDUCTION MOTOR WILL BE STARTED AT LOW SPEED (AND STARTING CURRENT), THEN ACCELERATED TO REQUIRED PUMP OPERATING SPEED.

SBT STRONG BACK TRAILER - 50A, (ESTIMATE)
LATEST INFO FROM WEST. IS THAT 2-10HP, 3ϕ, 460V MOTORS WILL ALTERNATELY BE USED. THE OTHER LOADS ARE NOT YET AVAILABLE.

SPT - SINGLE PHASE TRANSFORMER BANK - 1-50KVA, 1ϕ, 480-120/240V FOR CONSTRUCTION TRAILERS

70A, 120/240V, 1ϕ SERVICES FOR 3 TRAILERS FOR KEH CONSTRUCTION FORCES.

3- CONSTRUCTION TRAILERS @ 15KVA CONN. LOAD EA = 45 KVA.

3. DATA

CABLES:

a) 13.8KV PRIMARY — 3-1/C #2 AWG, CU, 15KV INS, IN 3" STL C
b) 480V SECONDARY — 3/C CU, TYPE MC (STEEL ARMOR WITH GRD COND, DIRECT BURIAL

CABLE TAG/ID	SIZE (AWG	Z(L-N) Ω PER 1000 FT REF A p 35/36	FROM	TO	LENGTH (FT)	Z(L-N) OHMS	REMARKS
13.8KV PRI	#2	.210	POLE E0257	TRANSF T1	400	.084 Ω	
480V SEC	2-350 KCMIL	.027	TRANSF T1	CDDP-1	50	.00135Ω	
IT	2/0	.11	CPDP-1	CT	400	.044 Ω	
HPP	4/0	.0745	CPDP-1	HPP	400	.03 Ω	
SBT	2	.207	CPDP-1	SBT	500	.104 Ω	
SPT	1/0	.135	CPDP-1	SPT	70	.01 Ω	SHORTEST RUN
ST	4	.325	SPT	ST	50	.016 Ω	

• SEE DWGS. H-2-820749 SH1 & SH2 FOR CABLE LENGTH

13.8 KV 3Ø TRANSF — Z_t PU REF A p 22

DRY-TYPE 50 KVA, 1Ø, 600 CLASS TRANSF FOR CONST. TRAILER

FULL WINDING %R, %X, %Z REF E TABLE 1.17 p 96
%R = 1.3%, %X = 2.2% %Z = 2.6%

HALF WINDING (120V) %R, %X REF E p 748 T5
$\%R_{HALF\ WDG}$ = 1.44 x 1.3 = 1.87%, $\%X_{HALF\ WDG}$ = 1.2 x 2.2 = 2.64%

$\%Z_{HW} = \sqrt{(1.87)^2 + (2.64)^2} = 3.2\%$ = TRANSF. IMPEDANCE OF 120V WINDING

PAD MOUNTED TRANSF. BANK 3Ø MVA = .225 MVA

%Z = 4.43 ON .225 MVA BASE (FROM TRANSF. NAMEP

4. METHOD OF CALCULATIONS :

MANUAL METHOD USING PER UNIT FAULT CURRENT CALCULATIONS PER REFERENCE A.

5. FORMULAS

PER UNIT IMPEDANCES ON MVA BASE

UTILITY SYSTEM:

$Z_{UT.SYST}$ IN PER UNIT $= \dfrac{\text{MVA BASE}}{\text{MVA SC UTILITY SYTEM}}$ REF A P31

FEEDER CABLE:

$Z_{PU\,(L-N),\,FDR} = \dfrac{Z_{OHM\,(L-N)} \times \text{KVA BASE}}{KV^2 \times 1000}$ REF A

$= Z_{OHM\,(L-N)} \left(\dfrac{\text{MVA BASE}}{KV^2}\right)$

TRANSFORMER:

Z_{T} (IN PER UNIT ON 10 MVA BASE) $= Z_{t\,pu}$ (on own MVA) $\times \dfrac{\text{MVA BASE}}{\text{MVA}t}$ REF A P34

MOTOR:

Z_M IN PER UNIT ON 10 MVA BASE $= Z_{m\,pu}$ (on own MVA) $\times \dfrac{\text{MVA BASE}}{\text{MVA}m}$ $Z_{m\,pu}$ (REF A P21 on motor base & P33)

$Z_{FX} = \Sigma$ Z PER UNIT FROM UTILITY SYSTEM TO POINT OF FAULT
$= Z_{UT.SYST} + Z_T + Z_{FDR}$

WHERE F1 = FAULT AT PDP (POWER DIST. PNL) BUS
F2 = FAULT AT HPP
F3 = FAULT AT CT CB LOAD SIDE
F4 = FAULT AT SBT CB
F5 = FAULT AT SPT PRIMARY SIDE OF SPT
F6 = FAULT AT ST (SERVICE TRAILERS)

$MVA_{FX} = \dfrac{\text{MVA BASE}}{Z_{FX}}$ = SHORT CIRCUIT MVA AT POINT OF FAULT FX REF A P37

$I_{FX}\,(kA) = \dfrac{MVA_{FX}}{\sqrt{3}\ KV}$ WHERE KV = PREFAULT VOLTAGE IN KILOVOLTS AT POINT OF FAULT REF A P 37

Client WHC		WO/Job No. ER 4289	
Subject FAULT CURRENT ANALYSIS FEEDER CABLE & CB SIZING		Date 2/25/94	By J.C. DEL ROSARIO
		Checked 5/27/94	By Dan Larson
Location TANK FARM C, 200 EAST AREA		Revised	By

5. FORMULAS

WHERE: MVA BASE = 10 (CHOSEN BASE - SEE REF A)
MVA SC = 50 (ELECT. UTILITIES CALC - REF D)
KV = PREFAULT VOLTAGE IN KILOVOLT AT POINT OF CALCULATION.

$Z_{OHM\ (L-N)}$ = LINE TO NEUTRAL IMPEDANCE OF FEEDER CABLE IN OHMS

$Z_{FDR\ IN\ P.U.}$ = FEEDER CABLE (L-N) PER UNIT IMPEDANCE ON 10 MVA BASE

$\%Z_t$ = TRANSF. % IMPEDANCE ON ITS OWN MVA

$Z_{T\ IN\ P.U.}$ = TRANSF. PER UNIT IMPEDANCE ON 10 MVA BA

$\%Z_m$ = MOTOR % IMPEDANCE ON ITS OWN MVA

$Z_{m\ IN\ P.U.}$ = MOTOR PER UNIT IMPEDANCE ON 10 MVA BASE

$$Z_{UT\ SYST\ IN\ P.U.} = \frac{\text{MVA BASE}}{\text{MVA SC (UT. SYST)}} \quad P3$$

NOTE THAT $Z_{UT\ SYST\ P.U.}$ DECREASES AS THE AVAILABLE S.C. MVA SC FROM UTILITY SYSTEM INCREASES. FOR INFINITE UTILITY BUS $Z_{UT\ SYST}$ IS IGNORED. ($Z_{UT} = 0$)

FOR INFINITE UTILITY BUS:

$$MVA_{FI} = \frac{\text{MVA BASE}}{Z_{FI}} = \frac{\text{MVA BASE}}{Z_{UT\ SYST} + Z_{T\ (P.U.)}} = \frac{\text{MVA BASE}}{Z_{T\ (P.U.)}} \quad P3$$

(AT PDP SEC. BUS) ($Z_{UT} = 0$)

13.8 KV LINE IMPEDANCE IS NEGLECTED.

$$MVA_{FI} = \frac{\text{MVA BASE}}{\frac{\%Z_T}{100}\left(\frac{\text{MVA BASE}}{MVA_T}\right)} = \frac{MVA_T}{\frac{\%Z_T}{100}} = \frac{MVA_T}{Z_{T\ (P.U.)}} \quad P3$$

FAULT MVA_{FI} AT TRANSFORMER SECONDARY TERMINAL (FI) NEGLECTING $Z_{UT.\ SYST.}$ (INFINITE UTILITY BUS) IS DIRECTLY PROPORTIONAL TO THE BANK CAPACITY AND INVERSEL PROPORTIONAL TO $\%Z_T$ OR $Z_{T\ (P.U.)}$

FOR 225 KVA BANK, $MVA_{FI} = \frac{.225}{.0443} = 5.08$ MVA

Client WHC
WO/Job No. ER4289
Subject FAULT CURRENT ANALYSIS FEEDER CABLE & CB SIZING
Date 2/25/94 By J.C. DEL ROSARIO
Checked 5/27/94 By Don Jensen
Location TANK FARM C 200 EAST AREA
Revised By

6 CALCULATIONS:

CONSIDER WORST CASE OF SHORT-CIRCUIT CONDITION — 3Ø BOLT FAULT FOR ALL 3Ø LOADS AND 120V L-G FAULT FOR 120/24 1Ø, 3W CONSTRUCTION TRAILER SERVICE.

MVA BASE = 10, $\frac{MVA\ BASE}{KV^2}$, FOR 480V $= \frac{10}{(.48)^2} = 43.4$

FOR 13.8 KV $= \frac{10}{(13.8)^2} = 0.0525$

PER UNIT IMPEDANCE ON MVA BASE:

a) $Z_{UTILITY\ SYSTEM} = \frac{MVA\ BASE}{MVA_{SC\ UT.\ SYST}} = \frac{10}{50} = .2$ PU

b) $Z_{13.8\ KV\ PRI} = Z_{OHM\ (L-N)}\left(\frac{MVA\ BASE}{KV^2}\right) = .084 \times 0.0525 = .0044$ PU (FROM P2) (NEGLIGIBL

(c) $Z_{3\phi\ TRANSF} = \frac{\%Z}{100} \times \frac{MVA\ BASE}{MVA_T} = \frac{4.43}{100} \times \frac{10}{.225} = 1.97$ P.U.

(d) $Z_{1\phi\ TRANSF} = \frac{3.2}{100} \times \frac{10}{.05} = 6.4$ P.U.

(e) $Z_{480V\ FEEDER\ CABLES} = Z_{OHM\ (L-N)}\left(\frac{MVA\ BASE}{KV^2}\right)$ — 43.4

$Z_{SEC\ (L-N)} = .00135 \times 43.4 = .059$ P.U. (NEGLIGIBLE

$Z_{IT\ (L-N)} = .044 \times 43.4 = 1.91$ PU.

$Z_{HPP\ (L-N)} = .03 \times 43.4 = 1.3$ P.U.

$Z_{SBT\ (L-N)} = .104 \times 43.4 = 4.5$ P.U.

$Z_{SPT\ (L-N)} = .01 \times \frac{10}{(.48)^2} = .434$ P.U.

$Z_{ST\ (L-N)} = 0.016 \times \frac{10}{(.12)^2} = 11.11$ PU.

(f) $Z_{MOTOR\ P.U.\ ON\ 10\ MVA\ BASE} = Z_{m\ PU\ ON\ MOTOR\ BASE} \times \frac{MVA\ BASE}{MVA_T}$

MOTOR CONTRIBUTION IS NOT INCLUDED SINCE THE VARIABLE FREQUENCY CONTROLLER WILL NOT PASS THE MOTOR CONTRIBUTION TO THE SUPPLY SIDE.

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DESIGN ANALYSIS

Calc. No. W320-31-001
Revision 0
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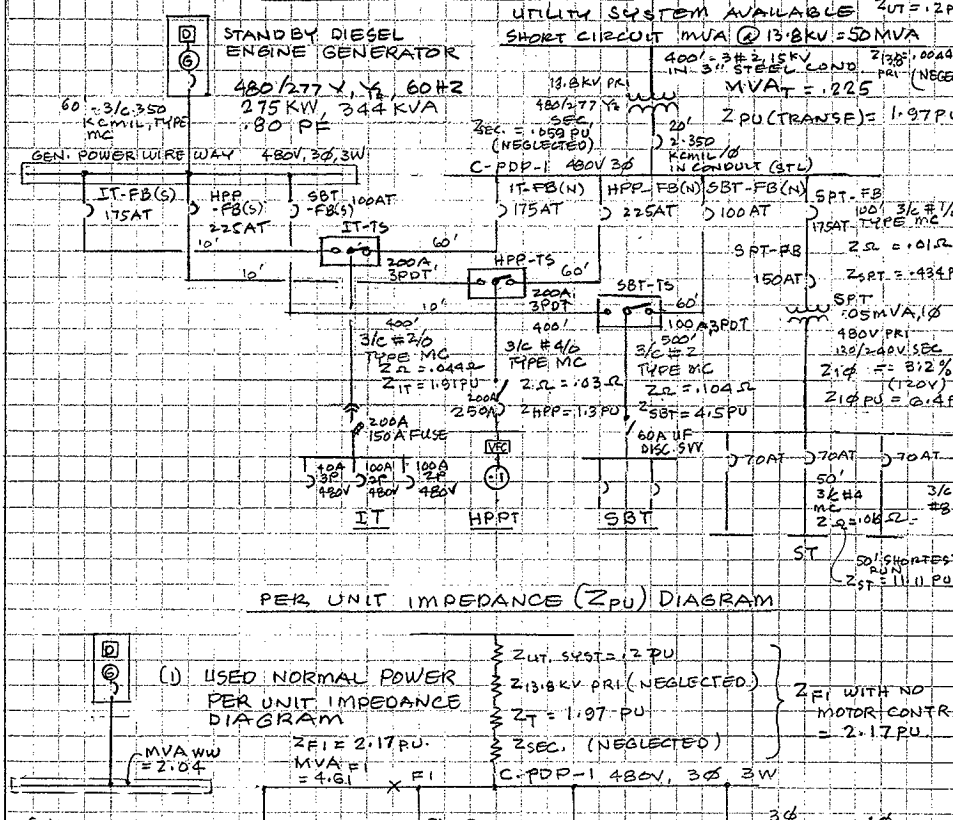
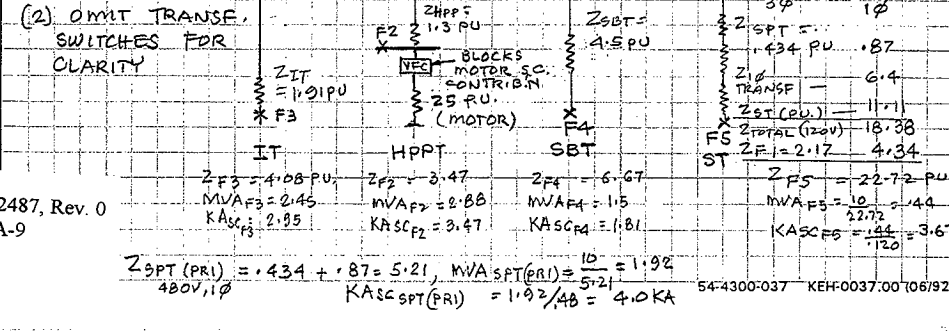
Client WHC
WO/Job No. ER 4289
Subject FAULT CURRENT ANALYSIS FEEDER CABLE & CB SIZING
Date 2/25/94 By J.C. DEL ROSARIO
Checked 5/27/94 By Don Jordan
Revised By
Location TANK FARM C, 200 EAST AREA

ONE LINE DIAGRAM



PER UNIT IMPEDANCE (Z_{PU}) DIAGRAM



$Z_{SPT\,(PRI)} = .434 + .87 = 5.21$, $MVA_{SPT(PRI)} = \frac{10}{5.21} = 1.92$
480V, 1Ø
$KASC_{SPT(PRI)} = 1.92/.48 = 4.0$ KA

Client WHC
WO/Job No. ER4289
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FEEDER CABLE & CB SIZING
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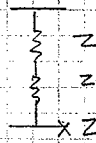
Checked 5/27/94 By D. Jonson
Location TANK FARM C, 200 EAST AREA
Revised By

100 HP MOTOR WILL NOT PASS MOTOR CONTRIBUTION TO FAULT THRU VARIABLE FREQUENCY CONTROLLER.

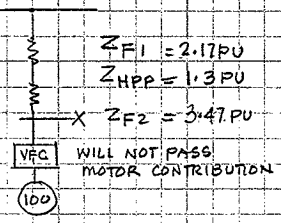
FAULT AT CPDP-1 MAIN CB (F1)



$$MVA_{F1} = \frac{10}{Z_{F1}} = \frac{10}{2.17} = 4.61 \text{ MVA}$$

$$I_{F1} = \frac{MVA_{F1}}{\sqrt{3} \times .48} = 5.5 \text{ KA}$$

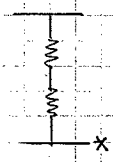
FAULT AT HPPT (F2)



$$MVA_{F2} = \frac{10}{Z_{F2}} = \frac{10}{3.47} = 2.88 \text{ MVA}$$

$$I_{F2} = \frac{MVA_{F2}}{\sqrt{3} \times .48} = 3.47 \text{ KA}$$

FAULT AT IT (F3)



$$MVA_{F3} = \frac{10}{Z_{F3}} = \frac{10}{4.08} = 2.45 \text{ MVA}$$

$$I_{F3} = \frac{MVA_{F3}}{\sqrt{3} \times .48} = 2.95 \text{ KA}$$

Client WHC
WO/Job No. ER4289
Subject FAULT CURRENT ANALYSIS
Date 2/25/94 By J C DEL ROSARIO
FEEDER CABLE & CB SIZING
Checked 5/27/94 By Don Jansen
Location TANK FARM C 200 EAST AREA
Revised By

FAULT AT SBT (F4)

$Z_{F1} = 2.17$ PU

$Z_{SBT} = 4.5$ PU

$Z_{F4} = 6.67$ PU

$MVA_{F4} = \frac{10}{Z_{F4}} = \frac{10}{6.67} = 1.50$ MVA

$I_{F4} = \frac{MVA_{F4}}{\sqrt{3} \times .48} = 1.81$ KA

1Ø FAULT AT ST PRI (F5)

	3Ø (L-N)	1Ø (L-L)	
Z_{F1} =	2.17 PU	4.34 PU	5.21 PU
Z_{SPT}	.434 P.U.	.87 PU	
$Z_{1Ø\ TRANSF}$	-	6.4 PU	
Z_{ST} =	-	11.11 PU	
		Z_{F5} = 22.72 PU	

F5

$MVA_{SPT\ PRI} = \frac{10}{5.21} = 1.9$

$I_{SPT\ PRI} = \frac{1.92}{.48} = 4.0$ (480V, 1Ø)

$MVA_{F5} = \frac{10}{Z_{F5}} = \frac{10}{22.72} = .44$ MVA

$I_{F5} = \frac{MVA_{F5}}{.12} = \frac{.44}{.12} = 3.67$ KA

STANDBY GENERATOR:
AVAILABLE MVA_{SC} AT GEN. POWER WIREWAY WITH 275KW (344 KVA) STANDBY GEN WITH 60' - 3/C 350 KCMIL FEEDER TO WIREWAY ASSUME Z_d'' gen = 15%

MVA_{SC} GEN = 344 / .15 = 2.29 MVA, $Z_{PU\ GEN} = \frac{10\ MVA\ BASE}{2.29} = 4.366$

$Z\ \Omega$ OF 60' 3/C 350 kcmil = .06 x .21 = .0126 Ω

Z_{PU} = .0126 x 43.4 = .547 PU

$Z_{TOTAL(GPW)}$ AT WIREWAY = Z_{PU} (GEN) + Z_{PU} (FEEDER)
= 4.36 PU + .547 PU = 4.9 PU AT THE WIREWAY

MVA_{SC} AT THE WIREWAY = $\frac{10\ MVA\ BASE}{Z_{TOTAL}} = \frac{10}{4.9} = 2.04$ MVA

STANDBY GEN I_{GPW} (KA) = 2.04 / $\sqrt{3}$ x .480 = 2.46 KA (RMS SYMM)

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

KAISER ENGINEERS
HANFORD

DESIGN ANALYSIS

Calc. No. W320-31-001
Revision 0
Page No. 9 of 10

Client WHC
WO/Job No. ER 4289
Subject FAULT CURRENT ANALYSIS FEEDER CABLE & CB SIZING
Date 2/25/94 By J.C. DEL ROSARIO
Checked 5/27/94 By
Revised By
Location TANK FARM C

SUMMARY OF 3Ø SHORT CIRCUIT MVA (MVAsc) FAULT CURRENTS IN KILO AMPS (KAsc) AND PER UNIT IMPEDANCE (ZF P.U.) AT POINT OF FAULT. BASED ON NORMAL POWER (13.8KV TRANSF) SOURCE.

NORMAL: 480 VOLT 3Ø — 120/240V, 1Ø

FAULT LOCATION / UNITS	PDP MAIN CB	F1	HPPT	F2	IT	F3	SBT	F4	FAULT LOCATION / UNITS	ST	F5
ZF PU (L-N)	2.17		3.47		4.08		6.67		ZF PU (L-L)	22.72	
MVAsc	4.61		2.88		2.45		1.50		MVAsc	.44	
KAsc (L-L)	5.5		3.47		2.95		1.81		KAsc (L-L)	3.67	

275KW/344KVA STANDBY GEN	MVAsc	Z TOTAL @ GPW IN P.U.	Isc @ GPU IN KA	REMARKS
	2.04	4.9	2.48	GEN. Isc = 2.46KA NORM. PWR IF1 = 5.5 K USED 10KA CB'S.

BREAKER CLEARING TIME (CT) USING G.E MOLDED CASE CIRCUIT BREAKERS TO PROTECT FEEDER CABLES TO TRAILERS, GROUND CONDUCTOR MELTING TIME (MT) FOR GROUND FAULT CURRENT MAGNITUDE ASSUMED EQUAL TO 3Ø FAULT, INSULATION WITHSTAND TIME (THERMAL DAMAGE TIME IN SEC - TDT ARE SUMMARIZED BELOW:

LOAD (FAULT, FX)	① FAULT KA	CB TRIP	② (①×1000)/(③) MULT. OF TRIP	WIRE SIZE PHASE	WIRE SIZE GRD	A-4, A-5, A-6 CB CT (s)	A-2 GRD WIRE MT (s)	A-3 PHASE WIRE INS TDT (s)	REMARKS
HPPT (F2)	4	225	18	4/0	4	A-4 (.0325)	>10S	8.0	OK
IT (F3)	3	175	17	2/0	6	A-4 (.0305)	>10S	5	OK
SBT (F4)	2	100	20	2	6	A-5 (.0215)	3.5	3	OK
SPT -	4 SEE SDT.P6	150	25	1/0	6	A-6 (.025)	.9	2	OK
ST (F5)	3.67	70	5.2	4	6	A-5 (.0195)	1.1	.4	OK

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

5. FINDINGS AND CONCLUSIONS:

THE SUMMARY OF 3Ø FAULT CURRENTS SHOWS MAXIMUM FAULT OF APPROXIMATELY 5.5KA AT THE 225 KVA TRANSFORMER SECONDARY TERMINALS. THE FAULT MAGNITUDE VARIES FROM 1.81 TO 3.47KA AT THE DIFFERENT ER TRAILERS, AT THE NEAREST CONSTRUCTION TRAILER FAULT ACROSS THE 120VAC TERMINALS IS 3.67KA.

MOLDED CASE CB WITH MINIMUM INTERRUPTING RATING OF 10 KA AT 480V SHALL BE USED. THE TRANSFER SWITCHES SHALL HAVE THE SAME INTERRUPTING RATING AS THE CB'S. THE USE OF HIGHER IC ON THE RE-USABLE TRANSFER SWITCHES/BREAKERS SKID WILL PERMIT ITS USE ON LOCATIONS WITHIN ITS IC DUTY. FOR THE SINGLE PHASE 120/240V TRAILERS 240V, 2P MOLDED CASE CB'S WITH 5KA INTERRUPTING RATINGS SHALL BE USED

THE BREAKERS WILL CLEAR THE FAULT BEFORE INSULATION ARE DAMAGED DUE TO OVERHEATING AND THE GROUND CONDUCTORS MELT AS INDICATED IN THE TABLE SUMMARIZING BREAKER CLEARING TIME, INSULATION THERMAL DAMAGE TIME AND GROUND WIRE MELTING TIME.

Calculations by Jim Webber of Electrical Utilities Engineering. James J. Webber 11/6/93

3-Phase Fault Duty at AY Tank Farm. Fault duty is calculated at the 13.8kV side of the 3-25KVA transformers.

$I_f := 2200 \cdot amp \quad X_R := 2.97$

Three phase fault current and X/R ratio at point previously calculated (node 6500 of H-2-818278 Sheet 6, Rev.0).

$MVA_B := 100 \cdot 10^6 \cdot volt \cdot amp \quad kV_B := 13.8 \cdot 10^3 \cdot volt$

$$I_B := \frac{MVA_B}{\sqrt{3} \cdot kV_B} \qquad Z_B := \frac{kV_B^2}{MVA_B}$$

$Z_9 := 0.00841 + 0.01846j \quad Z_{10} := 0.01137 + 0.02497j$

$Z_{96} := 0.01256 + 0.01893j \quad Z_{97} := 0.02746 + 0.04141j$

$Z_{126} := 0.12516 + 0.03578j$

Positive sequence impedances of line segments between the calculation point and the point of previous calculation.

$$Z_{pu} := \left(\frac{I_f}{I_B}\right)^{-1}$$

$$Z_{FB} := \sqrt{\frac{Z_{pu}^2}{1 + X_R^2}} + X_R \cdot \sqrt{\frac{Z_{pu}^2}{1 + X_R^2}} \cdot j$$

Per unit impedance at the upstream fault box.

$Z_{Tpu} := Z_{FB} + Z_9 + Z_{10} + Z_{96} + Z_{97} + Z_{126}$

$I_{Tpu} := (|Z_{Tpu}|)^{-1}$

$Z_{Tpu} = 0.79178 + 1.94181j$

Total positive sequence per unit impedance at calculation point (100MVA base).

$F_{3\Phi} := I_{Tpu} \cdot I_B$

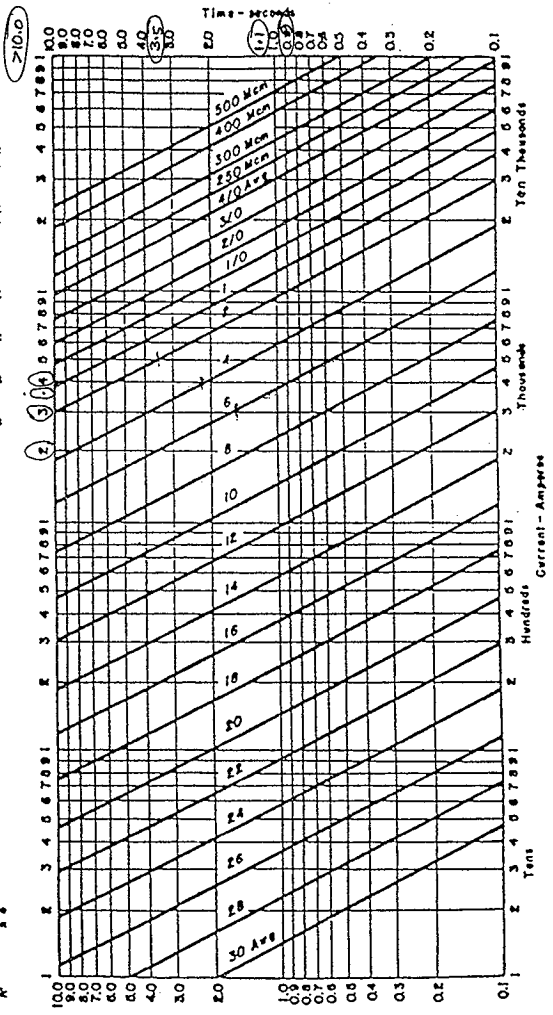
$F_{3\Phi} = 1.99505 \cdot 10^3 \cdot amp$

13.8 kV three phase fault current at calculation point.

Constant—I^2t Characteristics for Copper Conductors to Reach the Melting Temperature

Notes: These characteristics permit close estimates for the conditions and assumptions below:

1. Currents are in terms of constant rms values which may be a-c or d-c for the assumptions named.
2. Heat dissipation is neglected.
3. Resistance of 1 cm cube of copper at 0 C is 1.589 microhms.
4. Temperature coefficient of resistance of copper per degree C is 1/234.
5. Melting temperature of copper is 1083 C.
6. Starting temperature of copper is 40 C.

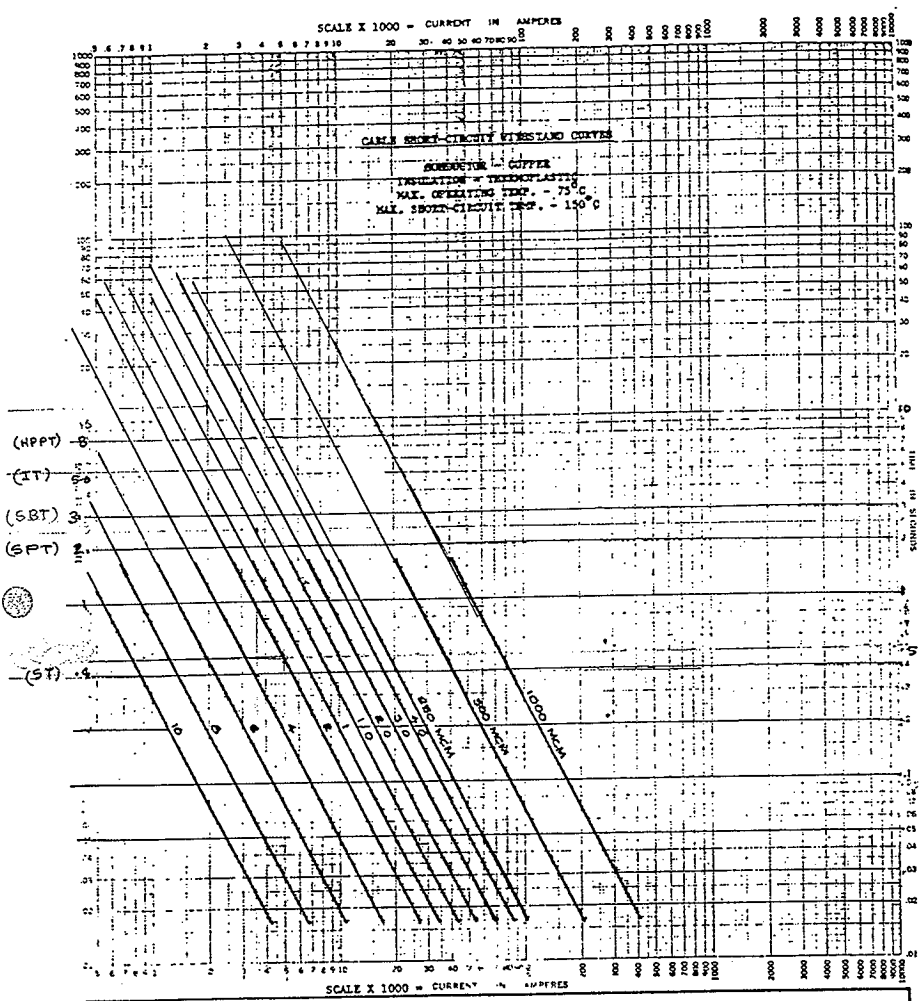


(Photo 1104139)

Fig. 1. Times required for overcurrents to produce stored-heat melting temperature in uncoiled copper conductors*

* Data taken from the Standard Handbook for Electrical Engineers, 9th Edition.

Formerly Section 332 page 6 dated Dec. 7, 1953.



OVERCURRENT DEVICE COORDINATION TIME-CURRENT CHARACTERISTIC CURVES	
JOB TITLE:	
LOCATION:	
CURVES DRAWN FROM INSULATED POWER CABLE ENGINEERS ASSOCIATION PUBLICATION P-32-382.	
	DWG. NO:
	DATE:

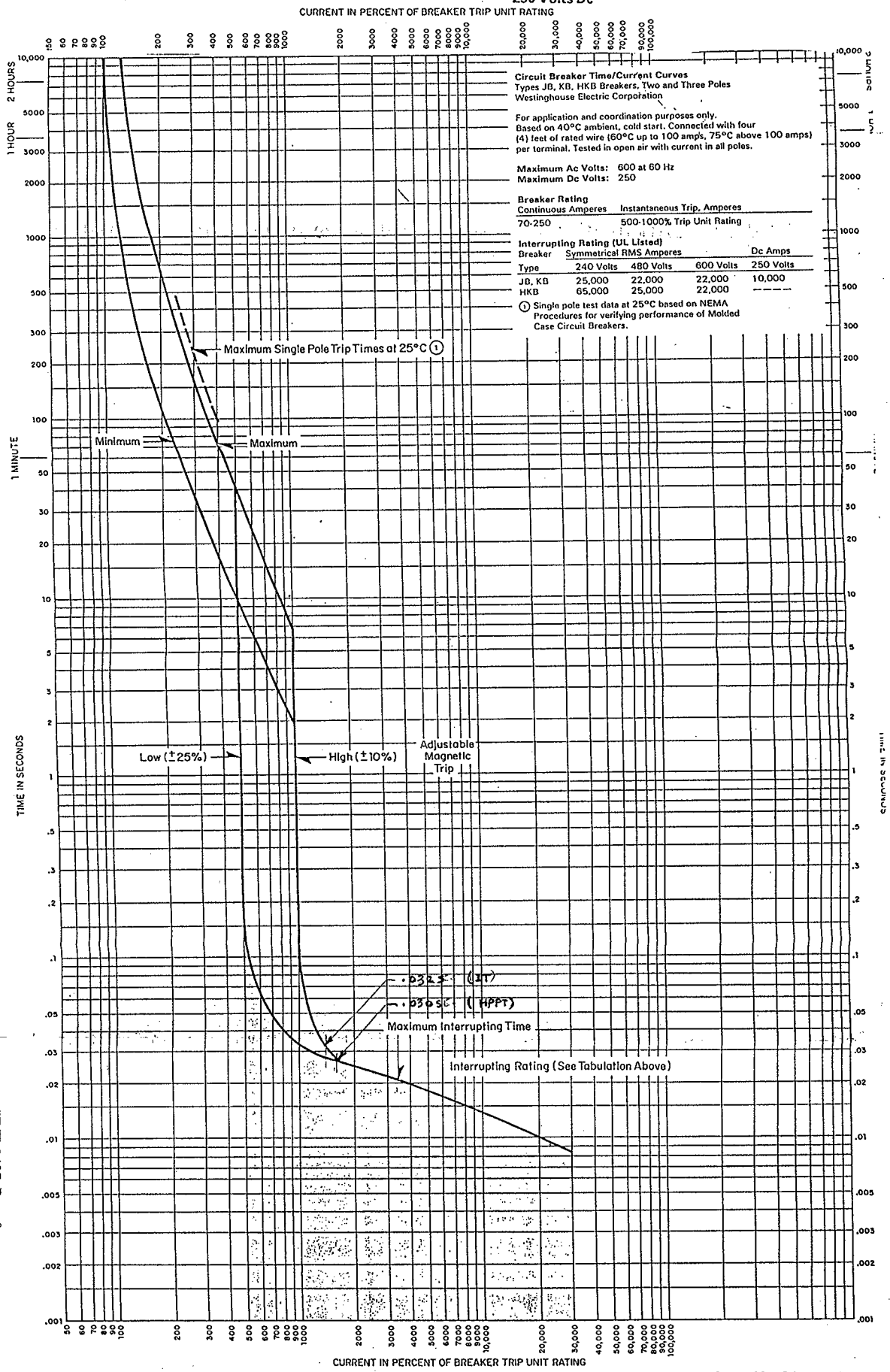
W320-31-001

APPENDIX A-4

AB DE-ION® CIRCUIT BREAKERS

Types JB and KB
MARK 75® Type HKB

70-250 Amperes, 2 and 3 Poles, 600 Volts Ac Max.
250 Volts Dc



Westinghouse Electric Corporation
Low Voltage Breaker Division, Beaver, Pa.

Curve No. SC-4009-77
November, 1977

A-4

W 320-31-001

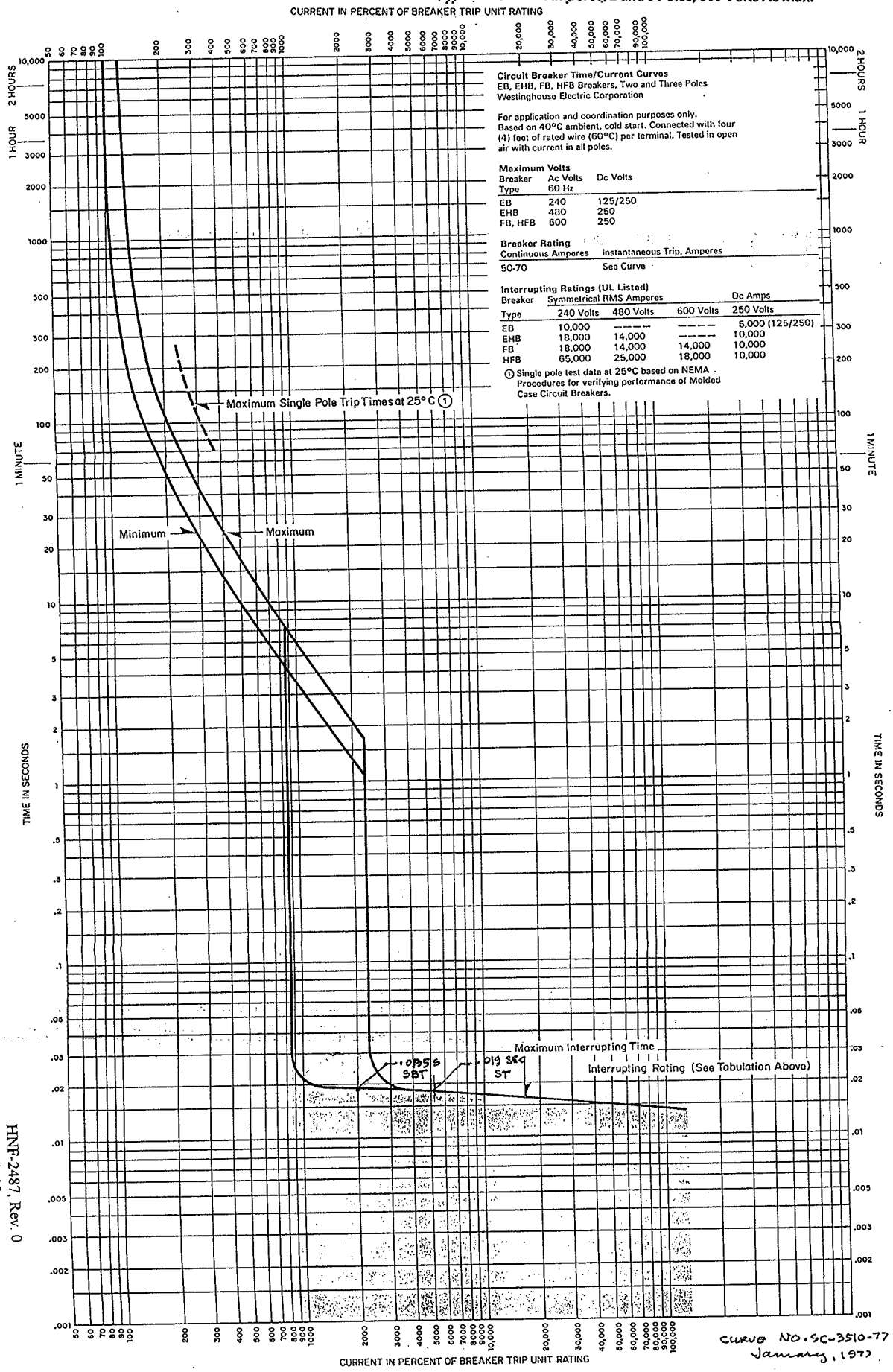
REF. F2

AB DE-ION® CIRCUIT BREAKERS

Types EB, EHB, FB, MARK 75® HFB

APPENDIX A-5

Type EB: 50-70 Amperes, 2 and 3 Poles, 240 Volts Ac Max.
Type EHB: 50-70 Amperes, 2 and 3 Poles, 480 Volts Ac Max.
Type FB: 50-70 Amperes, 2 and 3 Poles, 600 Volts Ac Max.
Type HFB: 50-70 Amperes, 2 and 3 Poles, 600 Volts Ac Max.



Circuit Breaker Time/Current Curves
EB, EHB, FB, HFB Breakers, Two and Three Poles
Westinghouse Electric Corporation

For application and coordination purposes only. Based on 40°C ambient, cold start. Connected with four (4) feet of rated wire (60°C) per terminal. Tested in open air with current in all poles.

Maximum Volts

Breaker Type	Ac Volts 60 Hz	Dc Volts
EB	240	125/250
EHB	480	250
FB, HFB	600	250

Breaker Rating

Continuous Amperes	Instantaneous Trip, Amperes
50-70	See Curve

Interrupting Ratings (UL Listed)

Breaker Type	Symmetrical RMS Amperes 240 Volts	480 Volts	600 Volts	Dc Amps 250 Volts
EB	10,000	----	----	5,000 (125/250)
EHB	18,000	14,000	----	10,000
FB	18,000	14,000	14,000	10,000
HFB	65,000	25,000	18,000	10,000

① Single pole test data at 25°C based on NEMA Procedures for verifying performance of Molded Case Circuit Breakers.

CURVE NO. SC-3510-77
January, 1977

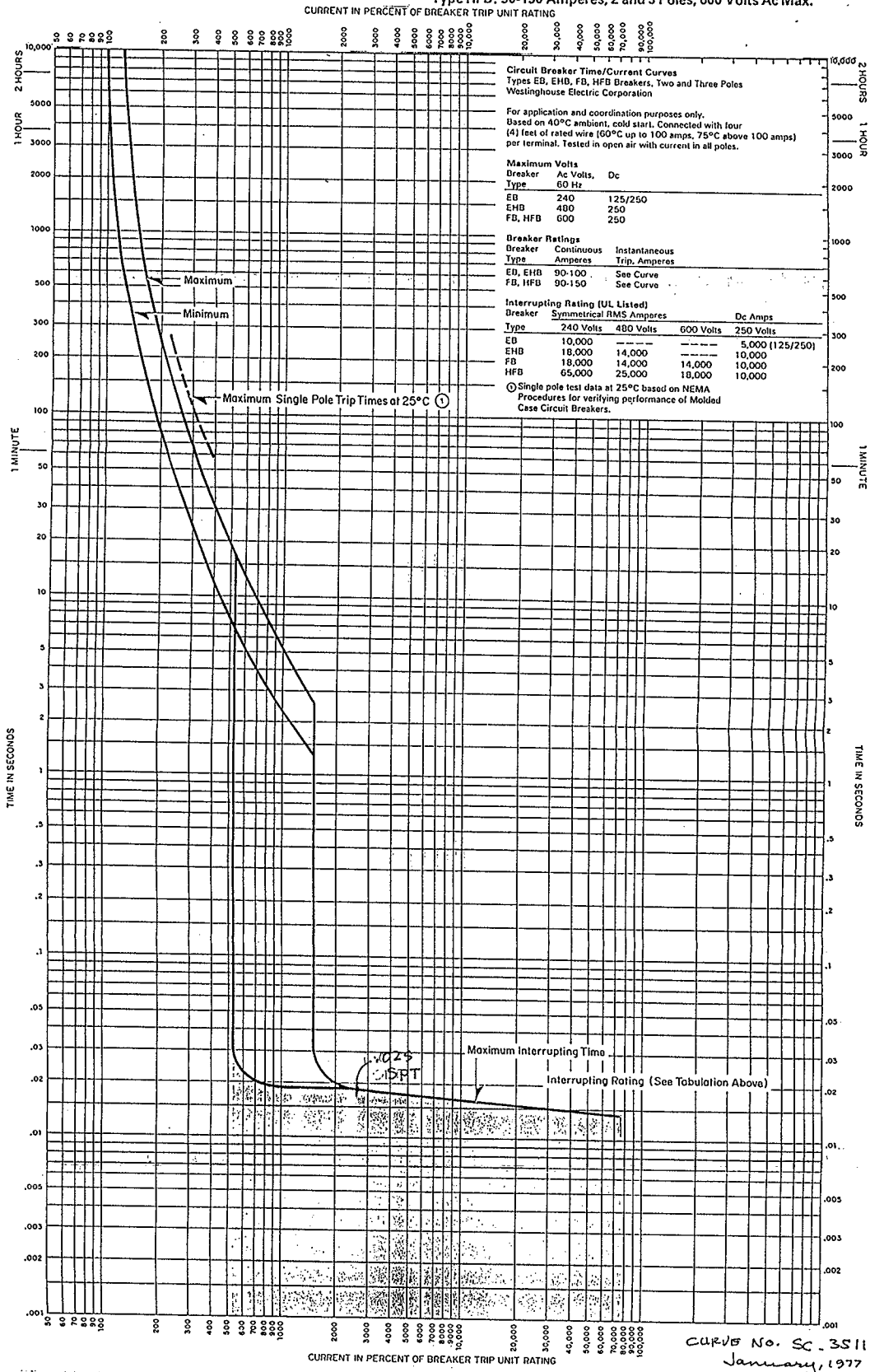
W320-31-001

APPENDIX A-6

AB DE-ION® CIRCUIT BREAKERS

Types EB, EHB, FB, MARK 75® HFB

Type EB: 90-100 Amperes, 2 and 3 Poles, 240 Volts Ac Max.
Type EHB: 90-100 Amperes, 2 and 3 Poles, 480 Volts Ac Max.
Type FB: 90-150 Amperes, 2 and 3 Poles, 600 Volts Ac Max.
Type HFB: 90-150 Amperes, 2 and 3 Poles, 600 Volts Ac Max.



CURVE No. SC-3511-77
January, 1977

W320-31-001

From IEEE Buff Book IEEE 242 1986

Table 14
Impedance Data for Single-Phase Transformers

kVA 1φ	Suggested X/R Ratio for Calculation	Normal Range of Percent Impedance (%Z)*	Impedance Multipliers** for Line-to-Neutral Fault for %X	for %R
25.0	1.1	1.2–6.0	0.6	0.75
37.5	1.4	1.2–6.5	0.6	0.75
50.0	1.6	1.2–6.4	0.6	0.75
75.0	1.8	1.2–6.6	0.6	0.75
100.0	2.0	1.3–5.7	0.6	0.75
167.0	2.5	1.4–6.1	1.0	0.75
250.0	3.6	1.9–6.8	1.0	0.75
333.0	4.7	2.4–6.0	1.0	0.75
500.0	5.5	2.2–5.4	1.0	0.75

* National standards do not specify %Z for single-phase transformers. Consult manufacturer for values to use in calculation.
** Based on rated current of the winding (one-half nameplate kVA divided by secondary line-to-neutral voltage).

2.2.2 Calculation Method. Two methods of making short-circuit calculations are presented. They are identified as the *direct method* and the *per-unit method*. While they represent different calculation concepts, if both use the same data, they produce results of the same degree of accuracy.

The direct method of short-circuit calculation presented here is so designated because, for the most part, it uses the system one-line diagram directly, uses system and equipment data such as volts, amperes, and ohms directly, and uses basic electrical equations and relationships directly without utilizing special diagrams, abstract units, or mathematical techniques.

The per-unit method is more representative of conventional electrical circuit analysis. It involves converting the system one-line diagram into an equivalent impedance diagram and reducing this to a single impedance value. This is best accomplished especially when several voltage levels are involved by using a special mathematical technique that establishes base (or reference) values for volts, current, kVA, and ohms and then refers the actual parameters to these bases in special equations to derive per-unit (or sometimes percent) values. Applying these values in special equations produces the short-circuit values.

For those who do not specialize in short-circuit calculation work, the direct method is usually easier to comprehend since it uses the familiar system one-line diagram and is compatible with the intuitive analogy of water flowing from sources to point of fault. Also, it instills confidence since system and equipment data are applied directly to familiar electrical equations producing recognizable values that can be immediately appraised.

The direct method is particularly adapted to progressive analysis of a whole or portion of a system starting at the source, considering each eschelon step by step, and determining short-circuit values at each location out to the end of the various

W320-31-002

Standby Generator Sizing

KAISER ENGINEERS HANFORD

CALCULATION IDENTIFICATION AND INDEX

Page i of iii
Date 3/30/94

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

Discipline: ELECTRICAL WO/Job No. W320/ER4289 Calculation No. W320-31-002

Project No. & Name: W320 EQUIPMENT REMOVAL SYSTEM

Calculation Item: STANDBY GENERATOR SIZING

These calculations apply to:

Dwg. No. H-2-820748 SH1 Rev. No. 0

Dwg. No. H-2-820749 SH2 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	[illegible] 3/30/94		
Checked by	Don Jorson 5/27/94		
Approved by	[illegible] 8/31/94		
Checked Against Approved Vendor Data	[illegible] 7/24/98		

INDEX

Design Analysis Page No.	Description
i	INDEX
ii	CALCULATION CROSS INDEX
iii	DESIGN VERIFICATION SCREENING CRITERIA
1	OBJECTIVE, REFERENCES/SOURCES, DATA
2	DATA, ASSUMPTIONS
3	CALCULATIONS
4	SUMMARY OF RESULTS
5	KW/KVA STARTING & RUNNING LOAD PROFILE
6	FINDINGS & CONCLUSION
~~APPENDICES~~ A-1 THRU ~~A-6~~	% MOTOR STARTING KVA, ALTITUDE CORR. FACTOR, GEN. VOLTAGE BEHAVIOR DURING MOTOR STARTING, GEN. SIZING (KOHLER QSIZE) INSTRUMENT TRAILER (IT) LOAD, HPPT DATA

SFS No. _____

DESIGN VERIFICATION SCREENING CRITERIA

Project/Document No. W320 / W320-31-002

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

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

[signature] 7/19/94

Assigned Lead Engineer — Date

Responsible Discipline Manager — Date

Original Design Package Distribution:

Project Manager

Design Verification Officer

Engineering Document Control

Design Change Distribution:

Attach to Engineering Change Notice

KEH-1981.00 (09/92)

CALCULATION CROSS INDEX (Typical)

Subject Calculation No. W320-31-002

Subject Calculation Revision No.	Superceded by Calculation No.	These interfacing calculation/documents provide input to the subject calculation, and if revised may require revision of the subject calculation.		Results and conclusions of the subject calculation are used in these interfacing calculations and/or documents.		Does the output interface calculation/ documents require revision?		Has the output interface calculation/ documents been revised?		Discipline-manager's signature and date indicating evaluation complete.
		Calculation/Document No.	Revision No.	Calculation/Document No.	Revision No.	Yes	No	Yes	No	
0	N/A			H-2-820748 SH.1	0		✓		✓	
				H-2-820749 SH.2	0		✓		✓	

KAISER ENGINEERS
HANFORD

DESIGN ANALYSIS

Calc. No. W320-31-00
Revision 0
Page No. 1 of 6

Client WHC
Subject STANDBY GENERATOR SIZING
Location TANK FARMS C RAY 200 EAST AREA

WO/Job No. ER 4289
Date 3/30/94 By J.C. DEL ROSARIO
Checked 5/27/94 By Don Jensen
Revised By

I OBJECTIVE:

DETERMINE THE MINIMUM REQUIRED CAPACITY OF THE TEMPORARY GENERA ADEQUATE TO SUPPORT A 2 WEEK EQUIPMENT REMOVAL OPERATION TO BE PERFORMED IN AUGUST BEFORE THE START OF THE SLUICING PHASE

II REFERENCES / SOURCES:

1. WESTINGHOUSE INSTR. TLR DWG H-2-78535 (APPENDIX A-7)
2. WESTINGHOUSE HIGH PRESS. PUMP RATING & PROT (APPENDIX A-
3. KOHLER PRINTOUT OF GENERATOR CALCULATIONS & SPECS USING QUICKSIZE VERSION 5.1 SOFTWARE.
4. INDUSTRIAL POWER DISTRIBUTION SYSTEM HDBK BY BEEMAN
5. MOTOR EFFICIENCIES & MOTOR NEMA CODE DESIGNATIONS FROM CATERPILLAR GEN. CATALOG.
6. GENERATOR CORRECTION FACTOR DUE TO ALTITUDE — IEEE ORANGE BOOK

III DATA:

ELEVATION OF SITE — 300 FT
LOCATION MAX. TEMPERATURE = 50°C (122°F)

DIRECTIVE TO INSTALL STANDBY GENERATOR — GIVEN BY CHARLES O'NEILL. I REQUESTED FOR ITS INCLUSION OF GENERATOR REQUIREMENT IN LOI

CONSTRUCTION GROUP TO FURNISH / LEASE THE GENERATOR PER C. O'NEILL.

LOADS: SEE REF. 1, 2 AND PAGES 2 & 3 OF CALC. # W320-31-03

1. HIGH PRESSURE PUMP (HPPT) - 100 HP, 3Ø, 460V
2. INST. TRAILER - 75 KW AND 1-12.5HP 460V MOTOR
3. STRONG BACK TRAILER WITH REDUNDANT 10 HP, 3Ø, 460V HYD. PUMP — ONE SHALL BE OPERATED AT A TIME.

III DATA : CONTINUED

A DIESEL GENERATOR SHALL SUPPLY STANDBY POWER TO THE EQUIPMENT REMOVAL TRAILERS (LOADS) SHOULD THE NORMAL POWER LOSS OCCUR DURING THE EQUIPMENT REMOVAL OPERATION.

THE STANDBY GENERATOR WILL BE MANUALLY STARTED AFTER THE FEEDER CBS IN THE TRANSFER SWITCH BREAKERS SKID ARE CHECKED TO BE IN OPEN POSITION.

THE TRANSFER SWITCH FOR HPPT IS MANUALLY SWITCHED TO THE STANDBY GENERATOR. THE HPP-FB IS CLOSED STANDBY GENERATOR POWER IS SIMILARLY TRANSFERRED IN STEPS TO THE INSTRUMENT TRAILER AND THEN TO THE STRONG-BACK TRAILER.

IV ASSUMPTIONS :

1. THE HPPT IS STARTED FIRST AFTER THE GENERATOR HAS ATTAINED SPEED TO RECEIVE FULL LOAD. MAXIMUM GEN. VOLTAGE DIP DUE TO STARTING OF THE LARGEST MOTOR (100HP) IS LIMITED TO 20% OF GEN. VOL
2. WORST HPPT INDUCTION MOTOR STARTING CONDITION IS ASSUMED - HPPT IS STARTED AT FULL SPEED (THAT THE 200A FUSES AT THE DISCONNECT SWITCH & THE SETTING OF THE 250AF VARIABLE FREQUENCY DRIVE WILL PASS THIS STARTING CURRENT). 100HP IS FULLY LOADED.
3. NO DEMAND FACTOR IS APPLIED ON ANY OF TH LOADS. CONNECTED LOADS ARE USED IN THE CALCULATIONS
4. TRAILER MOTOR LOAD DATA :

LOAD	EFF.	PF_R	NEMA CODE LETTER	KVA/HP	PF_S
100HP HPP	92	.80	E	5.6	.30
12.5HP PUMP	89	.80	G	6.29	.53
10 HP	89	.80	G	6.29	.53

5. OTHER INSTRUMENT TRAILER LOADS — 2.25KVA, Ø TRANSFORMER. ASSUMED 75 KVA BALANCED 3Ø LOAD, .85

54-4300-037 KEH-0037.00 (06/5

Client WHC
Subject STANDBY GENERATOR SIZING
Location TANK FARMS C & AY 200 EAST AREA

WO/Job No. ER 4289
Date 3/30/94 By J.C. DEL ROSARIO
Checked 5/27/94 By
Revised By

V CALCULATIONS: (MANUAL)

(A) KW_R (RUNNING) = $\frac{HP \times .746}{EFF}$

KW_R (100 HP HPP) = $\frac{100 \times .746}{.92}$ = 81 kw

KW_R (12.5 HP HYD. PP) = $\frac{12.5 \times .746}{.89}$ = 10.5 kw

KW_R (10 HP STB HYD. PP) = $\frac{10 \times .746}{.89}$ = 8.4 kw

(B) KVA_R (RUNNING) = $\frac{KW_R}{PF_R}$

WHERE PF_R = RUNNING PF

KVA_R (100 HP HPP) = 81 / .80 = 101 KVA

KVA_R (12.5 HP HYD. PP) = 10.5 / .80 = 13 KVA

KVA_R (10 HP STB. HYD. PP) = 8.4 / .80 = 10.5 KVA

(C) KVA_S (STARTING) = HP x KVA / HP

KVA_S (100 HP HPP) = 100 x 5.6 = 560 KVA

KVA_S (12.5 HP HYD. PP) = 12.5 x 6.29 = 78.63 KVA

KVA_S (10 HP STB HYD PP) = 10 x 6.29 = 62.9 KVA

54-4300-037 KEH-0037.00 (06/9

IV CALCULATIONS (CONT)

(D) KW_S (STARTING) = $KVA_R \times PF_S$

KW_S (100 HP HPP) = 560 x .3 = 168 KW

KW_S (12.5 HP HYD PP) = 72.63 x .53 = 41.67

KW_S (10 HP STB HYD. PP) = 62.9 x .53 = 33 KW

(E) FROM REF 4 FIG 4.42 %KVA_S OF MOTOR x GEN KVA
FOR 20% DIP (0 INITIAL LOAD, RATED GEN VOLTAGE = 1.
FOR 250 KVA GEN THIS IS = 250 x 1.7 = 425 KVA
USE KOHLER 200 ROZD MAX. KVA_S @ 20% DIP = 560 KVA

(F) SUMMARY OF RESULTS:

STEP	LOAD	PF$_R$	KW$_R$	RKVA$_R$	KVA$_R$	PF$_S$	KW$_S$	RKVA$_S$	KVA$_S$	% DIP
STEP 1	100 HP HPPT	.80	81	60.6	101	.30	168	543	560	20%
STEP 2	12.5 HP HYD. PP	.80	10.5	7.8	13.0	.53	41.67	66.68	78.63	
	MISC. INSTR. TRLR LOADS	.85	64.5	40	76	.85	64.5	40	76	
STEP 2 TOTALS ONLY		.84	75	47.8	89	.70	106.17	106.68	150.5	
STEP 2 + STEP 1 STEADY STATE		.82	156	108.4	190	.746	187.17	107.28	251	8.96
STEP 3 ONLY	10 HP STB PP.	.80	8.4	6.3	10.5	.53	33	53.3	62.9	
STEP 3 + STEP 2 STEADY STATE		.82	164.44	114.7	200.49	.76	189	161.7	248.73	8.89

G. GENERATOR DERATING DUE TO ALTITUDE 300 F
& AMBIENT TEMP (120° F) = .99 (KOHLER QUICKS
ALSO SEE REF. 6
200 KW GEN DERATED RATING = 198 KW

H. % OF DERATED CAPACITY USED = $\frac{164.44}{198} \times 100 = 8$

KAISER ENGINEERS
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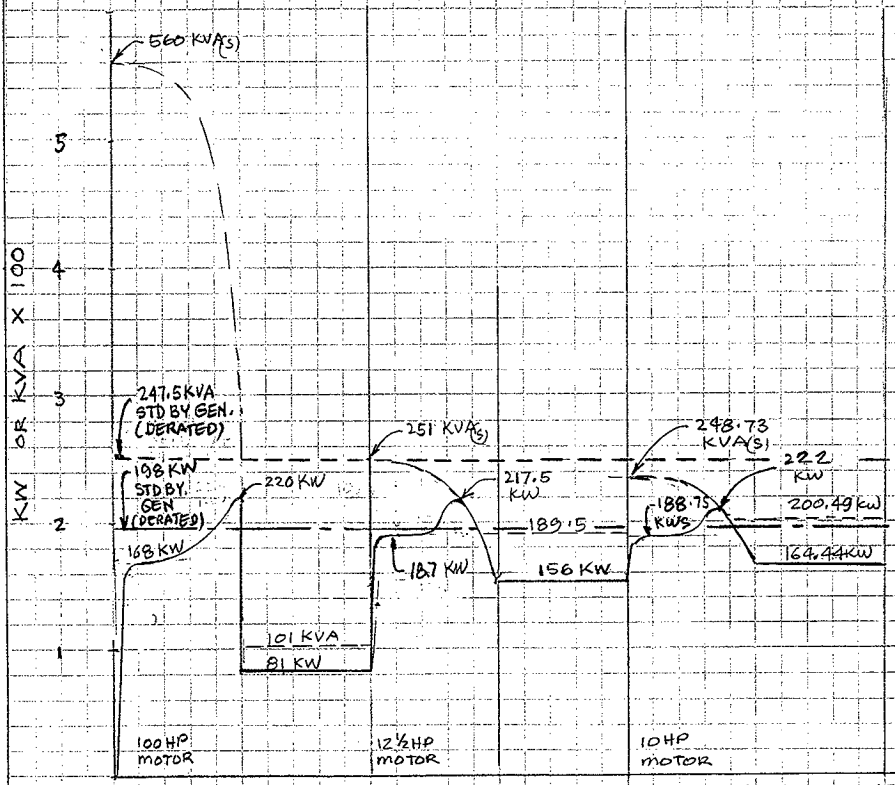
DESIGN ANALYSIS

Calc. No. W320-31-002
Revision 0
Page No. 5 of 6

Client: WHC
WO/Job No. ER 4289
Subject: STANDBY GENERATOR SIZING
Date 3/30/94 By J.C. DEL ROSARIO
Checked 5/27/94 By Dan Jensen
Location: TANK FARMS C&AY 200 EAST AREA
Revised By



KW/KVA STARTING & RUNNING LOAD PROFILE

54-4300-037 KEH-0037.00 (06/9

Client WHC
WO/Job No. ER4289
Subject STANDBY GENERATOR SIZING
Date 3/30/94 By J. C. DEL ROSARIO
Checked 5/21/94 By Don Parson
Location TANK FARMS C & AY, 200 EAST AREA
Revised By

FINDINGS & CONCLUSIONS:

THE SUMMARY OF RESULTS & THE LOAD PROFILE SHOW A STEADY STATE (RUNNING) LOAD OF 164.44 KW OR 200 KVA LOAD AT 82% PF. MAXIMUM STARTING KVA (560) OCCURS DURING FULL SPEED START OF 100HP HIGH PRESSURE PUMP CAUSING MAXIMUM VOLTAGE DIP OF 20%. (ALLOWABLE VOLTAGE DIP IS UP TO 30%)
A 200 KW GENERATOR (DERATED TO 198 KW), 250 KVA AT 80% PF WILL BE SUFFICIENT TO SUPPLY THE EQUIPMENT REMOVAL LOADS AND LIMIT THE VOLTAGE DIP TO LESS THAN 20% IF STARTED IN 3 STEPS AS SHOWN IN THE SUMMARY OF RESULTS.

KOHLER GENERATOR COMPUTER CALCULATIONS USING "QUICKSIZE 5.1" SOFTWARE IS ALSO ATTACHED FOR COMPARISON. (APPENDIX A-6)

DIESEL GENERATOR PRESENTLY IN COLD TEST FACILITY AS OF 8/24/94:

CATERPILAR 3406

275 KW, 344 KVA, 80% PF, 3Ø Y

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

APPENDIX A-1

FROM REF 4

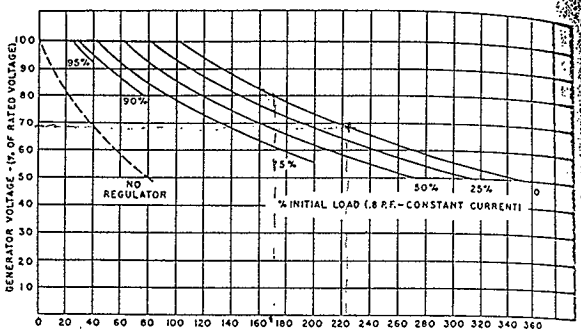


FIG. 4.42 Restored generator voltage.

Advantages of Voltage Regulators. Figures 4.38, 4.39, and 4.42 show dashed curves, marked N, which indicate the results to be expected if no regulator is used. It is apparent that regulators are very beneficial. They practically always justify their cost whenever the starting of large motors is involved. For example, consider a 480-volt 125-kva 1200-rpm generator. From Fig. 4.40 this may have a performance factor K of about 1.7 with a regulator. From Fig. 4.39, 110 per cent motor-starting load or 138 kva will cause a 28 per cent voltage dip.

This load would correspond to starting a 25-hp motor at full voltage.

To obtain the same motor-starting performance without a regulator would require a 438-kva generator, because the curve N shows that about 32 per cent motor-starting load will cause a 28 per cent voltage drop if no regulator is used. (138 kva is about 32 per cent of 438 kva.) The 438-kva generator would cost over twice as much as a 125-kva machine. The best and least expensive arrangement would be to provide a regulator adding less than 15 per cent to the cost of the 125-kva generator. This would permit successful starting of the 25-hp motor even against full-load torque and would improve normal generator performance.

In Fig. 4.39 are curves, marked E, which show the performance avail- [illegible] other very high-response excitation system. It s [illegible] limit to the improvement

FROM REF 6

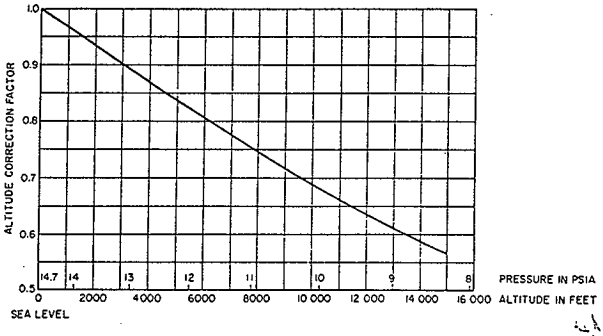


Fig 29
Typical Performance Correction Factor for Altitude

P131

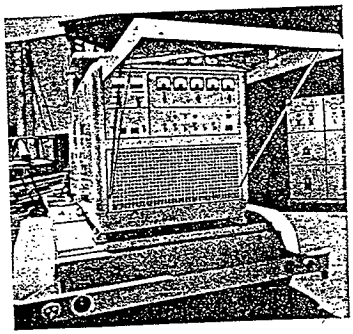


Fig 28
Modular Packaged Gas-Turbine-Generator Set Mounted on Trailer

P131

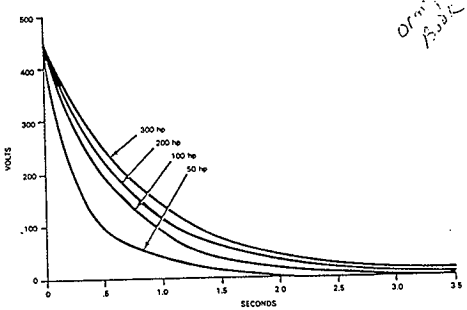
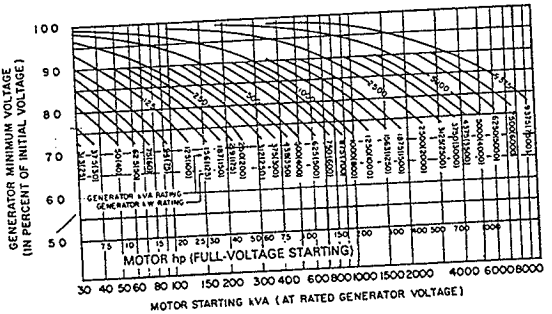


Fig 19
Induction Motor Open Circuit Voltage Decay
(Based on Constant Speed)

(because it is not influenced by a regulator as in the generator case) and does not recover until the motor approaches full speed. Since the transformer is usually the largest single impedance in the distribution system, it takes almost the total drop. Figure 22 has been plotted in terms of motor starting load in kilovolt-amperes that would be drawn if rated transformer secondary voltage were maintained.

Fig 21
Minimum Generator Voltage Due to Full-Voltage Starting of a Motor



NOTES: (1) The scale of motor horsepower is based on the starting current being equal to approximately 5.5 times normal.

(2) If there is no initial load, the voltage regulator will restore voltage to 100% after dip to values given by curves.

(3) Initial load, if any, is assumed to be of constant-current type.

(4) Generator characteristics are assumed as follows: (a) Generators rated 1000 kVA or less: Performance factor $k = 10$; transient reactance $X_d' = 25\%$; synchronous reactance $X_d = 120\%$. (b) Generators rated above 1000 kVA: Characteristics for 3600 r/min turbine generators.

APPENDIX A-4

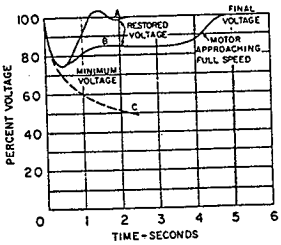
Table 14
Comparison of Motor-Starting Methods

Type of Starter (Settings Given Are the More Common for Each Type)	Motor Terminal Voltage (Percent Line Voltage)	Starting Torque (Percent Full-Voltage Starting Torque)	Line-Current (Percent Full-Voltage Starting Current)
Full-voltage starter	100	100	100
Autotransformer			
80% tap	80	64	68
65% tap	65	42	46
50% tap	50	25	30
Resistor starter, single step (adjusted for motor voltage to be 80% of line voltage)	80	64	80
Reactor			
50% tap	50	25	50
45% tap	45	20	45
37.5% tap	37.5	14	37.5
Part-winding starter (low-speed motors only)			
75% winding	100	75	75
50% winding	100	50	50

NOTE: For a line voltage not equal to the motor-rated voltage, multiply all values in the first and last columns by the ratio (actual voltage)/(motor-rated voltage). Multiply all values in the second column by the ratio $[(\text{actual voltage})/(\text{motor-rated voltage})]^2$.

Fig 20
Typical Generator Voltage Behavior Due to Full-Voltage Starting of a Motor

Similar to Calc



Motor-starting kVA = 100% of generator rating
A — No initial load on generator
B — 50% initial load on generator
C — No regulator

APPENDIX A-5

Red Book

Solution. Enter the chart on the horizontal scale at 2000 kVA, extend a line vertically to its intersection with the 0.85 power factor curve. Extend a line horizontally from this point to the left to its intersection with the vertical scale. This point on the vertical scale gives the percent voltage drop for rated load. Multiply this value by the ratio of actual load to rated load:

$$\text{percent drop at rated load} = 3.67$$

$$\text{percent drop at 1500 kVA} = 3.67 \cdot \frac{1500}{2000}$$

$$= 2.75$$

$$\text{actual voltage drop} = 2.75\% \cdot 480$$

$$= 13.2 \text{ V}$$

Figure 19 applies to the 34.5 kV insulation class power transformer in ratings from 1500–10 000 kVA. These curves can be used to determine the voltage drop for transformers in the 46 and 69 kV insulation classes by using appropriate multipliers at all power factors except unity.

To correct for 46 kV, multiply the percent voltage drop obtained from the chart by 1.065, and for 69 kV, multiply by 1.15.

3.11.5 Motor-Starting Voltage Drop. It is characteristic of ac motors that the current that they draw on starting is much higher than their normal running current. Synchronous and squirrel-cage induction motors started on full voltage may draw a current as high as seven or eight times their full-load running current. This sudden increase in the current drawn from the power system may result in excessive drop in voltage unless it is considered in the design of the system. The motor-starting load in kilovolt-amperes, imposed on the power supply system, and the available motor torque are greatly affected by the method of starting used. Table 14 gives a comparison of several common methods.

3.11.6 Effect of Motor Starting on Generators. Figure 20 shows the behavior of the voltage of a generator when an induction motor is started. Starting a synchronous motor has a similar effect up to the time of pull-in torque. The case used for this illustration utilizes a full-voltage starting device, and the full-voltage motor starting load in kilovolt-amperes is about 100% of the generator rating. It is assumed for curves A and B that the generator is provided with an automatic voltage regulator.

Similar to Calc

The minimum voltage of the generator as shown in Fig 20 is an important quantity because it is a determining factor affecting undervoltage devices and contactors connected to the system and the stalling of motors running on the system. The curves of Fig 21 can be used for estimating the minimum voltage occurring at the terminals of a generator supplying power to a motor being started.

3.11.7 Effect of Motor Starting on Distribution System. Frequently in the case of purchased power, there are transformers and cables between the starting motor and the generator. Most of the drop in this case is within the distribution equipment. When all the voltage drop is in this equipment, the voltage falls immediately

ER4289 STANDBY GENERATOR 03/18/94 08:20:09
Data for model - 200ROZD

GENERATOR DATA

```
*************************************************************************
Kohler genset model ............................ 200ROZD  Liquid cooled
Alternator model ............................... 4U13    (OVERSIZE)
Voltage and phase selected ..................... 277/480 volts, 3 phase 60 hz
Fuel selected .................................. Diesel
Altitude (meters) ............................... 300
Temperature (C) ................................   50
Generator's KW Standby rating ..................  200.0
Generator's derated running KW's ................  197.8
Percent of available KW's used ..................   90 %
Generator's KVA rating...........................  250.0
Maximum starting KVA at 20% voltage dip .........  560.0
Generator's power factor ........................    0.8
*************************************************************************
```

This generator meets the minimum requirements for a 20% voltage dip
When loads are started as specified by the loads report.
Largest actual voltage dip is 15.0 %

N O T E: When the available KW's used exceeds 85%, please read the following three notes before you specify this equipment:

1. During actual operation, the sequence of load application may vary from the data you input.

2. If motor code letters were assumed, actual motor starting could vary from the output data.

3. Reserve capacity for abnormal conditions or expansion is limited.

Kohler Company offers the full line of generator sets and accessories as well as other equipment which may be required for this application SUCH AS:

- Automatic Transfer Switches
- Bypass Isolation Switches
- Synchronizing Switchgear
- Weather Proof Housings

If you have any questions regarding this application call your local distributor or the Kohler Company Generator Division, Applications Engineering Department, at 414-565-3381.

ER4289 STANDBY GENERATOR 03/18/94 08:20:09
DATA FOR MODEL - 200ROZD

LOADS REPORT

QTY	RUN KW	RUN KVA	RUN PF	START KW	START KVA	DESCRIPTION
STEP - 1						
Loaded 100.00 hp code F motor						
1	84.00	105.00	0.80	126.00	420.00	High Pressure Pump
STEP TOTAL -	84.00	105.00	0.80	126.00	420.00	15 % V. DIP
STEP - 2						
Loaded 12.50 hp code G motor						
1	10.90	13.63	0.80	35.31	74.38	Hyd. Pumps
Miscellaneous Load						
1	75.00	75.00	1.00	75.00	75.00	Instrument Trailer Load
STEP TOTAL -	85.90	88.63	0.97	194.31	233.05	8 % V. DIP
STEP - 3						
Loaded 10.00 hp code G motor						
1	8.80	11.00	0.80	28.54	59.50	Strongback Hyd. Pp
STEP TOTAL -	8.80	11.00	0.80	198.44	241.27	9 % V. DIP
TOTALS	178.70	204.63	0.87			

W320-31-003

Feeder Cable Sizes & % Voltage Drop

KAISER ENGINEERS HANFORD	CALCULATION IDENTIFICATION AND INDEX	Page i of iii Date 2/18/84

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

Discipline ELECTRICAL WO/Job No. W320, ER4289 Calculation No. W320-31-003

Project No. & Name EQUIPMENT REMOVAL PROJECT

Calculation Item FEEDER CABLE SIZES & % VOLTAGE DROP

These calculations apply to:

Dwg. No. H-2-820749 SH1, SH2 Rev. No. D

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	[illegible] 2/18/84		
Checked by	Don Parson 5/27/94		
Approved by	[illegible] 8/31/94		
Checked Against Approved Vendor Data	[illegible] 7/24/98		

HNF-2487, Rev. 0
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Design Analysis Page No.	Description
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ii	CALCULATION CROSS INDEX
iii	DESIGN VERIFICATION SCREENING CRITERIA
1	OBJECTIVE, DATA
2	ASSUMPTIONS, METHODS TO BE USED, REF., CALCS. (HPPT LOAD)
3	CALCS., HPPT LOAD (CONT.), IT LOAD, STB TRAILER LOAD
4	CONSTRUCTION TRAILER LOAD
5	DERATED AMPACITIES OF TYPE MC CABLES, TOTAL ER LOAD
6	CABLE DATA, % VOLTAGE DROP, MAXIMUM CABLE LENGTHS
7	FINDINGS & CONCLUSIONS
APPENDICES A-1 THRU A-4	%VD TABLE, DERATING MOLDED CASE CB, CABLE LENGTHS / EQUIPT. ARRANGEMENT (TANK FARMS C & AY)

CALCULATION CROSS INDEX (Typical)

Subject Calculation No. W320-31-003

Subject Calculation Revision No.	Superceded by Calculation No.	These interfacing calculation/documents provide input to the subject calculation, and if revised may require revision of the subject calculation.		Results and conclusions of the subject calculation are used in these interfacing calculations and/or documents.		Does the output interface calculation/documents require revision?		Has the output interface calculation/documents been revised?		Discipline-manager's signature and date indicating evaluation complete.
		Calculation/Document No.	Revision No.	Calculation/Document No.	Revision No.	Yes	No	Yes	No	
0	N/A			H-2-820749 SH.1 & 2	0		✓		✓	

SFS No. _____

DESIGN VERIFICATION SCREENING CRITERIA

Project/Document No. W 320 / W320-31-003

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?

J Kosnik — Assigned Lead Engineer — Date: 7/9/94

Responsible Discipline Manager — Date

Original Design Package Distribution:

Project Manager

Design Verification Officer

Engineering Document Control

Design Change Distribution:

Attach to Engineering Change Notice

KEH-1981.00 (09/92)

KAISER ENGINEERS
HANFORD

DESIGN ANALYSIS

Calc. No. W320-31-003
Revision 0
Page No. 1 of 7

Client WHC
WO/Job No. ER4289
Subject FEEDER CABLE SIZES & % VOLTAGE DROP
Date 2/17/94 By J.C. DEL ROSARIO
Checked 5/27/94 By Don Larson
Revised By
Location TANK FARM C, 200 EAST AREA

I. OBJECTIVE:

DETERMINE THE FEEDER CABLE SIZE BASED ON 1993 NEC AMPACITY AND VOLTAGE DROP REQUIREMENTS. THE FEEDER VOLTAGE DROP SHALL NOT BE MORE THAN 2% OF THE NOMINAL 480 VAC, OR 240 VAC FOR THE CONSTRUCTION TRAILER SERVICES.

EQUIPMENT REMOVAL WILL BE DONE IN TWO WEEKS IN AUGUST, BEFORE THE SLUICING PHASE. FAST INSTALLATION OF ER TRAILERS AND EQUIPMENT NECESSITATES THE USE OF TEMPORARY SERVICE WIRING METHOD THAT IS QUICKLY AND EASILY INSTALLED AND REMOVED.

II DATA:

HIGH PRESSURE PUMP AND CONTROL TRAILERS (DESIGNED BY WHC) ARE PROVIDED WITH 150A, 3P, 460V CIRCUIT BREAKERS AND 200A, 3P DISCONNECT SW. WITH 200A FUSE

AMBIENT TEMPERATURE - 115°F (AUGUST)

3/C COPPER TYPE MC CABLE WITH GROUND APPROVED FOR DIRECT BURIAL INSTALLATION IS USED.

ASSUMPTIONS:

DEMAND CURRENT WILL BE CB RATING AS GIVEN BY WHC FOR INSTRUMENT TRAILER & HIGH PRESSURE PUMP TRAILER

DEMAND CURRENT FOR STRONG BACK TRAILER IS ASSUMED 50A. (THIS FIGURE WILL BE CHECKED AGAINST VENDORS INFO.

THE FEEDER CABLE AMPACITIES FOR DRY 100°C WILL BE DERATED FOR USE IN 115°F AMBIENT TEMP.

ASSUMPTIONS:

NO DEMAND FACTORS WILL BE APPLIED ON TRAILER LOADS.
200A FUSES WILL LIMIT HPPT VF CONTROLLER INPUT STARTING CURRENT AND 150A CB WILL LIMIT MOTOR RUNNING CURRENT.
VF CONTROLLER IS TO "SOFT START" THE 100 HP HPP.
ASSUME 1 HP = 1 KVA (SEE P3)
AT JT TRAILER WITH 2 - 25KVA, 480V, 1Ø TRANSFORMER
ASSUME 25 KVA, 480V, 1Ø LOAD ON UNLOADED PHASE TO BALANCE THE LOADS ACROSS THE THREE PHASES (
ASSUME 50A MAXIMUM DEMAND ON THE SBT ON P3

D. METHOD TO BE USED:
MANUAL CALCULATION

E. REFERENCES / SOURCES:

1. 1993 NEC, NFPA-70
2. WESTINGHOUSE CPT. 55-0000 1991-1992
3. WEST. TRAILER DWG. H-2-78935 (INST. TRAILER)
4. HIGH PRESSURE PUMP HP RATING & PROTECTION

III CALCULATIONS:

1. DETERMINE TRAILER LOADS:

a) HIGH PRESSURE PUMP TRAILER (HPPT)
LOAD FURNISHED BY WHC — (REF. 4)
1 - 100 HP, 460V PUMP MOTOR WITH VF CONTROLLER PROTECTED BY 150A, 460V, 3P, CB
2 - 2HP MOTORS @ 3.4A EA, 460V WITH CB (ONE 2 HP MOTOR OPERATED AT A TIME)
3 - MISC 460V, 1Ø LOAD @ .5A

FROM NEC I_{FL} FOR 100HP, 460V 3Ø MOTOR = 124A
(TABLE 430-150) FOR 2HP, 3Ø I_{FL} = 3.4A

TOTAL I_{FL} FROM HIGH PRESSURE PUMP TRAILER
= 124 + 3.4A + .5 = 127.9A

HPP TRAILER INCLUDING PROTECTION — BY WESTINGHOU
CAT. SHEETS OF VF CONTROLLER WERE REQUESTED FROM MR. JACK DOWELL OF WESTINGHOUSE.

BRANCH CIRCUIT PROTECTION INSTALLED BY PUMP VENDOR
150A CCB WITH 200A FUSED DISCONNECT SWITCH.

$I_{TOTAL} + .25\, I_{LARGEST\ MOTOR} = 127.9 + 0.25 \times 124$

$= 127.9 + 31 = 158.9A$

USE 4/0 AWG, DERATED AMPACITY @ 120°F = 213 A
SEE SH 5

FEEDER CB – 225AT DERATED FOR 122°F (50°C) AMBIENT
TEMP, = 205 A SEE REF 2, P 263
(USED WEST TYPE FB & JB BREAKERS FOR CALCS)

b. INSTRUMENT TRAILER (IT): 150 A, 3P, 480V (BY VENDOR)
(DESIGNED BY WHC – REF 3)

3Φ LOAD – 1 – 12.5HP PUMP (ASSUME 1 HP = 1 KVA
= 12.5 KVA (INFO FROM WESTINGHOUS
(JACK DOWELL)

2 - 25 KVA, 1Φ 480 - 120/240V TRANSF
3 x 25 = 75 KVA ASSUME BALANCE 3Φ LO

TOTAL CONNECTED LOAD = 75 + 12.5 = 87.5 KV

$I_{FL} = 87.5 KVA / \sqrt{3} \times .48 KV = 105 A$

USE 2/0 AWG – DERATED AMP = 160 A

USE 175 AT F225 MOLDED CASE CB, DERATED AMP = 159
@ 122°F AMBIENT TEMP, REF 2 p 263

c. STRONG BACK TRAILER:
2 - 10HP, 3Φ, 460V PUMPS OPERATING ALTER
NATELY; ASSUME 50A MAX. LOAD
USE 3/c # 2 AWG – DERATED AMPACITY
@ 122°F = 107 A, USE 100 AT FEEDER CB,
DERATED @ 122°F TO 94A REF 2 P 263

d.) CONSTRUCTION TRAILER POWER

BASED ON AVERAGE ESTIMATED CONN. LOAD OF 15 KVA PER TRAILER:

LOAD PER TRAILER = 15 KVA

TOTAL LOAD FOR 3 TRAILERS = 45 KVA

ASSUME 100% DEMAND FACTOR.

ESTIMATED KVA DEMAND = 45 KVA

USE 50 KVA, 1Ø TRANSFORMER

I_{PRI} = 104 AMPS

$1.25\ I_{PRI}$ = 130A, USE 3/C #1/0 AWG, 90°C INS, AMPACITY @ 120°F = 139A SEE PAGE 5

USE 150 A, 2P CB TRANSFORMER PRIMARY CB DERATED AMPACITY @ 120°F = 138A – REF 2 p 26

$I_{TRAILER} = \frac{15\ KVA}{.24\ KV} = 62.5\ A$

$1.25\ I_{TRAILER} = 78.125\ A$ USE # 4 AWG DERATED AMP. @ 120°F = 78A SEE PAGE 5

USE 70A, 2P, 240V SERVICE FEEDER PROTECTION

TOTAL CURRENT RATING OF TRANSF SEC. CBS = 3 x 70 = 210 AMPS

TRANSFORMER SEC. @ 240V SEC. $I_{FL} = \frac{50\ KVA}{.24\ KV} = 208\ A$

Client WHC
WO/Job No. ER 4289
Subject FEEDER CABLE SIZES & VOLTAGE DROP
Date 2/17/94 By J.C. DEL ROSARIO
Checked 5/27/94 By D.E. Larson
Location TANK FARM C 200 EAST AREA
Revised By

DERATING FACTOR FOR 120°F AMBIENT TEMP. FOR 60-90° COPPER CABLE = .82 REF: TABLE 310-16

DERATED AMPACITIES OF 90°C (DRY) COPPER CABLES W/ XHHW INS.

AWG/ KCMIL	AMPACITY (A) @ 30°C (86°F)	AMPACITY (A) @ 120°F
6	75	62
4	95	78
2	130	107
1/0	170	139
2/0	195	160
4/0	260	213
250	290	238
350	350	287
500	430	353

EQUIPMENT REMOVAL LOADS IN AMPS @ 480V, 3Ø (EXCLUDING CONSTRUCTION TRAILER LOADS)

LOAD	AMP
HPPT	128
IT	105
STB	25

TOTAL (LESS CONSTR. TRLR) = 258 A USE 350 kcmil @ 120°F CONT. RATING = 287A
CONSTR. TRLR CONN. LOAD = 50,000 / 480 = 104 A
TOTAL CONN. LOAD INCLUDING CONSTR. TRAILERS = 362A
USE 2-350kcmil/Ø TRANSF. SEC. FDR TO PDP AT TANK FARM
CONTINUOUS CURRENT AMPACITY @ 120°F = 574 A

KAISER ENGINEERS
HANFORD

DESIGN ANALYSIS

Calc. No. W320-31-00
Revision 0
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Client WHC
WO/Job No. ER 4289
Subject FEEDER CABLE SIZES & % VOLTAGE DROP
Date 2/17/94 By J.C. DEL ROSARIO
Checked 5/27/94 By Don Jensen
Revised By
Location TANK FARM C, 200 EAST AREA

ASSUME TRANSF. SECONDARY VOLTAGE AT TERMINAL = 480V

CABLE DATA: TRANSF. FULL LOAD %IZ = 4.43% (NOT INCLUDED)

* VOLTAGE DROP FACTOR FOR COPPER CONDUCTORS IN MAGNETIC DUCT @ 80% PF 3Ø Ø-Ø = VOLTS/AMPS/100 FT REF 2 P32

□ SEE DWG H-2-820749 (C-FARM) & H-2-820752 (A-T FARM) FOR CABLE LAYO

0 ITEM	1 CABLE TAG	2 FROM	3 TO	4 AMP LOAD	5 SIZE AWG/KCMIL	6 L □ (FT)	7 VD FACTOR * REF 2 P32	8 Ø-Ø VD (VOLTS)	9 %VD	10 REMARK
1	ERG-3P1	GEN	GPW	258	350	60	.0102	1.6	.33	50KVA CONSR. T LOAD EXC
2	SBT-3P1	PDP-1	SBT-TS	25	#2	60	.0323	.5	.1%	
3	IT-3P1	PDP-1	IT-TS	105	#2/0	60	.0187	1.2	.25%	
4	HPPT-3P1	PDP-1	HPP-TS	128	#4/0	60	.0136	1.0	.2%	MAX. C RUN FO 2% VD G 460 N 500
5	HPPT-3P4	HPP-TS	HPPT	128	#4/0	470	.0136	8.18	1.7%	
6	IT-3P4	IT-TS	IT	105	#2/0	420	.0187	8.2	1.72%	G 400 N 430
7	SBT-3P4	SBT-TS	SBT	25	#2	540	.0323	4.31	.9%	G 550 N 1050 SEEP
8	C106-3P11 1Ø, 480V	PDP-1	SPT	104	#1/0	100	.0257	2.66	.055%	
9	C106-3P15-1 1Ø, 240V	SPT	RE	62.5	#4	280	.056	9.8	4.08%	
10	13.8 KV CABLE	POLE E257	TRANSF T1	1.0	#2	400	.0323	1.3	$.94 \times 10^{-4}$	NEGLIG BLE

VD Ø-Ø (8) = VD FACTOR (7) x L (6) /100 x AMP LOAD (4)

$$\%VD\ (9) = \frac{VD\ \phi\phi\ (8)}{V\ \phi-\phi} \times 100\%$$

$V_{\phi,\phi}$ = 480V, LV; 13,800V (HV

POINT OF REFERENCE OF %VD — TRANSF. SEC. TERM'LS,

MAXIMUM ALLOWABLE VOLTAGE DROP PER REF 1 ART 210-19 p 70

BRANCH — 3%, COMBINED BRANCH & FEEDER — 5%, FEEDER 2%

NORMAL POWER LOAD ON PDP-1 = 258 (1,4) + 50,000/480 = 362

% VOLTAGE DROP ON TRANSF SEC, FEEDER FROM TRANSF TO PDP = .23%

NORMAL POWER FEEDER % VOLTAGE DROP: SEE NEXT PAGE

FR TRANSF SEC TO IT VIA PDP, TS = .23 + .25% (3,9) + 1.72% (6,9) = 2.2% (WORST CASE

FR TRANSF SEC TO HPPT VIA PDP, TS = .23 + .2% (4,9) + 1.7% (5,9) = 2.13%

FR TRANSF SEC TO SBT VIA PDP, TS = .23 + .1 (2,9) + .9 (7,9) = 1.23%

GENERATOR POWER % FEEDER VOLTAGE DROPS = .33% (1,9) + 1.70% (5,9) = 2.0

MAXIMUM CABLE LENGTH FOR MAX. PERMISSIBLE 2% FEEDER DROP (INCLUDING GEN. FEEDER %VD) FOR RUN BET. TS & HPPT

$$= \frac{(2.0 - .33)}{128 \times .0136} \times 480 = 460'\ \text{OF}\ \#4/0 \quad **$$

KAISER ENGINEERS
HANFORD

DESIGN ANALYSIS

Calc. No. W 320-31-00
Revision 0
Page No. 7 of 7

Client: WHC
WO/Job No. ER 4289
Subject: FEEDER CABLE SIZES & % VOLTAGE DROP
Date 2/17/94 By J. C. DEL ROSARIO
Checked 5/27/94 By Donfarson
Revised By
Location: TANK FARM C

MAXIMUM CABLE LENGTH BET. TS & HPPT ON NORMAL POWER:

$= \frac{(2.0 - .23)}{.128 \times .0136} \times 480 = 488'$ USE 470'

MAXIMUM CABLE LENGTH FOR TRAILER IT ON ST. BY GEN POWER (2%

LENGTH OF CABLE RUN IN FT FROM TS TO IT TRAILER

$= \frac{(2.0 - .33)\,480}{.105 \times .0187} = 408'$ SAY 400' OF #2/0

MAX. RUN ON NORMAL POWER BETWEEN C-PDP-1 & IT VIA TS ***

$= \frac{(2.0 - .23)\,480}{.105 \times .0187} = 433'$ SAY 430'

MAXIMUM CABLE LENGTH FOR SBT, (ON STD BY GEN PWR

ASSUMING MAXIMUM TOTAL % VD OF 2%, LESS .1% V

LENGTH OF CABLE RUN IN FT FROM TS TO TRAILER SBT

$= \frac{(2.0 - .33)\,480}{.25 \times .0323} = 992$ FT SAY 990 FT **** OF #2

MAX RUN ON NORMAL POWER BETWEEN C-PDP-1 & SBT VIA TS

$= \frac{(2.0 - .23)\,480}{.25 \times .0323} = 1050$ FT

THE ABOVE CALCULATIONS LIMIT THE FEEDER DROP TO 2% MAXIMUM. SINCE THE BRANCH CIRCUITS IN THE TRAILERS ARE SHORT, THE BRANCH CIRCUIT VOLTAGE DROPS ARE NEGLIGIBLE. 5% COMBINED FEEDER AND BRANCH CIRCUIT VOLTAGE DROP WILL NOT BE EXCEEDED EVEN ON STANDBY GENERATOR POWER.

TRANSFORMER SECONDARY FEEDER TO CPDP-1

2-350 KCMIL / ϕ, Z PER 100' = .0051 Ω

FEEDER LENGTH = 60'

LOAD = 258 (1.4) + 50,000 / 480 = 362 A

$\% VD = \frac{362 \times .6 \times .0051}{480} = .23\%$

THE TRANSFORMER PRIMARY % VD = $.94 \times 10^{-4}$ % (10.5)
IS NEGLIGIBLE.

% VOLTAGE DROP AT FURTHEST CONST TRAILER ASSUMING 100% DE
FACTOR = .23 + .55 + 4.08 = 4.86 % LESS THAN 5%

FINDINGS AND CONCLUSIONS:
THE PRECEDING CALCULATIONS SHOW THAT THE SIZES OF THE 3/C TYPE MC CABLES ARE ADEQU FOR THE LOADS AND THE CALCULATED % VOLTAGE DROPS ARE WITHIN THE NEC PERMISSIBLE LIMIT

W. CAT 55-0000
1991-1992

Voltage Drop

Voltage Drop
Volts per Amp per 100 Feet; 3-Phase, Phase-to-Phase

Copper Conductors

Conductor Size AWG or MCM	Magnetic Conduit (Steel) Load Power Factor, % 60	70	80	90	100	Nonmagnetic Conduit (Aluminum or Nonmetallic) Load Power Factor, % 60	70	80	90	1
14	.3390	.3910	.4430	.4940	.5410	.3370	.3900	.4410	.4930	.5
12	.2170	.2490	.2810	.3130	.3410	.2150	.2480	.2800	.3120	.3
10	.1390	.1590	.1790	.1980	.2150	.1370	.1580	.1780	.1970	.2
8	.0905	.1030	.1150	.1260	.1350	.0888	.1010	.1140	.1250	.1
6	.0595	.0670	.0742	.0809	.0850	.0579	.0656	.0730	.0800	.0
4	.0399	.0443	.0485	.0522	.0534	.0384	.0430	.0473	.0513	.0
2	.0275	.0300	.0323	.0342	.0336	.0260	.0287	.0312	.0333	.0
1	.0233	.0251	.0267	.0279	.0267	.0218	.0238	.0256	.0270	.0
1/0	.0198	.0211	.0229	.0229	.0213	.0183	.0198	.0211	.0220	.0
2/0	.0171	.0180	.0187	.0190	.0170	.0156	.0167	.0176	.0181	.0
3/0	.0148	.0154	.0158	.0158	.0136	.0134	.0141	.0147	.0149	.0
4/0	.0130	.0134	.0136	.0133	.0109	.0116	.0121	.0124	.0124	.0
250	.0122	.0124	.0124	.0120	.0094	.0107	.0111	.0112	.0110	.0
300	.0111	.0112	.0111	.0106	.0080	.0097	.0099	.0099	.0096	.0
350	.0104	.0104	.0102	.0096	.0069	.0090	.0091	.0091	.0087	.0
500	.0100	.0091	.0087	.0080	.0053	.0078	.0077	.0075	.0070	.0
600	.0088	.0086	.0082	.0074	.0046	.0074	.0072	.0070	.0064	.0
750	.0084	.0081	.0077	.0069	.0040	.0069	.0067	.0064	.0058	.0
1000	.0080	.0077	.0072	.0063	.0035	.0064	.0062	.0058	.0052	.0

Aluminum Conductors

Conductor Size AWG or MCM	Magnetic Conduit (Steel) Load Power Factor, % 60	70	80	90	100	Nonmagnetic Conduit (Aluminum or Nonmetallic) Load Power Factor, % 60	70	80	90	10
12	.3296	.3811	.4349	.4848	.5330	.3312	.3802	.4328	.4848	.53
10	.2133	.2429	.2741	.3180	.3363	.2090	.2410	.2740	.3052	.33
8	.1305	.1552	.1758	.1951	.2106	.1286	.1534	.1745	.1933	.21
6	.0898	.1018	.1142	.1254	.1349	.0887	.1011	.1127	.1249	.13
4	.0595	.0660	.0747	.0809	.0862	.0583	.0654	.0719	.0800	.08
2	.0403	.0443	.0483	.0523	.0535	.0389	.0435	.0473	.0514	.05
1	.0332	.0357	.0396	.0423	.0428	.0318	.0349	.0391	.0411	.04
1/0	.0286	.0305	.0334	.0350	.0341	.0263	.0287	.0322	.0337	.03
2/0	.0234	.0246	.0275	.0284	.0274	.0227	.0244	.0264	.0274	.02
3/0	.0209	.0220	.0231	.0241	.0217	.0160	.0171	.0218	.0233	.02
4/0	.0172	.0174	.0179	.0177	.0170	.0152	.0159	.0171	.0179	.01
250	.0158	.0163	.0162	.0159	.0145	.0138	.0144	.0147	.0155	.01
300	.0137	.0139	.0143	.0144	.0122	.0126	.0128	.0133	.0132	.01
350	.0130	.0133	.0128	.0131	.0100	.0122	.0123	.0119	.0120	.01
500	.0112	.0111	.0114	.0099	.0076	.0093	.0094	.0094	.0091	.00
600	.0101	.0106	.0097	.0090	.0063	.0084	.0085	.0085	.0081	.00
750	.0095	.0094	.0090	.0084	.0056	.0081	.0080	.0078	.0072	.00
1000	.0085	.0082	.0078	.0071	.0043	.0069	.0068	.0065	.0058	.00

SEE IEEE REDBOOK P 99
FOR 1Ø MULTIPLIER (1.18)

HNF-2487, Rev. 0
Page C-11

APPENDIX A-

Table K: Derating Chart for Non-Compensated Thermal Magnetic Breakers Calibrated for 40°C

Breaker Ampere Rating at 40° C	Ampere Rating At 25° C (77° F)	50° C (122° F)	60° C (140° F)
Type EB			
15	17	13	11
20	22	18	16
25	28	23	21
30	33	28	26
35	39	30	25
40	44	37	34
50	55	46	42
60	66	56	52
70	77	65	60
90	99	84	78
100	110	94	87
Type EHB			
15	17	13	11
20	22	18	16
25	28	23	21
30	33	28	26
35	39	30	25
40	44	37	34
50	55	46	42
60	66	56	52
70	77	65	60
90	99	84	78
100	110	94	87
Type FB			
15	17	13	11
20	22	18	16
25	28	23	21
30	33	28	26
35	39	30	25
40	44	37	34
50	55	46	42
60	66	56	52
70	77	65	60
90	99	84	78
100	110	94	87
125	137	116	105
150	165	138	125
Type CA			
125	137	114	100
150	165	136	120
175	192	159	140
200	220	182	160
225	247	205	180
Type JB, KB			
70	79	63	55
90	102	81	71
100	115	89	76
125	140	114	102
150	171	134	116
175	200	156	134
200	230	178	153
225	252	205	183
250	281	227	201
Type DA			
250	275	235	220
300	330	276	252
350	385	325	301
400	440	372	340
Type LBB, LB			
70	85	63	55
90	107	82	73
100	121	90	79
125	145	116	106
150	188	132	111
175	210	159	141
200	243	180	157
225	255	212	198
250	294	230	208
300	364	270	236
350	412	322	291
400	471	368	333
Type LA 600 Amp Frame			
250	275	235	220
300	330	276	252
350	385	325	301
400	440	372	340
500	550	468	435
600	660	564	525
Type MA			
125	138	115	103
150	165	139	128
175	192	163	151
200	220	186	170
225	247	210	195
250	275	232	213
300	332	277	252
350	388	322	292
400	444	368	334
450	495	418	383
500	550	468	435
600	660	564	525
700	770	658	613
800	880	754	704
Type NB			
700	770	658	613
800	880	754	704
900	990	828	749
1000	1100	900	825
1200	1320	1090	1000
Type PB			
600	660	540	474
700	770	630	554
800	880	728	632
900	990	820	720
1000	1100	920	800
1100	1210	1010	891
1200	1320	1115	972
1400	1540	1304	1148
1600	1760	1500	1320
1800	1980	1690	1485
2000	2200	1880	1650
2500	2750	2350	2060
3000	3300	2820	2470

Molded Case Breakers for Application on Resistance Welding Circuits

Short circuit protection for resistance welding devices can be obtained by properly applying instantaneous trip molded case circuit breakers. These breakers permit normally high welding currents, but trip instantaneously if a short circuit develops.

These breakers include standard molded case circuit breaker features such as trip-free operation, dead front and single phase protection. Because the breakers are resistible after tipping, replacement costs and downtime are minimized.

The proper breaker can be selected by using the instantaneous trip range tables (Table L) using the "during- weld" amperes and % duty cycle.

Duty Cycle is based on the one minute averaging time of the breaker, and can be determined as follows:

$$\% \text{ Duty Cycle} = \frac{\text{Weld Time} * 100}{\text{Weld Time} + \text{Off Time}}$$

"During weld" amperes can be obtained from the welder manufacturer, or as follows:

$$\text{During-weld Amperes} = \frac{\text{During-weld KVA} * 1000}{\text{Voltage}}$$

Interrupting capacity of the breaker should be within the maximum available at the point of application.

For application information on Series C breakers in welding circuits, refer to Westinghouse.

TYPICAL DESIGNATION

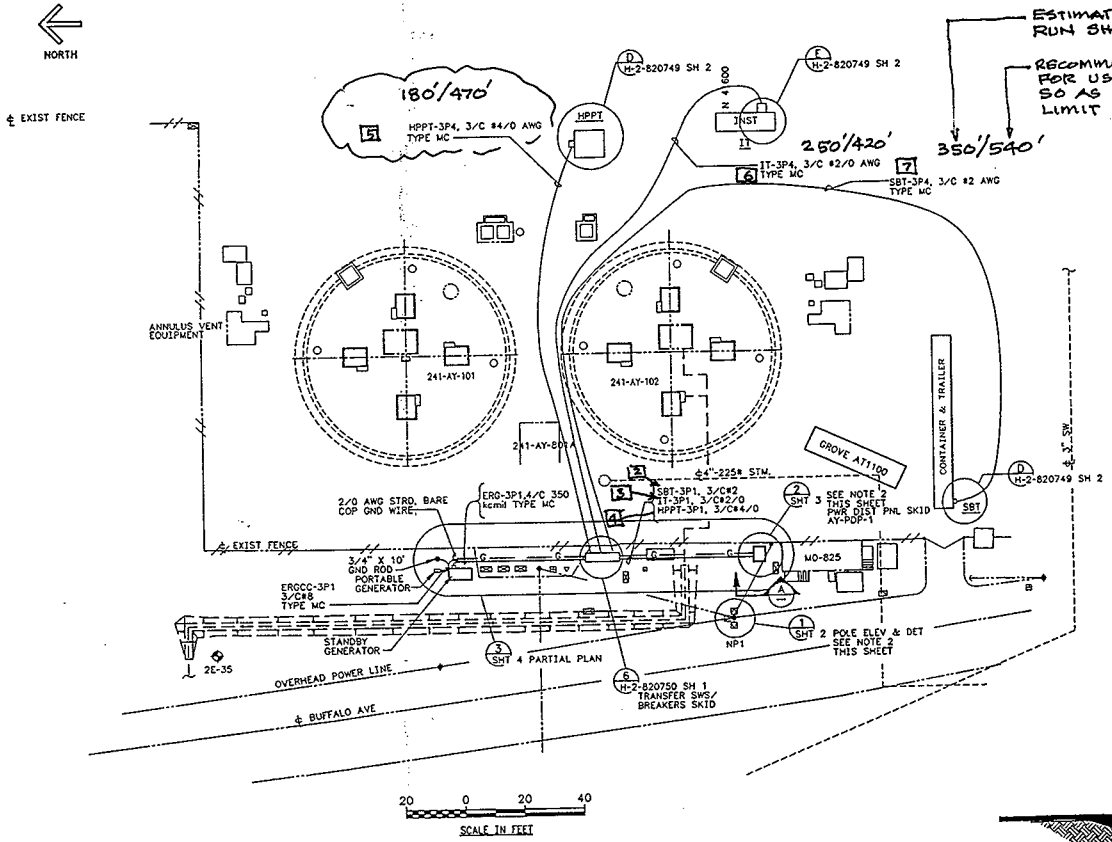
LENGTH OF CABLE RUN :

ESTIMATED CABLE LENGTH OF RUN SHOWN ON THIS PLAN

RECOMMENDATED CABLE LENGTHS FOR USE ON BOTH FARMS SO AS NOT TO EXCEED % VD LIMIT

NOTES:

1. THE EQUIPMENT REMOVAL SYSTEM (ERS) COMPONENTS (WHICH CONSISTS OF THREE EQUIPMENT TRAILERS, ONE TRANSFER SWITCHES/BREAKERS SKID, ONE STANDBY GENERATOR AND ASSOCIATED TYPE MC POWER CABLES) ARE NOT ALWAYS PRESENT AND WILL BE INSTALLED IN C-FARM AS SHOWN ON AN AS-NEEDED BASIS DURING PROJECT W320. THERE IS ONLY ONE SET OF ERS COMPONENTS, WHICH CAN BE INSTALLED IN EITHER C-FARM OR AY-FARM, AND THEN RELOCATED AS NECESSARY. THE TYPICAL DURATION FOR AN EQUIPMENT REMOVAL OPERATION IS ONE MONTH.
2. THIS WORK INCLUDES REPLACEMENT OF POLE MOUNTED TRANSFORMER BANK, INSTALLATION OF POWER DISTRIBUTION PANEL ON SKID AND TRANSFER OF EXISTING 480V SERVICES TO NEW TRANSFORMER BANK, INSTALLATION OF SERVICE ENTRANCE MAST AND METER ON STEEL POST, FEEDER IN UNDERGROUND CONDUIT TO AY-PDP-1 AND INSTALLATION OF AERIAL SERVICE DROP TO AY-PDP-1 SERVICE.
3. TYPE MC FEEDER CABLES REMOVED FROM 241-C-106 WILL BE REUSED AT 241-AY-102; EQUIPMENT LOCATIONS ARE PRELIMINARY. MAXIMUM CABLE LENGTHS ARE AS SHOWN IN NOTE 3, DRAWING H-2-820749 SH 1. CABLES WILL BE LAID ON GROUND AS SHOWN ON SECTION F OF DRAWING H-2-820749 SH 2. ROUTE CABLES ALONG FENCES OR WHERE THEY ARE FREE FROM POSSIBLE DISTURBANCES AND AWAY FROM THE ROUTE OF PUMP BEING LIFTED BY CRANE. EXCESS LENGTHS WILL BE COILED OR SNAKED. WHERE ADDED PHYSICAL PROTECTION IS NEEDED, COVER CABLE WITH 3" OF SAND AND 2" x 8" LUMBER OR 1" THICK PLYWOOD CUT TO REQUIRED WIDTH. CABLES THAT COULD POSE TRIPPING HAZARDS TO WORKERS MAY BE INSTALLED IN SHALLOW TRENCHES AND COVERED WITH SAND.
4. ROUTE CABLE AFTER CRANES AND TRAILERS ARE POSITIONED. CLEAR CABLES AWAY FROM WORK AREAS AND CRANE OPERATION AREA. REMOVE TEMPORARY CABLES AND EQUIPMENT AFTER EQUIPMENT REMOVAL AND BEFORE CRANE AND TRAILERS ARE TRANSPORTED OUT.
5. GROUND ALL NON-CURRENT CARRYING METAL PARTS SUCH AS CABINETS, SKIDS, FRAMES, CABLE ARMORS/SHIELDS, LA GROUND TERMINAL, CABLE TERMINATOR AND OPEN FUSE CUTOUT MOUNTING HARDWARE TO GROUND CONDUCTOR OR GROUND ROD.
6. SYMBOLS PER ANSI Y14.15 AND/OR Y32.2 AND ABBREVIATIONS PER ANSI Y1.1.

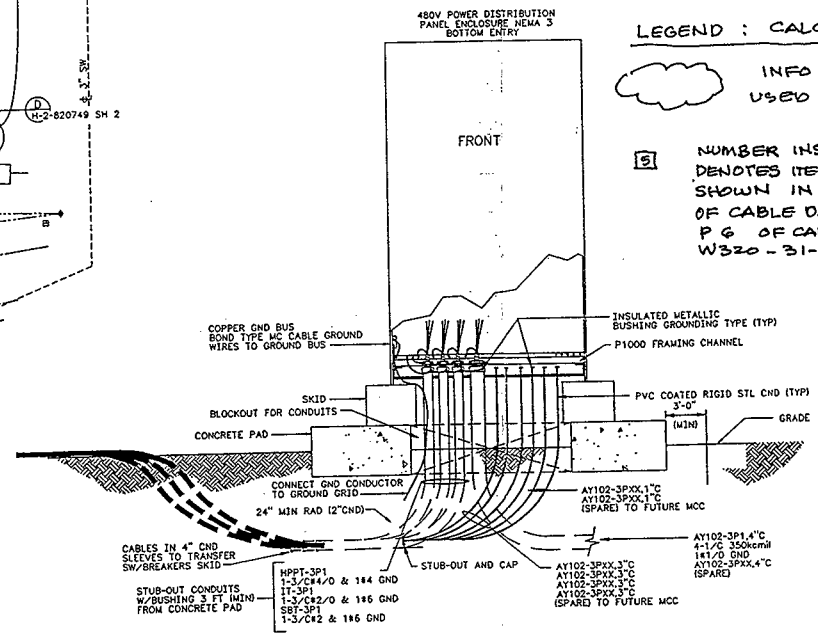


PLAN - AY FARM

LEGEND : CALCS.

INFO / DATA USED IN CALCS.

5 NUMBER INSIDE SQUARE DENOTES ITEM NO. SHOWN IN COL. 0 OF CABLE DATA ON P 6 OF CALC. NO. W320-31-003



A DETAIL - CONDUITS
SCALE: NONE

W320-31-003
APPENDIX A-3

USE	CONSTRUCTION
DESIGNED KB KNOWLES	SAFETY CLASS 3
DRAWN SEE DR/AT FORM	U.S. DEPARTMENT OF ENERGY RICHLAND OPERATIONS OFFICE ICF KAISER HANFORD COMPANY
CHECKED SEE DR/AT FORM	ELECTRICAL AY-FARM TEMPORARY SERVICE
SEE DR/AT FORM	W-320 EQUIPMENT REMOVAL SYSTEM
SEE DR/AT FORM	F 200E 8001 H-2-820752 0
REVISION NO. 0	SCALE SHOWN
APPROVED FOR IMPLEMENTATION WHC	JOB NO. ER5735 SHEET 1 OF 4
2 PLOT SCALE: 1=60	KEMCAD 1

H-2-820722 DRAWING LIST

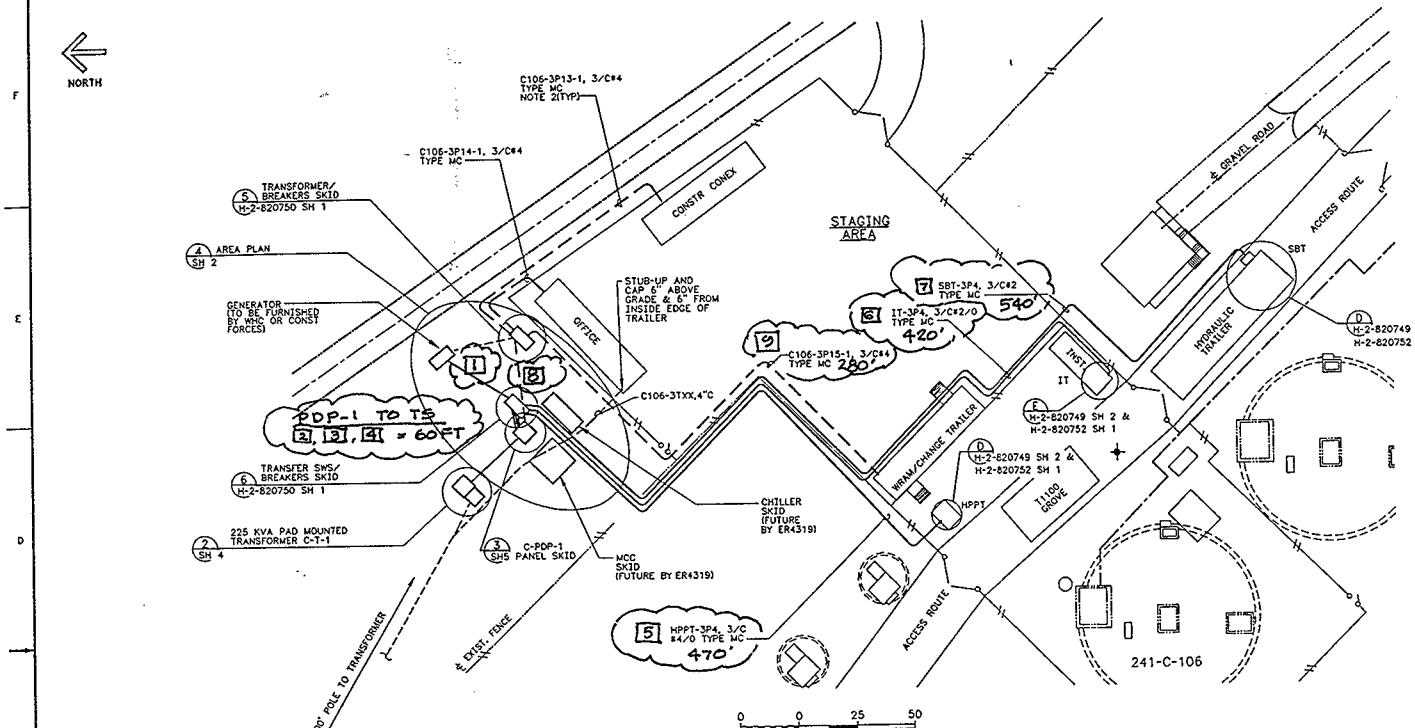
NUMBER	TITLE

DRAWING TRACEABILITY LIST

REV NO.	DATE	DESCRIPTION	REV BY	ECN APPROVALS

REVISIONS

CAD FILE B820752A CAD SCALE 2J-IBM-ACD2:12.0:NN UNITS N



PLAN - C-FARM

NOTES:

1. THIS WORK IS FOR PERMANENT INSTALLATION OF PAD MOUNTED 13.8KV-480Y/277V TRANSFORMER T1, 13.8KV UNDERGROUND FEEDER TO EXISTING POLE E257 AND POWER DISTRIBUTION PANEL C-PDP-1, TO PROVIDE POWER TO THE EQUIPMENT REMOVAL SYSTEM AND SLUICING PHASES OF W-320. THE EQUIPMENT REMOVAL SYSTEM (ERS) COMPONENTS (WHICH CONSISTS OF THREE EQUIPMENT TRAILERS, ONE TRANSFER SWITCHES/BREAKERS SKID, ONE STANDBY GENERATOR AND ASSOCIATED TYPE MC POWER CABLES) ARE NOT ALWAYS PRESENT AND WILL BE INSTALLED IN C-FARM AS SHOWN ON AN AS NEEDED BASIS DURING PROJECT W320; THERE IS ONLY ONE SET OF ERS COMPONENTS, WHICH CAN BE INSTALLED IN EITHER C-FARM OR AY-FARM, AND THEN RELOCATED AS NECESSARY. THE TYPICAL DURATION FOR AN EQUIPMENT REMOVAL OPERATION IS ONE MONTH.
2. CABLE FOR THE EQUIPMENT REMOVAL TRAILERS SHALL BE 3/C COPPER 600V, XHHW INSULATED TYPE MC, (GALVANIZED STEEL ARMOR JACKETED) APPROVED FOR DIRECT BURIAL WITH STRANDED BARE COPPER GROUND CONDUCTOR SIZED PER 1993 NEC.
3. EQUIPMENT LOCATIONS ARE PRELIMINARY. CABLE LENGTHS SHALL INCLUDE SUFFICIENT ALLOWANCE TO PERMIT RE-USE AT TANK FARM AY.
   MAXIMUM CABLE LENGTHS FROM C-PDP-1 VIA TRANSFER SWITCHES TO THE TRAILERS:
   SBT - 600'
   IT - 480'
   HPPT - 530'
4. ROUTE CABLE AFTER CRANES AND TRAILERS ARE POSITIONED. CLEAR CABLES AWAY FROM WORK AREAS AND CRANE OPERATION AREA. REMOVE TEMPORARY CABLES AND EQUIPMENT AFTER EQUIPMENT REMOVAL AND BEFORE CRANE AND TRAILERS ARE TRANSPORTED OUT.
5. SYMBOLS PER ANSI Y14.15 AND/OR Y32.2 AND ABBREVIATIONS PER ANSI Y1.1.

LEGEND: CALCS.

[9] NUMBER INSIDE SQUARE DENOTES ITEM NO. SHOWN IN COLUMN 0 (CABLE DATA P6 OF CALC # W320-31-003

INFO/DATA USED IN CALCULATIONS

LEGEND

--- UNDERGROUND CONDUIT/CABLE (PERMANENT UNLESS OTHERWISE SPECIFIED)

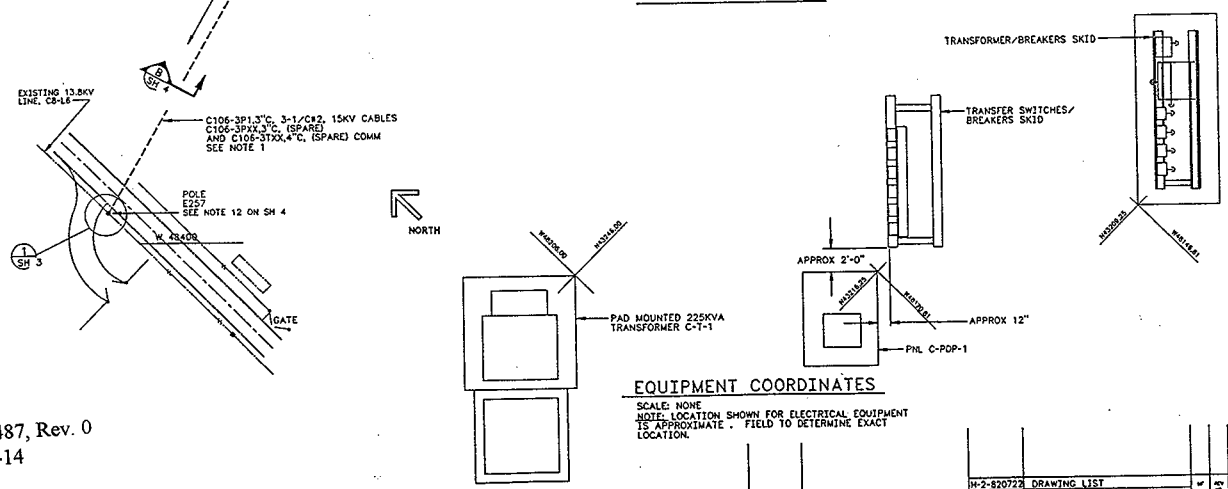
—— ABOVE GROUND TEMPORARY CABLE

☐ ELECTRICAL EQUIPMENT OR DEVICE AS INDICATED

CONDUIT/CABLE NUMBERING LEGEND

C106-3P14,1"C

- CONDUIT SIZE
- CONDUIT/CABLE NUMBER SUFFIX
- P = POWER, C = CONTROL, S = SIGNAL, T = TELEPHONE, X = DATA LINK
- SAFETY CLASS 2 OR 3
- BUILDING OR AREA DESIGNATOR (PREFIX - MAY BE OMITTED AND REFERENCED)



EQUIPMENT COORDINATES

SCALE: NONE
NOTE: LOCATION SHOWN FOR ELECTRICAL EQUIPMENT IS APPROXIMATE. FIELD TO DETERMINE EXACT LOCATION.

W320-31-003

APPENDIX A-4

USE: CONSTRUCTION			
DESIGNED KB KNOWLES	SAFETY CLASS 3	U.S. DEPARTMENT OF ENERGY RICHLAND OPERATIONS OFFICE 1CF KAISER HANFORD COMPANY	
SAFETY SEE DR/AT FORM		ELECTRICAL C-FARM TEMPORARY SERVICE PLAN	
CHKR SEE DR/AT FORM			
DWG. SUP SEE DR/AT FORM			
PROJECT W-320 EQUIPMENT REMOVAL SYSTEM			
SCALE SHOWN	DWG. NO. ER5735	SHEET 1 OF 5	REV. NO. 0
F 200E 8001	H-2-820749		

H-2-820722 DRAWING LIST

B820749A 2J1BM:ACD2:12.0:NN WHC

PLOT SCALE: 1=480 KEMCAD

8/26/04

W320-31-010

C-106 Demand Load Analysis,
Size Feeders, Voltage Drop and
Fault Study

Fluor Daniel Northwest	CALCULATION IDENTIFICATION AND INDEX	Page i of 3 Date 07/21/98

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

Discipline Electrical WO/Job No. Task Order N09 Calculation No. W320-31-010

Project No. & Name W320, Tank 241-C-106 Sluicing

Calculation Item C-106 Demand Load Analysis, Size Feeders, Voltage Drop, and Fault Study

These calculations apply to:

Dwg. No. H-2-818680, Sheet 1 Rev. No. 1

Dwg. No. Rev. No.

Other (Study, CDR)

The status of these calculations is:

[] Preliminary Calculations

[X] Final Calculations

[] Check Calculations (On Calculation Dated)

[] Void Calculation (Reason Voided)

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

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

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	TJ Kasnick 10/3/95	[illegible] 7/24/98	
Checked by	SA Najjar 10/3/95	TJ Kasnick 7/24/98	
Approved by	TJ Kasnick 10/3/95	TJ Kasnick 7/24/98	
Checked Against Approved Vendor Data	N/A	TJ Kasnick 7/24/98	

INDEX

Design Analysis Page No.	Description
i	Calculation Identification and Index
ii	Calculation Cross Index
1	Objective
2-3	Design Inputs
3	Calculations
4	Findings and Conclusions
A-1 to A-7	Attachment A: Study Input Report
B-1 to B-11	Attachment B: Demand Load Analysis
C-1 to C-9	Attachment C: Size Feeders and Transformers
D-1 to D-14	Attachment D: Load Flow and Voltage Drop
E-1 to E-36	Attachment E: Short Circuit Analysis
F	Attachment F: Drawing H-2-818680

KEH 0378.00 (06/92) KEF072

CALCULATION CROSS INDEX (Typical)

Subject Calculation No.: W320-31-010

Subject Calculation Revision No.	Superceded by Calculation No.	These interfacing calculation/documents provide input to the subject calculation, and if revised may require revision of the subject calculation.		Results and conclusions of the subject calculation are used in these interfacing calculations and/or documents		Does the output interface calculation/ documents require revision?		Has the output interfacecalculation/ documents been revised?		Discipline manager's signature and date indicating evaluation complete.
		Calculation/Document No.	Revision No.	Calculation/Document No.	Revision No.	Yes	No	Yes		
0	N/A	H-2-818680	1	W320-31-017	0		X		X	

DESIGN ANALYSIS

Client Numatec Hanford Corporation
Subject C-106 Demand Load Analysis, Size Feeders, Voltage Drop, Fault Study
Location 200E, C Tank Farm

WO/Job No. Task Order N09
Date 9/5/95 By TJ Kasnick
Checked 10/3/95 By SA Najjar
Revised 5/14/98 By Cris Carlson

1. OBJECTIVE

Determine the size of electrical equipment necessary to support the loads required for Project W320, Tank 241-C-106 Sluicing, at Tank C-106.

2. DESIGN INPUTS

2.1 Function Design Criteria for Tank 241-C-106 Waste Retrieval, Project W-320, HNF-SD-W320-FDC-001 Rev. 5.

2.2 Given or Known Data

The loads are shown on drawing H-2-818680, Sheet 1, Rev. 1. The size of motors and other equipment data are based on the Project W-320 vendor information file #22668.

2.2.1 The Variable Speed Drives (VSD) are 95% efficient.

2.2.2 Motor currents, full load amperes (FLA), which are based on the 1993 National Electrical Code (NEC) for the motor nameplate values except for the 250 HP motor which is based on vendor information, are tabulated as follows:

1) In-line Booster Pump (P-1362), at 250 HP (273A), driven by VSD.
2) Submersible (Immersible) pump (P-1361), at 40 HP (52A), driven by a soft starter.
3) Slurry Winch (W-1361), at 1.5 HP (2.6A).
4) Exhaust Skid:
   Exhaust Fan (FN-1362), at 7.5 HP (11A), driven by VSD.
   Vacuum pumps (P-1366 & P-1367), at 3 HP (4.8A) each.
5) Chiller Skid:
   Circ Pumps (P-1364 & P-1365), at 15 HP (21A) each.
   Compressor (R-1361), at 56 KVA.
6) Process Bldg: Recirc Fan (FN-1361), at 7.5 HP (11A).
7) Service Bldg: Compressor (CPR-1361), at 7.5 HP (11A).
8) Sluicer Pkg: Hydraulic Power Unit (SHC-1361), at 3 HP (4.8A)

2.2.3 Other loads:

1) Process Bldg:
   HVAC Process Heater (HC-1361), at 30 KW.
   Space Heaters (UH-1361 & UH-1362), at 4 KW each.
2) Exhaust Skid: Process Heater (HC-1362), at 3 KW.

2.2.4 Mini-Power Panels are loaded to the transformer rating:

1) C106-PP1 (Process Bldg) is 7.5 KVA.
2) C106-PP2 (EES) is 15 KVA.
3) C106-PP3 (Exhaust Skid) is 5 KVA.
4) C106-PP4 (Chiller Skid) is 3 KVA.
5) C106-PP5 (Service Bldg) is 5 KVA.
6) Sluicer Package is 0.3 KVA.

2.3 Assumptions

2.3.1 Miscellaneous loads:

1) Construction Support Trailers:
Office Trailer, at 16.6 KVA.
WRAM Trailer, at 16.6 KVA.
Conex Trailer, at 16.6 KVA.

2.3.2 Transformer impedances used are typical NEMA three phase values.

2.3.3 The utility fault current values are assumed typical values derived from previous projects and data obtained from the utilities department.

2.3.4 Dapper treats all loads as three phase loads: feeders for single phase loads must be considered separately (not part of this calculation).

2.4 Method to be used

2.4.1 The FDNW approved (for design use) software: SKM Power Tools, version 3.4.0.1, 1995-1997.

2.5 References/Sources

2.5.1 Drawing H-2-818680, Sheet 1, Rev. 1, Electrical C-Farm One-Line Diagram

2.5.2 NFPA 70, National Electrical Code (NEC), 1993 edition.

2.5.3 ANSI C2, National Electrical Safety Code, (NESC) 1990.

2.5.4 U.S. Department of Energy (DOE), order DOE 6430.1A, General Design Criteria

2.5.5 Vendor information file #22668.

3. CALCULATIONS

3.1 Attachment A: Input Report: This is the feeder, transformer, and generation input data that is used by the studies below.

3.2 Attachment B: Demand Load Analysis: This analysis calculates the total system loads based upon system bus load inputs and summarizes them on a bus by bus basis, including total system load and power factor.

3.3 Attachment C: Size Feeders and Transformers: This analysis provides the NEC Code sized feeders and transformers to meet the minimum load requirements of the Demand Load Analysis Study - Total Connected Load, and the evaluation of a fixed-size feeder to the MCC. Impedance and capacity information for the feeders and transformers were taken directly from the Dapper library, which represents typical values found in the industry. Conduit sizes determined are the minimum size required.

3.4 Attachment D: Load Flow and Voltage Drop: This analysis calculates the exact system operating voltages, loads flows, and system losses.

3.5 Attachment E: Short Circuit Analysis: This analysis calculates the system short circuit fault currents. The calculations are based upon typical Hanford 13.8 Kv utility fault current contributions, plus those from any motors running within the system.

4. FINDINGS AND CONCLUSIONS

4.1 Refer to Attachment C for system equipment sizing. Refer to other Attachments for various design information related to the distribution system equipment.

4.2 Refer to drawing H-2-818680 for one-line diagram of the electrical distribution equipment necessary to support the loads.

Attachment A

Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)
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SKM POWER*TOOLS FOR WINDOWS
INPUT DATA REPORT
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ALL PU VALUES ARE EXPRESSED ON A 100 MVA BASE.

Tue Jul 21 17:17:49 1998
Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

FEEDER INPUT DATA

FEEDER FROM NAME	FEEDER TO NAME	QTY /PH	VOLTS L-L	LENGTH	FEEDER SIZE	TYPE	DUCT	INSUL
Ug Rsr Pl E257	XFMR C-T-1 Pri	1	13800	260.0 FT	2	C M		EPR
+/- Impedance:	0.2050 + J 0.0727		OHMS/M	Length	0.0280 + J		0.0099	PU
Z0 Impedance:	0.6461 + J 0.1790		OHMS/M	Length	0.0882 + J		0.0244	PU
XFMR C-T-1 Sec	C-PDP-1 600A	2	480	25.0 FT	600	C M		THWN
+/- Impedance:	0.0250 + J 0.0480		OHMS/M	Length	0.1356 + J		0.2604	PU
Z0 Impedance:	0.0788 + J 0.1182		OHMS/M	Length	0.4275 + J		0.6413	PU
C-PDP-1 600A	Xfmr Skid	1	480	50.0 FT	1/0	C M		MCXH
+/- Impedance:	0.1200 + J 0.0550		OHMS/M	Length	2.60 + J		1.19	PU
Z0 Impedance:	0.3782 + J 0.1355		OHMS/M	Length	8.21 + J		2.94	PU
C-PDP-1 600A	MCC-N1 800A	3	480	30.0 FT	350	C M		THWN
+/- Impedance:	0.0390 + J 0.0500		OHMS/M	Length	0.1693 + J		0.2170	PU
Z0 Impedance:	0.1229 + J 0.1231		OHMS/M	Length	0.5335 + J		0.5345	PU
Process Bldg	C106-PP1 Bus	1	480	15.0 FT	8	C M		THHN
+/- Impedance:	0.7400 + J 0.0650		OHMS/M	Length	4.82 + J		0.4232	PU
Z0 Impedance:	2.33 + J 0.1601		OHMS/M	Length	15.18 + J		1.04	PU
MCC-N1 800A	Process Bldg	1	480	240.0 FT	2	C M		THWN
+/- Impedance:	0.1900 + J 0.0570		OHMS/M	Length	19.79 + J		5.94	PU
Z0 Impedance:	0.5988 + J 0.1404		OHMS/M	Length	62.37 + J		14.62	PU
MCC-N1 800A	C106-PP2 Bus	1	480	5.0 FT	12	C M		THWN
+/- Impedance:	1.90 + J 0.0680		OHMS/M	Length	4.12 + J		0.1476	PU
Z0 Impedance:	5.99 + J 0.1675		OHMS/M	Length	12.99 + J		0.3634	PU
Process Bldg	FN-1361 Bus	1	480	40.0 FT	10	C M		THHN
+/- Impedance:	1.14 + J 0.0630		OHMS/M	Length	19.79 + J		1.09	PU
Z0 Impedance:	3.59 + J 0.1552		OHMS/M	Length	62.37 + J		2.69	PU
Process Bldg	HC-1361 Bus	1	480	40.0 FT	4	C M		THHN
+/- Impedance:	0.3000 + J 0.0600		OHMS/M	Length	5.21 + J		1.04	PU
Z0 Impedance:	0.9455 + J 0.1478		OHMS/M	Length	16.41 + J		2.57	PU

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

FEEDER INPUT DATA

FEEDER FROM NAME	FEEDER TO NAME	QTY /PH	VOLTS L-L	LENGTH		FEEDER SIZE	DESCRIPTION TYPE	DUCT	INSUL
Process Bldg	UH-1362 Bus	1	480	50.0	FT	12	C	M	THHN
+/- Impedance:	1.90 + J 0.0680		OHMS/M	Length		41.23 + J		1.48	PU
ZO Impedance:	5.99 + J 0.1675		OHMS/M	Length		129.95 + J		3.63	PU
Process Bldg	UH-1361 Bus	1	480	30.0	FT	12	C	M	THHN
+/- Impedance:	1.90 + J 0.0680		OHMS/M	Length		24.74 + J		0.8854	PU
ZO Impedance:	5.99 + J 0.1675		OHMS/M	Length		77.97 + J		2.18	PU
MCC-N1 800A	Service Bldg	1	480	65.0	FT	10	C	M	THWN
+/- Impedance:	1.14 + J 0.0630		OHMS/M	Length		32.16 + J		1.78	PU
ZO Impedance:	3.59 + J 0.1552		OHMS/M	Length		101.36 + J		4.38	PU
Service Bldg	CPR-1361 Bus	1	480	15.0	FT	10	C	M	THWN
+/- Impedance:	1.14 + J 0.0630		OHMS/M	Length		7.42 + J		0.4102	PU
ZO Impedance:	3.59 + J 0.1552		OHMS/M	Length		23.39 + J		1.01	PU
Xfmr Skid	Office Trl Bus	1	480	50.0	FT	4	C	M	MCXH
+/- Impedance:	0.3000 + J 0.0600		OHMS/M	Length		6.51 + J		1.30	PU
ZO Impedance:	0.9455 + J 0.1478		OHMS/M	Length		20.52 + J		3.21	PU
Xfmr Skid	Conex Tlr Bus	1	480	100.0	FT	4	C	M	MCXH
+/- Impedance:	0.3000 + J 0.0600		OHMS/M	Length		13.02 + J		2.60	PU
ZO Impedance:	0.9455 + J 0.1478		OHMS/M	Length		41.04 + J		6.41	PU
MCC-N1 800A	Chiller Skid	1	480	30.0	FT	4/0	C	M	THWN
+/- Impedance:	0.0630 + J 0.0510		OHMS/M	Length		0.8203 + J		0.6641	PU
ZO Impedance:	0.1985 + J 0.1256		OHMS/M	Length		2.59 + J		1.64	PU
MCC-N1 800A	Exhaust Skid	1	480	320.0	FT	10	C	M	THWN
+/- Impedance:	1.14 + J 0.0630		OHMS/M	Length		158.33 + J		8.75	PU
ZO Impedance:	3.59 + J 0.1552		OHMS/M	Length		499.00 + J		21.55	PU
MCC-N1 800A	EXH Fan Vfd	1	480	10.0	FT	12	C	M	THWN
+/- Impedance:	1.90 + J 0.0680		OHMS/M	Length		8.25 + J		0.2951	PU
ZO Impedance:	5.99 + J 0.1675		OHMS/M	Length		25.99 + J		0.7269	PU

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

FEEDER INPUT DATA

FEEDER FROM NAME	FEEDER TO NAME	QTY /PH	VOLTS L-L	LENGTH	FEEDER SIZE	DESCRIPTION TYPE	DUCT	INSUL
Xfmr Skid	WRAM Tlr Bus	1	480	220.0 FT	4	C M		MCXH
+/- Impedance:	0.3000 + J 0.0600		OHMS/M	Length	28.65 + J 5.73			PU
Z0 Impedance:	0.9455 + J 0.1478		OHMS/M	Length	90.28 + J 14.11			PU
MCC-N1 800A	MCC-N2	2	480	70.0 FT	350	C M		THWN
+/- Impedance:	0.0390 + J 0.0500		OHMS/M	Length	0.5924 + J 0.7595			PU
Z0 Impedance:	0.1229 + J 0.1231		OHMS/M	Length	1.87 + J 1.87			PU
MCC-N1 800A	Sluicer Skid	1	480	240.0 FT	12	C M		THWN
+/- Impedance:	1.90 + J 0.0680		OHMS/M	Length	197.92 + J 7.08			PU
Z0 Impedance:	5.99 + J 0.1675		OHMS/M	Length	623.74 + J 17.44			PU
MCC-N1 800A	Slurry Winch	1	480	240.0 FT	12	C M		THWN
+/- Impedance:	1.90 + J 0.0680		OHMS/M	Length	197.92 + J 7.08			PU
Z0 Impedance:	5.99 + J 0.1675		OHMS/M	Length	623.74 + J 17.44			PU
MCC-N2	Booster Vfd	1	480	10.0 FT	500	C M		THWN
+/- Impedance:	0.0290 + J 0.0480		OHMS/M	Length	0.1259 + J 0.2083			PU
Z0 Impedance:	0.0914 + J 0.1182		OHMS/M	Length	0.3967 + J 0.5131			PU
MCC-N2	P-1361 SS	1	480	1.000 FT	1/0	C N		THWN
+/- Impedance:	0.1200 + J 0.0440		OHMS/M	Length	0.0521 + J 0.0191			PU
Z0 Impedance:	0.1908 + J 0.1119		OHMS/M	Length	0.0828 + J 0.0486			PU
P-1361 SS	P-1361 Bus	1	480	280.0 FT	1/0	C M		THWN
+/- Impedance:	0.1200 + J 0.0550		OHMS/M	Length	14.58 + J 6.68			PU
Z0 Impedance:	0.3782 + J 0.1355		OHMS/M	Length	45.96 + J 16.46			PU
Booster Vfd	P-1362 Bus	1	480	330.0 FT	500	C M		THWN
+/- Impedance:	0.0290 + J 0.0480		OHMS/M	Length	4.15 + J 6.88			PU
Z0 Impedance:	0.0914 + J 0.1182		OHMS/M	Length	13.09 + J 16.93			PU
EXH Fan Vfd	FN-1362 Bus	1	480	320.0 FT	12	C M		THWN
+/- Impedance:	1.90 + J 0.0680		OHMS/M	Length	263.89 + J 9.44			PU
Z0 Impedance:	5.99 + J 0.1675		OHMS/M	Length	831.66 + J 23.26			PU

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C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

FEEDER INPUT DATA

FEEDER FROM NAME	FEEDER TO NAME	QTY /PH	VOLTS L-L	LENGTH	FEEDER SIZE	DESCRIPTION TYPE	DUCT	INSUL
Service Bldg	C106-PP3 Bus	1	480	5.0 FT	10	C M		THWN
+/- Impedance:	1.14 + J 0.0630	OHMS/M	Length		2.47 + J 0.1367			PU
Z0 Impedance:	3.59 + J 0.1552	OHMS/M	Length		7.80 + J 0.3367			PU

Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
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TRANSFORMER INPUT DATA

PRIMARY RECORD NO NAME	VOLTS L-L	* SECONDARY RECORD NO NAME	VOLTS L-L	FULL-LOAD KVA	NOMINAL KVA
XFMR C-T-1 Pri D	13800.0	XFMR C-T-1 Sec YG	480.00	258.80	225.00

Pos. Seq. Z%: 1.20 + J 2.96 5.34 + j 13.13 PU
Zero Seq. Z%: 1.20 + J 2.96 5.34 + j 13.13 PU
Taps Pri. -2.50 % Sec. 0.000 % Phase Shift (Pri. Leading Sec.): 30.00 Deg.

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GENERATION DATA

BUS NAME	GENERATION	VOLT	SIZE	InitKW	MaxKVAR	TYPE
Ug Rsr P1 E257	C8-L6 13.8Kv	1.03 pu				SB

Three Phase Contribution: 3219.00 AMPS X/R : 1.75
Line to Earth Contribution: 1260.00 AMPS X/R : 1.0000
Pos sequence impedance (100 MVA base) 0.6448 + J 1.13 PU
Zero sequence impedance (100 MVA base) 5.75 + J 4.79 PU

Attachment B

Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

DATE: 7:21:1998
TIME: 17:17:11.62

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DEMAND LOAD ANALYSIS REPORT
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*** SOLUTION COMMENTS ***
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LOAD ANALYSIS INCLUDES ALL LOADS.

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C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

LOAD SUMMARY

****

LOAD SCHEDULE FOR Ug Rsr Pl E257 13800. VOLTS LINE TO LINE
SOURCE OF PWR SOURCE BUS

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
BRANCH LOADS							
XFMR C-T-1 Pri	501.1	21.0	501.1	21.0	566.9	23.7	89.63
TOTALS	501.1	21.0	501.1	21.0	566.9	23.7	89.63

LOAD SCHEDULE FOR XFMR C-T-1 Pri 13800. VOLTS LINE TO LINE
SOURCE OF PWR Ug Rsr Pl E257

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
BRANCH LOADS							
XFMR C-T-1 Sec	501.1	21.0	501.1	21.0	566.9	23.7	89.63
TOTALS	501.1	21.0	501.1	21.0	566.9	23.7	89.63

LOAD SCHEDULE FOR XFMR C-T-1 Sec 480. VOLTS LINE TO LINE
SOURCE OF PWR XFMR C-T-1 Pri

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
BRANCH LOADS							
C-PDP-1 600A	501.1	602.7	501.1	602.7	566.9	681.9	89.63
TOTALS	501.1	602.7	501.1	602.7	566.9	681.9	89.63

LOAD SCHEDULE FOR C-PDP-1 600A 480. VOLTS LINE TO LINE
SOURCE OF PWR XFMR C-T-1 Sec

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
BRANCH LOADS							
Xfmr Skid	49.8	59.9	49.8	59.9	49.8	59.9	90.00
MCC-N1 800A	451.3	542.8	451.3	542.8	517.2	622.0	89.59
TOTALS	501.1	602.7	501.1	602.7	566.9	681.9	89.63

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
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LOAD SUMMARY

****

LOAD SCHEDULE FOR Xfmr Skid 480. VOLTS LINE TO LINE
SOURCE OF PWR C-PDP-1 600A

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
BRANCH LOADS							
Office Trl Bus	16.6	20.0	16.6	20.0	16.6	20.0	90.00
Conex Tlr Bus	16.6	20.0	16.6	20.0	16.6	20.0	90.00
WRAM Tlr Bus	16.6	20.0	16.6	20.0	16.6	20.0	90.00
TOTALS	49.8	59.9	49.8	59.9	49.8	59.9	90.00

LOAD SCHEDULE FOR MCC-N1 800A 480. VOLTS LINE TO LINE
SOURCE OF PWR C-PDP-1 600A

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
BRANCH LOADS							
Process Bldg	52.8	63.5	52.8	63.5	64.2	77.3	98.77
C106-PP2 Bus	15.0	18.0	15.0	18.0	15.0	18.0	90.00
Service Bldg	14.1	16.9	14.1	16.9	16.4	19.7	83.69
Chiller Skid	76.4	91.9	76.4	91.9	90.4	108.8	80.38
Exhaust Skid	11.6	14.0	11.6	14.0	13.3	16.0	92.11
EXH Fan Vfd	9.1	11.0	9.1	11.0	11.4	13.7	80.50
MCC-N2	269.5	324.1	269.5	324.1	326.2	392.4	89.17
Sluicer Skid	4.3	5.2	4.3	5.2	5.3	6.4	80.65
Slurry Winch	2.2	2.6	2.2	2.6	2.7	3.2	80.00
TOTALS	451.3	542.8	451.3	542.8	517.2	622.0	89.59

LOAD SCHEDULE FOR C106-PP1 Bus 480. VOLTS LINE TO LINE
SOURCE OF PWR Process Bldg

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
GENERAL LOADS	7.5	9.0	7.5	9.0	7.5	9.0	90.00
TOTALS	7.5	9.0	7.5	9.0	7.5	9.0	90.00

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
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LOAD SUMMARY

****

LOAD SCHEDULE FOR Process Bldg 480. VOLTS LINE TO LINE
SOURCE OF PWR MCC-N1 800A

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
BRANCH LOADS							
C106-PP1 Bus	7.5	9.0	7.5	9.0	7.5	9.0	90.00
FN-1361 Bus	9.1	11.0	9.1	11.0	11.4	13.7	80.50
HC-1361 Bus	30.0	36.1	30.0	36.1	37.5	45.1	100.00
UH-1362 Bus	4.0	4.8	4.0	4.8	5.0	6.0	100.00
UH-1361 Bus	4.0	4.8	4.0	4.8	5.0	6.0	100.00
TOTALS	52.8	63.5	52.8	63.5	64.2	77.3	98.77

LOAD SCHEDULE FOR C106-PP2 Bus 480. VOLTS LINE TO LINE
SOURCE OF PWR MCC-N1 800A

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
GENERAL LOADS	15.0	18.0	15.0	18.0	15.0	18.0	90.00
TOTALS	15.0	18.0	15.0	18.0	15.0	18.0	90.00

LOAD SCHEDULE FOR FN-1361 Bus 480. VOLTS LINE TO LINE
SOURCE OF PWR Process Bldg

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
LARGEST KVA MTR	9.1	11.0	9.1	11.0	11.4	13.7	80.50
TOTALS	9.1	11.0	9.1	11.0	11.4	13.7	80.50

LOAD SCHEDULE FOR HC-1361 Bus 480. VOLTS LINE TO LINE
SOURCE OF PWR Process Bldg

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
HEATING	30.0	36.1	30.0	36.1	37.5	45.1	100.00
TOTALS	30.0	36.1	30.0	36.1	37.5	45.1	100.00

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

LOAD SUMMARY

****

LOAD SCHEDULE FOR UH-1362 Bus 480. VOLTS LINE TO LINE
SOURCE OF PWR Process Bldg

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
HEATING	4.0	4.8	4.0	4.8	5.0	6.0	100.00
TOTALS	4.0	4.8	4.0	4.8	5.0	6.0	100.00

LOAD SCHEDULE FOR UH-1361 Bus 480. VOLTS LINE TO LINE
SOURCE OF PWR Process Bldg

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
HEATING	4.0	4.8	4.0	4.8	5.0	6.0	100.00
TOTALS	4.0	4.8	4.0	4.8	5.0	6.0	100.00

LOAD SCHEDULE FOR Service Bldg 480. VOLTS LINE TO LINE
SOURCE OF PWR MCC-N1 800A

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
BRANCH LOADS							
C106-PP3 Bus	5.0	6.0	5.0	6.0	5.0	6.0	90.00
CPR-1361 Bus	9.1	11.0	9.1	11.0	11.4	13.7	80.50
TOTALS	14.1	16.9	14.1	16.9	16.4	19.7	83.69

LOAD SCHEDULE FOR C106-PP3 Bus 480. VOLTS LINE TO LINE
SOURCE OF PWR Service Bldg

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
GENERAL LOADS	5.0	6.0	5.0	6.0	5.0	6.0	90.00
TOTALS	5.0	6.0	5.0	6.0	5.0	6.0	90.00

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

LOAD SUMMARY

****

LOAD SCHEDULE FOR CPR-1361 Bus 480. VOLTS LINE TO LINE
SOURCE OF PWR Service Bldg

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
LARGEST KVA MTR	9.1	11.0	9.1	11.0	11.4	13.7	80.50
TOTALS	9.1	11.0	9.1	11.0	11.4	13.7	80.50

LOAD SCHEDULE FOR Office Trl Bus 480. VOLTS LINE TO LINE
SOURCE OF PWR Xfmr Skid

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
GENERAL LOADS	16.6	20.0	16.6	20.0	16.6	20.0	90.00
TOTALS	16.6	20.0	16.6	20.0	16.6	20.0	90.00

LOAD SCHEDULE FOR Conex Tlr Bus 480. VOLTS LINE TO LINE
SOURCE OF PWR Xfmr Skid

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
GENERAL LOADS	16.6	20.0	16.6	20.0	16.6	20.0	90.00
TOTALS	16.6	20.0	16.6	20.0	16.6	20.0	90.00

LOAD SCHEDULE FOR Chiller Skid 480. VOLTS LINE TO LINE
SOURCE OF PWR MCC-N1 800A

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
GENERAL LOADS	3.0	3.6	3.0	3.6	3.0	3.6	90.00
KVA TYPE MTR	17.5	21.0	17.5	21.0	17.5	21.0	80.00
LARGEST KVA MTR	56.0	67.4	56.0	67.4	70.0	84.2	80.00
TOTALS	76.4	91.9	76.4	91.9	90.4	108.8	80.38

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

LOAD SUMMARY

****

LOAD SCHEDULE FOR Exhaust Skid 480. VOLTS LINE TO LINE
SOURCE OF PWR MCC-N1 800A

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
GENERAL LOADS	5.0	6.0	5.0	6.0	5.0	6.0	90.00
HEATING	3.0	3.6	3.0	3.6	3.8	4.5	100.00
LARGEST KVA MTR	4.0	4.8	4.0	4.8	5.0	6.0	80.00
TOTALS	11.6	14.0	11.6	14.0	13.3	16.0	92.11

LOAD SCHEDULE FOR EXH Fan Vfd 480. VOLTS LINE TO LINE
SOURCE OF PWR MCC-N1 800A

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
BRANCH LOADS							
FN-1362 Bus	9.1	11.0	9.1	11.0	11.4	13.7	80.50
TOTALS	9.1	11.0	9.1	11.0	11.4	13.7	80.50

LOAD SCHEDULE FOR WRAM Tlr Bus 480. VOLTS LINE TO LINE
SOURCE OF PWR Xfmr Skid

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
GENERAL LOADS	16.6	20.0	16.6	20.0	16.6	20.0	90.00
TOTALS	16.6	20.0	16.6	20.0	16.6	20.0	90.00

LOAD SCHEDULE FOR MCC-N2 480. VOLTS LINE TO LINE
SOURCE OF PWR MCC-N1 800A

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
BRANCH LOADS							
P-1361 SS	43.2	52.0	43.2	52.0	54.0	65.0	80.30
Booster Vfd	227.0	273.0	227.0	273.0	283.7	341.2	90.30
TOTALS	269.5	324.1	269.5	324.1	326.2	392.4	89.17

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

LOAD SUMMARY

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LOAD SCHEDULE FOR Sluicer Skid 480. VOLTS LINE TO LINE
SOURCE OF PWR MCC-N1 800A

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
GENERAL LOADS	0.3	0.4	0.3	0.4	0.3	0.4	90.00
LARGEST KVA MTR	4.0	4.8	4.0	4.8	5.0	6.0	80.00
TOTALS	4.3	5.2	4.3	5.2	5.3	6.4	80.65

LOAD SCHEDULE FOR Slurry Winch 480. VOLTS LINE TO LINE
SOURCE OF PWR MCC-N1 800A

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
LARGEST KVA MTR	2.2	2.6	2.2	2.6	2.7	3.2	80.00
TOTALS	2.2	2.6	2.2	2.6	2.7	3.2	80.00

LOAD SCHEDULE FOR P-1361 SS 480. VOLTS LINE TO LINE
SOURCE OF PWR MCC-N2

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
BRANCH LOADS							
P-1361 Bus	43.2	52.0	43.2	52.0	54.0	65.0	80.30
TOTALS	43.2	52.0	43.2	52.0	54.0	65.0	80.30

LOAD SCHEDULE FOR P-1361 Bus 480. VOLTS LINE TO LINE
SOURCE OF PWR P-1361 SS

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
LARGEST KVA MTR	43.2	52.0	43.2	52.0	54.0	65.0	80.30
TOTALS	43.2	52.0	43.2	52.0	54.0	65.0	80.30

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
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LOAD SUMMARY

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LOAD SCHEDULE FOR Booster Vfd 480. VOLTS LINE TO LINE
SOURCE OF PWR MCC-N2

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
BRANCH LOADS							
P-1362 Bus	227.0	273.0	227.0	273.0	283.7	341.2	90.30
TOTALS	227.0	273.0	227.0	273.0	283.7	341.2	90.30

LOAD SCHEDULE FOR P-1362 Bus 480. VOLTS LINE TO LINE
SOURCE OF PWR Booster Vfd

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
LARGEST KVA MTR	227.0	273.0	227.0	273.0	283.7	341.2	90.30
TOTALS	227.0	273.0	227.0	273.0	283.7	341.2	90.30

LOAD SCHEDULE FOR FN-1362 Bus 480. VOLTS LINE TO LINE
SOURCE OF PWR EXH Fan Vfd

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
LARGEST KVA MTR	9.1	11.0	9.1	11.0	11.4	13.7	80.50
TOTALS	9.1	11.0	9.1	11.0	11.4	13.7	80.50

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

TOTAL SOURCE LOAD SUMMARY

LOAD DESCRIPTION TYPE	UNITS	CONNECTED LOAD	DEMAND LOAD	DESIGN LOAD	POWER FACTOR %
GENERAL LOADS	KW	77.0	77.0	77.0	
	KVAR	37.3	37.3	37.3	
	KVA	85.6	85.6	85.6	90.00 LAGGING
HEATING	KW	41.0	41.0	51.2	
	KVAR	0.0	0.0	0.0	
	KVA	41.0	41.0	51.2	100.00 UNITY
KVA TYPE MTR	KW	123.7	123.7	123.7	
	KVAR	92.2	92.2	92.2	
	KVA	154.3	154.3	154.3	80.17 LAGGING
LARGEST KVA MTR	KW	204.9	204.9	256.2	
	KVAR	97.5	97.5	121.9	
	KVA	227.0	227.0	283.7	90.30 LAGGING
TOTAL LOADS	KW	446.7	446.7	508.2	
	KVAR	227.0	227.0	251.4	
	KVA	501.1	501.1	566.9	
	% PF	89.1 LAGGING	89.1 LAGGING	89.6 LAGGING	

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
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LOAD DEMAND TABLE

LOAD DESCRIPTION	LOAD TYPE	FIRST DEMAND KVA	FIRST DEMAND %	SECOND DEMAND KVA	SECOND DEMAND %	THIRD DEMAND KVA	THIRD DEMAND %	DESIGN FACT
GENERAL LOADS	Z	100.	100.	ALL	50.	ALL	50.	1.00
LIGHTING	K	ALL	100.	ALL	100.	ALL	100.	1.25
RECEPTACLES	Z	10.	100.	ALL	50.	ALL	50.	1.00
Load Not Defined	K	ALL	0.	ALL	0.	ALL	0.	1.00
HEATING	Z	ALL	100.	ALL	100.	ALL	100.	1.25
OFFICE EQUIPMENT	Z	ALL	100.	ALL	100.	ALL	100.	1.00
WATER PUMPS	K	ALL	100.	ALL	100.	ALL	100.	1.00
VAR SPEED DRIVE	K	ALL	5.	ALL	5.	ALL	5.	1.00
SPARE	K	ALL	100.	ALL	100.	ALL	100.	1.00
SPARE	K	ALL	100.	ALL	100.	ALL	100.	1.00
HVAC MTR LOAD	K	ALL	100.	ALL	100.	ALL	100.	1.00
HVAC LGST MTR	K	ALL	100.	ALL	100.	ALL	100.	1.25
ACC MTR LOAD	K	ALL	100.	ALL	100.	ALL	100.	1.00
ACC LGST MTR	K	ALL	100.	ALL	100.	ALL	100.	1.25
SPARE	K	ALL	100.	ALL	100.	ALL	100.	1.00
SPARE	K	ALL	100.	ALL	100.	ALL	100.	1.00
SPARE	K	ALL	100.	ALL	100.	ALL	100.	1.00
SPARE	K	ALL	100.	ALL	100.	ALL	100.	1.00
SPARE	K	ALL	100.	ALL	100.	ALL	100.	1.00
SPARE	K	ALL	100.	ALL	100.	ALL	100.	1.00

NOTES: LARGEST MOTOR CIRCUIT IDENTIFIED,
AND USED TO CALCULATE DEMAND LOAD BASED ON NEC ART 430
DEMAND AND DESIGN FACTORS APPLIED AT EACH LOAD BUS
AND ALL LOAD TOTALS ARE POWER FACTOR CORRECTED
DESIGN LOAD VALUES BASED ON MOTOR RUNING OR STARTING CONDITION

Attachment C

Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

DATE: 7:21:1998
TIME: 17:17:28.59

ALL INFORMATION PRESENTED IS FOR REVIEW, APPROVAL, INTERPRETATION
AND APPLICATION BY A REGISTERED ENGINEER ONLY

SKM POWER*TOOLS FOR WINDOWS
FEEDER AND TRANSFORMER SIZING REPORT
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FEEDER AND TRANSFORMER STUDY CRITERIA

==========

SIZE AND REPORT, DO NOT CHANGE THE DATA BASE

BRANCH VOLTAGE DROP CRITERIA 3.00 %

VOLTAGE DROP CALCULATIONS ARE PRELIMINARY
EXECUTE VOLTAGE DROP AND LOAD FLOW STUDY FOR MORE ACCURATE RESULTS

PRIMARY/SECONDARY TRANSFORMER FDRS SIZED AT 125. % OF TX FULL LOAD RATING
*** NOTICE *** FEEDER SIZED TO 125. PERCENT OF TRANSFORMER SIZE
BRANCH FROM XFMR C-T-1 Pri TO XFMR C-T-1 Sec
TX KVA: 501.1 TR FLA: 21.0
MINIMUM FEEDER AMPACITY: 26.2

*** NOTICE *** FEEDER SIZED TO 125. PERCENT OF TRANSFORMER SIZE
BRANCH FROM XFMR C-T-1 Pri TO XFMR C-T-1 Sec
TX KVA: 501.1 TR FLA: 602.7
MINIMUM FEEDER AMPACITY: 753.3

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

FEEDER SIZE REPORT

****

F E E D E R S C H E D U L E

FEEDER NO	ROUTING NAME	FEEDER VOLTAGE	NO /PH	WIRE QTY	SIZE FDR	TYPE MAT	INSUL TYPE	GROUND WIRE	RACEWAY SIZE	TYPE
FROM	Ug Rsr Pl E257	13800.								
TO	XFMR C-T-1 Pri	EX	(1)	3	2	CU	EPR		2 1/2" C	M
FROM	XFMR C-T-1 Sec	480.								
TO	C-PDP-1 600A	EX	(2)	5	600	CU	THWN	2/0	3 1/2" C	M
FROM	C-PDP-1 600A	480.								
TO	Xfmr Skid	EX	(1)	4	1/0	CU	MCXH		DB	M
TO	MCC-N1 800A	EX	(3)	5	350	CU	THWN	2/0	3" C	M
FROM	Process Bldg	480.								
TO	C106-PP1 Bus	EX	(1)	4	8	CU	THHN	10	3/4" C	M
FROM	MCC-N1 800A	480.								
TO	Process Bldg	EX	(1)	4	2	CU	THWN	8	1 1/4" C	M
TO	C106-PP2 Bus	EX	(1)	4	12	CU	THWN	12	1/2" C	M
FROM	Process Bldg	480.								
TO	FN-1361 Bus	EX	(1)	4	10	CU	THHN	10	1/2" C	M
TO	HC-1361 Bus	EX	(1)	4	4	CU	THHN	8	1" C	M
TO	UH-1362 Bus	EX	(1)	4	12	CU	THHN	12	1/2" C	M
TO	UH-1361 Bus	EX	(1)	4	12	CU	THHN	12	1/2" C	M
FROM	MCC-N1 800A	480.								
TO	Service Bldg	EX	(1)	4	10	CU	THWN	10	1/2" C	M
FROM	Service Bldg	480.								
TO	CPR-1361 Bus	EX	(1)	5	10	CU	THWN	10	1/2" C	M

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

FEEDER SIZE REPORT

F E E D E R S C H E D U L E

FEEDER NO	ROUTING NAME	FEEDER VOLTAGE	NO /PH	WIRE QTY	SIZE FDR	TYPE MAT	INSUL TYPE	GROUND WIRE	RACEWAY SIZE	RACEWAY TYPE
FROM	Xfmr Skid	480.								
TO	Office Trl Bus	EX	(1)	4	4	CU	MCXH		DB	M
TO	Conex Tlr Bus	EX	(1)	4	4	CU	MCXH		DB	M
FROM	MCC-N1 800A	480.								
TO	Chiller Skid	EX	(1)	4	4/0	CU	THWN	4	2" C	M
TO	Exhaust Skid	EX	(1)	4	10	CU	THWN	10	1/2" C	M
TO	EXH Fan Vfd	EX	(1)	4	12	CU	THWN	12	1/2" C	M
FROM	Xfmr Skid	480.								
TO	WRAM Tlr Bus	EX	(1)	4	4	CU	MCXH		DB	M
FROM	MCC-N1 800A	480.								
TO	MCC-N2	EX	(2)	5	350	CU	THWN	1/0	3" C	M
TO	Sluicer Skid	EX	(1)	4	12	CU	THWN	12	1/2" C	M
TO	Slurry Winch	EX	(1)	4	12	CU	THWN	12	1/2" C	M
FROM	MCC-N2	480.								
TO	Booster Vfd	EX	(1)	4	500	CU	THWN	3	3" C	M
TO	P-1361 SS	EX	(1)	4	1/0	CU	THWN	6	1 1/2" C	N
FROM	P-1361 SS	480.								
TO	P-1361 Bus	EX	(1)	4	1/0	CU	THWN	6	1 1/2" C	M
FROM	Booster Vfd	480.								
TO	P-1362 Bus	EX	(1)	4	500	CU	THWN	3	3" C	M
FROM	EXH Fan Vfd	480.								
TO	FN-1362 Bus		(1)	3	12	CU	THWN		1/2" C	M

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

FEEDER SIZE REPORT

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F E E D E R S C H E D U L E

FEEDER NO	ROUTING NAME	FEEDER VOLTAGE	NO /PH	WIRE QTY	SIZE FDR	TYPE MAT	INSUL TYPE	GROUND WIRE	RACEWAY SIZE	RACEWAY TYPE
FROM	Service Bldg	480.								
**********										
TO	C106-PP3 Bus	EX	(1)	4	10	CU	THWN	10	1/2" C	M

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

FEEDER EVALUATION

****

F E E D E R D E S I G N L O A D A N A L Y S I S

FEEDER ROUTING NO	NAME	EXTG	% VD	QTY /PH	SIZE FDR	FEEDER MAT	DESCRIPTION INSUL	AMBIENT	DESIGN LOAD	DERATED CAPACITY
FROM	Ug Rsr Pl E257		13800.							
**********										
TO	XFMR C-T-1 Pri	EX	0.02	1		CU	EPR	30.	24. A	150. A
FROM	XFMR C-T-1 Sec		480.							
**********										
TO	C-PDP-1 600A	EX	0.13	2		CU	THWN	30.	682. A	840. A
FROM	C-PDP-1 600A		480.							
**********										
TO	Xfmr Skid	EX	0.14	1		CU	MCXH	30.	60. A	150. A
TO	MCC-N1 800A	EX	0.13	3		CU	THWN	30.	622. A	930. A
FROM	Process Bldg		480.							
**********										
TO	C106-PP1 Bus	EX	0.03	1		CU	THHN	70.	9. A	23. A
FROM	MCC-N1 800A		480.							
**********										
TO	Process Bldg	EX	1.32	1		CU	THWN	30.	77. A	95. A
TO	C106-PP2 Bus	EX	0.06	1		CU	THWN	30.	18. A	20. A
FROM	Process Bldg		480.							
**********										
TO	FN-1361 Bus	EX	0.19	1		CU	THHN	70.	14. A	17. A
TO	HC-1361 Bus	EX	0.20	1		CU	THHN	70.	45. A	41. A
TO	UH-1362 Bus	EX	0.21	1		CU	THHN	70.	6. A	12. A
TO	UH-1361 Bus	EX	0.12	1		CU	THHN	70.	6. A	12. A
FROM	MCC-N1 800A		480.							
**********										
TO	Service Bldg	EX	0.46	1		CU	THWN	30.	20. A	30. A
FROM	Service Bldg		480.							
**********										
TO	CPR-1361 Bus	EX	0.07	1		CU	THWN	30.	14. A	30. A

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

FEEDER EVALUATION

****

F E E D E R D E S I G N L O A D A N A L Y S I S

FEEDER NO	ROUTING NAME	EXTG	% VD	QTY /PH	SIZE FDR	FEEDER MAT	DESCRIPTION INSUL	AMBIENT	DESIGN LOAD	DERATED CAPACITY
FROM	Xfmr Skid		480.							
**********										
TO	Office Trl Bus	EX	0.11	1		CU	MCXH	30.	20. A	70. A
TO	Conex Tlr Bus	EX	0.21	1		CU	MCXH	30.	20. A	70. A
FROM	MCC-N1 800A		480.							
**********										
TO	Chiller Skid	EX	0.10	1		CU	THWN	30.	109. A	230. A
TO	Exhaust Skid	EX	1.98	1		CU	THWN	30.	16. A	30. A
TO	EXH Fan Vfd	EX	0.08	1		CU	THWN	30.	14. A	20. A
FROM	Xfmr Skid		480.							
**********										
TO	WRAM Tlr Bus	EX	0.47	1		CU	MCXH	30.	20. A	70. A
FROM	MCC-N1 800A		480.							
**********										
TO	MCC-N2	EX	0.28	2		CU	THWN	30.	392. A	620. A
TO	Sluicer Skid	EX	0.87	1		CU	THWN	30.	6. A	20. A
TO	Slurry Winch	EX	0.44	1		CU	THWN	30.	3. A	20. A
FROM	MCC-N2		480.							
**********										
TO	Booster Vfd	EX	0.06	1		CU	THWN	30.	341. A	380. A
TO	P-1361 SS	EX	0.00	1		CU	THWN	30.	65. A	150. A
FROM	P-1361 SS		480.							
**********										
TO	P-1361 Bus	EX	0.85	1		CU	THWN	30.	65. A	150. A
FROM	Booster Vfd		480.							
**********										
TO	P-1362 Bus	EX	1.90	1		CU	THWN	44.	341. A	380. A
FROM	EXH Fan Vfd		480.							
**********										
TO	FN-1362 Bus		2.49	1	12	CU	THWN	30.	14. A	20. A

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH I, Rev. 1)

FEEDER EVALUATION

****

F E E D E R D E S I G N L O A D A N A L Y S I S

FEEDER NO	ROUTING NAME	EXTG	% VD	QTY /PH	SIZE FDR	FEEDER MAT	DESCRIPTION INSUL	AMBIENT	DESIGN LOAD	DERATED CAPACITY
FROM	Service Bldg		480.							
TO	C106-PP3 Bus	EX	0.01	1		CU	THWN	30.	6. A	30. A

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

TRANSFORMER SIZE REPORT

****

T R A N S F O R M E R S C H E D U L E

LOCATION DESCRIPTION BUS NO. NAME	VOLTAGE LEVELS	CONN CODE	PCT. TAP	TRANSFORMER DESCRIPTION	
FROM XFMR C-T-1 Pri	13800.	D	-2.5	TYPE: <Us SIZE:	0.0 KVA
TOr XFMR C-T-1 Sec	480.	YG		DESCRIPTION: XFMR C-T-1	
DEMAND LOAD: 501.1 KVA		EX		3.19 %Z NOMINAL RATING	0.0 KVA

Attachment D

Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

DATE: 7:21:1998
TIME: 17:17:54.68

ALL INFORMATION PRESENTED IS FOR REVIEW, APPROVAL
INTERPRETATION AND APPLICATION BY A REGISTERED ENGINEER ONLY

SKM POWER*TOOLS FOR WINDOWS
LOAD FLOW AND VOLTAGE DROP ANALYSIS REPORT
COPYRIGHT SKM SYSTEMS ANALYSIS, INC. 1995-1996

DATE: 7:21:1998 TIME:17:17:54.68
Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

*** SOLUTION COMMENTS ***
==========

SOLUTION PARAMETERS

BRANCH VOLTAGE CRITERIA	:	3.00 %
BUS VOLTAGE CRITERIA	:	5.00 %
ACCELERATION FACTOR FOR 'PV' GENERATORS	:	1.00
ACCELERATION FACTOR FOR CONSTANT KVA LOADS	:	1.00
EXACT(ITERATIVE) SOLUTION	:	YES
UTILITY IMPEDANCE	:	YES
TRANSFORMER PHASE SHIFT	:	NO

ALL PU VALUES ARE EXPRESSED ON A 100 MVA BASE

LOAD FLOW IS BASED ON CALCULATED DEMAND LOAD RESULTS
FROM THE DEMAND LOAD ANALYSIS STUDY.
LOAD ANALYSIS INCLUDES ALL LOADS.

<<PERCENT VOLTAGE DROPS ARE BASED ON NOMINAL DESIGN VOLTAGES>>

SWING GENERATORS

SOURCE NAME	VOLTAGE	ANGLE
C8-L6 13.8Kv	1.030	0.00

LARGEST LOAD:	226.96 KVA	
CONVERGENCE CRITERIA:	0.011 KVA	
LARGEST BUS MISMATCH	P-1362 Bus	10.559 KVA
LARGEST BUS MISMATCH	P-1362 Bus	0.766 KVA
LARGEST BUS MISMATCH	P-1362 Bus	0.060 KVA
LARGEST BUS MISMATCH	P-1362 Bus	0.005 KVA

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

BALANCED VOLTAGE DROP AND LOAD FLOW ANALYSIS (SWING GENERATORS)
****

SOURCE	VOLTAGE	ANGLE	KW	KVAR	VD%	(UTILITY IMPEDANCE)
C8-L6 13.8Kv	1.030	0.00	463.98	269.07	0.58	0.64485+J 1.12848

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 Project W-320 / Tank 241-C-106 Sluicing
 C-Farm Electrical Distribution
 Calc. No. W320-31-010  (Reference Drawing H-2-818680, SH 1, Rev. 1)

                    BALANCED VOLTAGE DROP AND LOAD FLOW ANALYSIS
*****************************************************************************
 VOLTAGE EFFECT ON LOADS MODELED
 VOLTAGE DROP CRITERIA: BRANCH =  3.00 %   BUS =  5.00


 ==== BUS:  Ug Rsr Pl E257 DESIGN VOLTS:   13800 BUS VOLTS:   14133 %VD: -2.42
 ========================= PU BUS VOLTAGE:  1.024       ANGLE:  -0.2 DEGREES
                 *** SWING  GENERATOR: C8-L6 13.8Kv      464.0 KW   269.1 KVAR

 LOAD   TO:  XFMR C-T-1 Pri  FEEDER AMPS:  21.7 VOLTAGE DROP:     2. %VD:  0.02
 PROJECTED POWER FLOW:   462.2 KW    266.0 KVAR    533.3 KVA  PF:  0.87 LAGGING
 LOSSES THRU FEEDER:       0.1 KW     0.0 KVAR      0.1 KVA


 ==== BUS:  XFMR C-T-1 Pri DESIGN VOLTS:   13800 BUS VOLTS:   14131 %VD: -2.40
 ========================= PU BUS VOLTAGE:  1.024       ANGLE:  -0.2 DEGREES

 LOAD FROM:  Ug Rsr Pl E257  FEEDER AMPS:  21.7 VOLTAGE DROP:     2. %VD:  0.02
 PROJECTED POWER FLOW:   462.2 KW    266.0 KVAR    533.2 KVA  PF:  0.87 LAGGING
 LOSSES THRU FEEDER:       0.1 KW     0.0 KVAR      0.1 KVA

 LOAD   TO:  XFMR C-T-1 Sec  TRANSF AMPS:  21.7 VOLTAGE DROP:   407. %VD:  2.95
 PROJECTED POWER FLOW:   462.2 KW    266.0 KVAR    533.2 KVA  PF:  0.87 LAGGING
 LOSSES THRU TRANSF:      13.8 KW    33.9 KVAR     36.5 KVA


 ==== BUS:  XFMR C-T-1 Sec DESIGN VOLTS:     480 BUS VOLTS:     477 %VD:  0.55
 ========================= PU BUS VOLTAGE:  0.994       ANGLE:  -2.7 DEGREES

 LOAD FROM:  XFMR C-T-1 Pri  TRANSF AMPS:  20.6 VOLTAGE DROP:    14. %VD:  2.95
 PROJECTED POWER FLOW:   462.2 KW    266.0 KVAR    533.2 KVA  PF:  0.87 LAGGING
 LOSSES THRU TRANSF:      13.8 KW    33.9 KVAR     36.5 KVA

 LOAD   TO:  C-PDP-1 600A    FEEDER AMPS: 610.6 VOLTAGE DROP:     1. %VD:  0.12
 PROJECTED POWER FLOW:   448.4 KW    232.1 KVAR    504.9 KVA  PF:  0.89 LAGGING
 LOSSES THRU FEEDER:       0.3 KW     0.7 KVAR      0.8 KVA


 ==== BUS:  C-PDP-1 600A   DESIGN VOLTS:     480 BUS VOLTS:     477 %VD:  0.67
 ========================= PU BUS VOLTAGE:  0.993       ANGLE:  -2.8 DEGREES

 LOAD FROM:  XFMR C-T-1 Sec  FEEDER AMPS: 610.6 VOLTAGE DROP:     1. %VD:  0.12
 PROJECTED POWER FLOW:   448.0 KW    231.5 KVAR    504.3 KVA  PF:  0.89 LAGGING
 LOSSES THRU FEEDER:       0.3 KW     0.7 KVAR      0.8 KVA

 LOAD   TO:  Xfmr Skid       FEEDER AMPS:  59.2 VOLTAGE DROP:     1. %VD:  0.14
 PROJECTED POWER FLOW:    44.1 KW     21.3 KVAR     48.9 KVA  PF:  0.90 LAGGING
 LOSSES THRU FEEDER:       0.1 KW     0.0 KVAR      0.1 KVA
```

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DATE: 7:21:1998 TIME:17:17:54.68                                          PAGE    5
 Project W-320 / Tank 241-C-106 Sluicing
 C-Farm Electrical Distribution
 Calc. No. W320-31-010  (Reference Drawing H-2-818680, SH 1, Rev. 1)

                    BALANCED VOLTAGE DROP AND LOAD FLOW ANALYSIS
*****************************************************************************
 VOLTAGE EFFECT ON LOADS MODELED
 VOLTAGE DROP CRITERIA: BRANCH =  3.00 %   BUS =  5.00


 LOAD   TO:  MCC-N1 800A     FEEDER AMPS: 551.4 VOLTAGE DROP:     1. %VD:  0.11
 PROJECTED POWER FLOW:   404.0 KW    210.2 KVAR    455.4 KVA  PF:  0.89 LAGGING
 LOSSES THRU FEEDER:       0.4 KW      0.5 KVAR      0.6 KVA


 ==== BUS:  Xfmr Skid      DESIGN VOLTS:     480 BUS VOLTS:     476 %VD:  0.81
 ======================== PU BUS VOLTAGE:  0.992        ANGLE:  -2.8 DEGREES

 LOAD FROM:  C-PDP-1 600A    FEEDER AMPS:  59.2 VOLTAGE DROP:     1. %VD:  0.14
 PROJECTED POWER FLOW:    44.0 KW     21.3 KVAR     48.9 KVA  PF:  0.90 LAGGING
 LOSSES THRU FEEDER:       0.1 KW      0.0 KVAR      0.1 KVA

 LOAD   TO:  Office Trl Bus  FEEDER AMPS:  19.7 VOLTAGE DROP:     1. %VD:  0.11
 PROJECTED POWER FLOW:    14.7 KW      7.1 KVAR     16.3 KVA  PF:  0.90 LAGGING
 LOSSES THRU FEEDER:       0.0 KW      0.0 KVAR      0.0 KVA

 LOAD   TO:  Conex Tlr Bus   FEEDER AMPS:  19.7 VOLTAGE DROP:     1. %VD:  0.21
 PROJECTED POWER FLOW:    14.7 KW      7.1 KVAR     16.3 KVA  PF:  0.90 LAGGING
 LOSSES THRU FEEDER:       0.0 KW      0.0 KVAR      0.0 KVA

 LOAD   TO:  WRAM Tlr Bus    FEEDER AMPS:  19.7 VOLTAGE DROP:     2. %VD:  0.46
 PROJECTED POWER FLOW:    14.6 KW      7.1 KVAR     16.3 KVA  PF:  0.90 LAGGING
 LOSSES THRU FEEDER:       0.1 KW      0.0 KVAR      0.1 KVA


 ==== BUS:  MCC-N1 800A    DESIGN VOLTS:     480 BUS VOLTS:     476 %VD:  0.79
 ======================== PU BUS VOLTAGE:  0.992        ANGLE:  -2.8 DEGREES

 LOAD FROM:  C-PDP-1 600A    FEEDER AMPS: 551.4 VOLTAGE DROP:     1. %VD:  0.11
 PROJECTED POWER FLOW:   403.6 KW    209.7 KVAR    454.9 KVA  PF:  0.89 LAGGING
 LOSSES THRU FEEDER:       0.4 KW      0.5 KVAR      0.6 KVA

 LOAD   TO:  Process Bldg    FEEDER AMPS:  62.6 VOLTAGE DROP:     5. %VD:  1.07
 PROJECTED POWER FLOW:    51.0 KW      8.7 KVAR     51.7 KVA  PF:  0.99 LAGGING
 LOSSES THRU FEEDER:       0.5 KW      0.2 KVAR      0.6 KVA

 LOAD   TO:  C106-PP2 Bus    FEEDER AMPS:  17.8 VOLTAGE DROP:     0. %VD:  0.06
 PROJECTED POWER FLOW:    13.3 KW      6.4 KVAR     14.8 KVA  PF:  0.90 LAGGING
 LOSSES THRU FEEDER:       0.0 KW      0.0 KVAR      0.0 KVA

 LOAD   TO:  Service Bldg    FEEDER AMPS:  17.0 VOLTAGE DROP:     2. %VD:  0.40
 PROJECTED POWER FLOW:    11.8 KW      7.6 KVAR     14.0 KVA  PF:  0.84 LAGGING
 LOSSES THRU FEEDER:       0.1 KW      0.0 KVAR      0.1 KVA
```

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

BALANCED VOLTAGE DROP AND LOAD FLOW ANALYSIS

****

VOLTAGE EFFECT ON LOADS MODELED
VOLTAGE DROP CRITERIA: BRANCH = 3.00 % BUS = 5.00

```
LOAD   TO:  Chiller Skid    FEEDER AMPS:  92.6 VOLTAGE DROP:     0. %VD:  0.08
PROJECTED POWER FLOW:    61.5 KW     45.4 KVAR     76.4 KVA  PF:  0.80 LAGGING
LOSSES THRU FEEDER:       0.0 KW      0.0 KVAR      0.1 KVA

LOAD   TO:  Exhaust Skid    FEEDER AMPS:  13.8 VOLTAGE DROP:     8. %VD:  1.72
PROJECTED POWER FLOW:    10.5 KW      4.5 KVAR     11.4 KVA  PF:  0.92 LAGGING
LOSSES THRU FEEDER:       0.2 KW      0.0 KVAR      0.2 KVA

LOAD   TO:  EXH Fan Vfd     FEEDER AMPS:  11.3 VOLTAGE DROP:     0. %VD:  0.06
PROJECTED POWER FLOW:     7.6 KW      5.4 KVAR      9.3 KVA  PF:  0.81 LAGGING
LOSSES THRU FEEDER:       0.0 KW      0.0 KVAR      0.0 KVA

LOAD   TO:  MCC-N2          FEEDER AMPS: 332.5 VOLTAGE DROP:     1. %VD:  0.24
PROJECTED POWER FLOW:   242.7 KW    127.8 KVAR    274.3 KVA  PF:  0.88 LAGGING
LOSSES THRU FEEDER:       0.5 KW      0.6 KVAR      0.7 KVA

LOAD   TO:  Sluicer Skid    FEEDER AMPS:   5.2 VOLTAGE DROP:     3. %VD:  0.71
PROJECTED POWER FLOW:     3.5 KW      2.5 KVAR      4.3 KVA  PF:  0.81 LAGGING
LOSSES THRU FEEDER:       0.0 KW      0.0 KVAR      0.0 KVA

LOAD   TO:  Slurry Winch    FEEDER AMPS:   2.6 VOLTAGE DROP:     2. %VD:  0.35
PROJECTED POWER FLOW:     1.7 KW      1.3 KVAR      2.2 KVA  PF:  0.80 LAGGING
LOSSES THRU FEEDER:       0.0 KW      0.0 KVAR      0.0 KVA

==== BUS:  C106-PP1 Bus   DESIGN VOLTS:     480 BUS VOLTS:     471 %VD:  1.89
========================= PU BUS VOLTAGE:  0.981       ANGLE:  -2.9 DEGREES
                 NET BRANCH DIVERSITY LOAD:     6.5 KW     3.1 KVAR

LOAD FROM:  Process Bldg    FEEDER AMPS:   8.8 VOLTAGE DROP:     0. %VD:  0.03
PROJECTED POWER FLOW:     6.5 KW      3.1 KVAR      7.2 KVA  PF:  0.90 LAGGING
LOSSES THRU FEEDER:       0.0 KW      0.0 KVAR      0.0 KVA

==== BUS:  Process Bldg   DESIGN VOLTS:     480 BUS VOLTS:     471 %VD:  1.86
========================= PU BUS VOLTAGE:  0.981       ANGLE:  -2.9 DEGREES

LOAD FROM:  MCC-N1 800A     FEEDER AMPS:  62.6 VOLTAGE DROP:     5. %VD:  1.07
PROJECTED POWER FLOW:    50.4 KW      8.6 KVAR     51.2 KVA  PF:  0.99 LAGGING
LOSSES THRU FEEDER:       0.5 KW      0.2 KVAR      0.6 KVA
```

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 Project W-320 / Tank 241-C-106 Sluicing
 C-Farm Electrical Distribution
 Calc. No. W320-31-010  (Reference Drawing H-2-818680, SH 1, Rev. 1)

                    BALANCED VOLTAGE DROP AND LOAD FLOW ANALYSIS
*****************************************************************************
 VOLTAGE EFFECT ON LOADS MODELED
 VOLTAGE DROP CRITERIA: BRANCH =  3.00 %   BUS =  5.00


 LOAD   TO:  C106-PP1 Bus    FEEDER AMPS:   8.8 VOLTAGE DROP:     0. %VD:  0.03
 PROJECTED POWER FLOW:     6.5 KW      3.1 KVAR      7.2 KVA  PF:  0.90 LAGGING
 LOSSES THRU FEEDER:      0.0 KW     0.0 KVAR     0.0 KVA

 LOAD   TO:  FN-1361 Bus     FEEDER AMPS:  11.2 VOLTAGE DROP:     1. %VD:  0.15
 PROJECTED POWER FLOW:     7.4 KW      5.4 KVAR      9.2 KVA  PF:  0.81 LAGGING
 LOSSES THRU FEEDER:      0.0 KW     0.0 KVAR     0.0 KVA

 LOAD   TO:  HC-1361 Bus     FEEDER AMPS:  35.3 VOLTAGE DROP:     1. %VD:  0.15
 PROJECTED POWER FLOW:    28.9 KW      0.0 KVAR     28.9 KVA  PF:  1.00 UNITY
 LOSSES THRU FEEDER:      0.0 KW     0.0 KVAR     0.0 KVA

 LOAD   TO:  UH-1362 Bus     FEEDER AMPS:   4.7 VOLTAGE DROP:     1. %VD:  0.16
 PROJECTED POWER FLOW:     3.8 KW      0.0 KVAR      3.8 KVA  PF:  1.00 UNITY
 LOSSES THRU FEEDER:      0.0 KW     0.0 KVAR     0.0 KVA

 LOAD   TO:  UH-1361 Bus     FEEDER AMPS:   4.7 VOLTAGE DROP:     0. %VD:  0.10
 PROJECTED POWER FLOW:     3.8 KW      0.0 KVAR      3.8 KVA  PF:  1.00 UNITY
 LOSSES THRU FEEDER:      0.0 KW     0.0 KVAR     0.0 KVA


 ==== BUS:  C106-PP2 Bus   DESIGN VOLTS:     480 BUS VOLTS:     476 %VD:  0.84
 ========================= PU BUS VOLTAGE:  0.992       ANGLE:  -2.8 DEGREES
                 NET BRANCH DIVERSITY LOAD:    13.3 KW     6.4 KVAR

 LOAD FROM:  MCC-N1 800A     FEEDER AMPS:  17.8 VOLTAGE DROP:     0. %VD:  0.06
 PROJECTED POWER FLOW:    13.3 KW      6.4 KVAR     14.7 KVA  PF:  0.90 LAGGING
 LOSSES THRU FEEDER:      0.0 KW     0.0 KVAR     0.0 KVA


 ==== BUS:  FN-1361 Bus    DESIGN VOLTS:     480 BUS VOLTS:     470 %VD:  2.01
 ========================= PU BUS VOLTAGE:  0.980       ANGLE:  -2.8 DEGREES
                 NET BRANCH DIVERSITY LOAD:     7.4 KW     5.4 KVAR

 LOAD FROM:  Process Bldg    FEEDER AMPS:  11.2 VOLTAGE DROP:     1. %VD:  0.15
 PROJECTED POWER FLOW:     7.4 KW      5.4 KVAR      9.1 KVA  PF:  0.81 LAGGING
 LOSSES THRU FEEDER:      0.0 KW     0.0 KVAR     0.0 KVA
```

Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

BALANCED VOLTAGE DROP AND LOAD FLOW ANALYSIS

****

VOLTAGE EFFECT ON LOADS MODELED
VOLTAGE DROP CRITERIA: BRANCH = 3.00 % BUS = 5.00

```
==== BUS:  HC-1361 Bus    DESIGN VOLTS:     480 BUS VOLTS:     470 %VD:  2.01
========================= PU BUS VOLTAGE:  0.980       ANGLE:  -2.9 DEGREES
                NET BRANCH DIVERSITY LOAD:    28.8 KW     0.0 KVAR

LOAD FROM:  Process Bldg    FEEDER AMPS:  35.3 VOLTAGE DROP:     1. %VD:  0.15
PROJECTED POWER FLOW:    28.8 KW      0.0 KVAR     28.8 KVA  PF:  1.00 UNITY
LOSSES THRU FEEDER:      0.0 KW     0.0 KVAR     0.0 KVA

==== BUS:  UH-1362 Bus    DESIGN VOLTS:     480 BUS VOLTS:     470 %VD:  2.02
========================= PU BUS VOLTAGE:  0.980       ANGLE:  -2.9 DEGREES
                NET BRANCH DIVERSITY LOAD:     3.8 KW     0.0 KVAR

LOAD FROM:  Process Bldg    FEEDER AMPS:   4.7 VOLTAGE DROP:     1. %VD:  0.16
PROJECTED POWER FLOW:     3.8 KW      0.0 KVAR      3.8 KVA  PF:  1.00 UNITY
LOSSES THRU FEEDER:      0.0 KW     0.0 KVAR     0.0 KVA

==== BUS:  UH-1361 Bus    DESIGN VOLTS:     480 BUS VOLTS:     471 %VD:  1.95
======================== PU BUS VOLTAGE:  0.980       ANGLE:  -2.9 DEGREES
                NET BRANCH DIVERSITY LOAD:     3.8 KW     0.0 KVAR

LOAD FROM:  Process Bldg    FEEDER AMPS:   4.7 VOLTAGE DROP:     0. %VD:  0.10
PROJECTED POWER FLOW:     3.8 KW      0.0 KVAR      3.8 KVA  PF:  1.00 UNITY
LOSSES THRU FEEDER:      0.0 KW     0.0 KVAR     0.0 KVA

==== BUS:  Service Bldg   DESIGN VOLTS:     480 BUS VOLTS:     474 %VD:  1.18
======================== PU BUS VOLTAGE:  0.988       ANGLE:  -2.7 DEGREES

LOAD FROM:  MCC-N1 800A     FEEDER AMPS:  17.0 VOLTAGE DROP:     2. %VD:  0.40
PROJECTED POWER FLOW:    11.8 KW      7.6 KVAR     14.0 KVA  PF:  0.84 LAGGING
LOSSES THRU FEEDER:      0.1 KW     0.0 KVAR     0.1 KVA

LOAD   TO:  C106-PP3 Bus    FEEDER AMPS:   5.9 VOLTAGE DROP:     0. %VD:  0.01
PROJECTED POWER FLOW:     4.4 KW      2.1 KVAR      4.9 KVA  PF:  0.90 LAGGING
LOSSES THRU FEEDER:      0.0 KW     0.0 KVAR     0.0 KVA

LOAD   TO:  CPR-1361 Bus    FEEDER AMPS:  11.1 VOLTAGE DROP:     0. %VD:  0.06
PROJECTED POWER FLOW:     7.4 KW      5.4 KVAR      9.2 KVA  PF:  0.81 LAGGING
LOSSES THRU FEEDER:      0.0 KW     0.0 KVAR     0.0 KVA
```

Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

BALANCED VOLTAGE DROP AND LOAD FLOW ANALYSIS

****

VOLTAGE EFFECT ON LOADS MODELED
VOLTAGE DROP CRITERIA: BRANCH = 3.00 % BUS = 5.00

```
==== BUS:  C106-PP3 Bus   DESIGN VOLTS:     480 BUS VOLTS:     474 %VD:  1.20
========================= PU BUS VOLTAGE:  0.988       ANGLE:  -2.7 DEGREES
                NET BRANCH DIVERSITY LOAD:     4.4 KW     2.1 KVAR

LOAD FROM:  Service Bldg    FEEDER AMPS:   5.9 VOLTAGE DROP:     0. %VD:  0.01
PROJECTED POWER FLOW:     4.4 KW      2.1 KVAR      4.9 KVA  PF:  0.90 LAGGING
LOSSES THRU FEEDER:      0.0 KW     0.0 KVAR     0.0 KVA

==== BUS:  CPR-1361 Bus   DESIGN VOLTS:     480 BUS VOLTS:     474 %VD:  1.24
========================= PU BUS VOLTAGE:  0.988       ANGLE:  -2.7 DEGREES
                NET BRANCH DIVERSITY LOAD:     7.4 KW     5.4 KVAR

LOAD FROM:  Service Bldg    FEEDER AMPS:  11.1 VOLTAGE DROP:     0. %VD:  0.06
PROJECTED POWER FLOW:     7.4 KW      5.4 KVAR      9.1 KVA  PF:  0.81 LAGGING
LOSSES THRU FEEDER:      0.0 KW     0.0 KVAR     0.0 KVA

==== BUS:  Office Trl Bus DESIGN VOLTS:     480 BUS VOLTS:     476 %VD:  0.92
======================== PU BUS VOLTAGE:  0.991       ANGLE:  -2.8 DEGREES
                NET BRANCH DIVERSITY LOAD:    14.7 KW     7.1 KVAR

LOAD FROM:  Xfmr Skid       FEEDER AMPS:  19.7 VOLTAGE DROP:     1. %VD:  0.11
PROJECTED POWER FLOW:    14.7 KW      7.1 KVAR     16.3 KVA  PF:  0.90 LAGGING
LOSSES THRU FEEDER:      0.0 KW     0.0 KVAR     0.0 KVA

==== BUS:  Conex Tlr Bus  DESIGN VOLTS:     480 BUS VOLTS:     475 %VD:  1.03
========================= PU BUS VOLTAGE:  0.990       ANGLE:  -2.8 DEGREES
                NET BRANCH DIVERSITY LOAD:    14.6 KW     7.1 KVAR

LOAD FROM:  Xfmr Skid       FEEDER AMPS:  19.7 VOLTAGE DROP:     1. %VD:  0.21
PROJECTED POWER FLOW:    14.6 KW      7.1 KVAR     16.3 KVA  PF:  0.90 LAGGING
LOSSES THRU FEEDER:      0.0 KW     0.0 KVAR     0.0 KVA

==== BUS:  Chiller Skid   DESIGN VOLTS:     480 BUS VOLTS:     476 %VD:  0.87
========================= PU BUS VOLTAGE:  0.991       ANGLE:  -2.8 DEGREES
                NET BRANCH DIVERSITY LOAD:    61.4 KW    45.4 KVAR

LOAD FROM:  MCC-N1 800A     FEEDER AMPS:  92.6 VOLTAGE DROP:     0. %VD:  0.08
PROJECTED POWER FLOW:    61.4 KW     45.4 KVAR     76.4 KVA  PF:  0.80 LAGGING
LOSSES THRU FEEDER:      0.0 KW     0.0 KVAR     0.1 KVA
```

```
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 Project W-320 / Tank 241-C-106 Sluicing
 C-Farm Electrical Distribution
 Calc. No. W320-31-010  (Reference Drawing H-2-818680, SH 1, Rev. 1)

                    BALANCED VOLTAGE DROP AND LOAD FLOW ANALYSIS
*******************************************************************************
 VOLTAGE EFFECT ON LOADS MODELED
 VOLTAGE DROP CRITERIA: BRANCH =  3.00 %   BUS =  5.00


 ==== BUS:  Exhaust Skid   DESIGN VOLTS:     480 BUS VOLTS:     468 %VD:  2.51
 ========================= PU BUS VOLTAGE:  0.975       ANGLE:  -2.5 DEGREES
                  NET BRANCH DIVERSITY LOAD:    10.3 KW     4.5 KVAR

 LOAD FROM:  MCC-N1 800A     FEEDER AMPS:  13.8 VOLTAGE DROP:     8. %VD:  1.72
 PROJECTED POWER FLOW:    10.3 KW      4.5 KVAR      11.3 KVA  PF:  0.92 LAGGING
 LOSSES THRU FEEDER:       0.2 KW      0.0 KVAR       0.2 KVA


 ==== BUS:  EXH Fan Vfd    DESIGN VOLTS:     480 BUS VOLTS:     476 %VD:  0.85
 ========================= PU BUS VOLTAGE:  0.991       ANGLE:  -2.8 DEGREES

 LOAD FROM:  MCC-N1 800A     FEEDER AMPS:  11.3 VOLTAGE DROP:     0. %VD:  0.06
 PROJECTED POWER FLOW:     7.6 KW      5.4 KVAR       9.3 KVA  PF:  0.81 LAGGING
 LOSSES THRU FEEDER:       0.0 KW      0.0 KVAR       0.0 KVA

 LOAD   TO:  FN-1362 Bus     FEEDER AMPS:  11.3 VOLTAGE DROP:    10. %VD:  2.06
 PROJECTED POWER FLOW:     7.6 KW      5.4 KVAR       9.3 KVA  PF:  0.81 LAGGING
 LOSSES THRU FEEDER:       0.2 KW      0.0 KVAR       0.2 KVA


 ==== BUS:  WRAM Tlr Bus   DESIGN VOLTS:     480 BUS VOLTS:     474 %VD:  1.28
 ========================= PU BUS VOLTAGE:  0.987       ANGLE:  -2.7 DEGREES
                  NET BRANCH DIVERSITY LOAD:    14.6 KW     7.1 KVAR

 LOAD FROM:  Xfmr Skid       FEEDER AMPS:  19.7 VOLTAGE DROP:     2. %VD:  0.46
 PROJECTED POWER FLOW:    14.6 KW      7.1 KVAR      16.2 KVA  PF:  0.90 LAGGING
 LOSSES THRU FEEDER:       0.1 KW      0.0 KVAR       0.1 KVA


 ==== BUS:  MCC-N2         DESIGN VOLTS:     480 BUS VOLTS:     475 %VD:  1.03
 ========================= PU BUS VOLTAGE:  0.990       ANGLE:  -2.9 DEGREES

 LOAD FROM:  MCC-N1 800A     FEEDER AMPS: 332.5 VOLTAGE DROP:     1. %VD:  0.24
 PROJECTED POWER FLOW:   242.3 KW    127.2 KVAR     273.6 KVA  PF:  0.89 LAGGING
 LOSSES THRU FEEDER:       0.5 KW      0.6 KVAR       0.7 KVA

 LOAD   TO:  P-1361 SS       FEEDER AMPS:  52.8 VOLTAGE DROP:     0. %VD:  0.00
 PROJECTED POWER FLOW:    35.0 KW     25.9 KVAR      43.5 KVA  PF:  0.80 LAGGING
 LOSSES THRU FEEDER:       0.0 KW      0.0 KVAR       0.0 KVA
```

Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

BALANCED VOLTAGE DROP AND LOAD FLOW ANALYSIS

****

VOLTAGE EFFECT ON LOADS MODELED
VOLTAGE DROP CRITERIA: BRANCH = 3.00 % BUS = 5.00

LOAD TO: Booster Vfd FEEDER AMPS: 280.4 VOLTAGE DROP: 0. %VD: 0.05
PROJECTED POWER FLOW: 207.3 KW 101.4 KVAR 230.7 KVA PF: 0.90 LAGGING
LOSSES THRU FEEDER: 0.1 KW 0.1 KVAR 0.1 KVA

==== BUS: Sluicer Skid DESIGN VOLTS: 480 BUS VOLTS: 473 %VD: 1.50
========== PU BUS VOLTAGE: 0.985 ANGLE: -2.5 DEGREES
NET BRANCH DIVERSITY LOAD: 3.5 KW 2.5 KVAR

LOAD FROM: MCC-N1 800A FEEDER AMPS: 5.2 VOLTAGE DROP: 3. %VD: 0.71
PROJECTED POWER FLOW: 3.5 KW 2.5 KVAR 4.3 KVA PF: 0.81 LAGGING
LOSSES THRU FEEDER: 0.0 KW 0.0 KVAR 0.0 KVA

==== BUS: Slurry Winch DESIGN VOLTS: 480 BUS VOLTS: 475 %VD: 1.14
========== PU BUS VOLTAGE: 0.989 ANGLE: -2.7 DEGREES
NET BRANCH DIVERSITY LOAD: 1.7 KW 1.3 KVAR

LOAD FROM: MCC-N1 800A FEEDER AMPS: 2.6 VOLTAGE DROP: 2. %VD: 0.35
PROJECTED POWER FLOW: 1.7 KW 1.3 KVAR 2.2 KVA PF: 0.80 LAGGING
LOSSES THRU FEEDER: 0.0 KW 0.0 KVAR 0.0 KVA

==== BUS: P-1361 SS DESIGN VOLTS: 480 BUS VOLTS: 475 %VD: 1.03
========== PU BUS VOLTAGE: 0.990 ANGLE: -2.9 DEGREES

LOAD FROM: MCC-N2 FEEDER AMPS: 52.8 VOLTAGE DROP: 0. %VD: 0.00
PROJECTED POWER FLOW: 35.0 KW 25.9 KVAR 43.5 KVA PF: 0.80 LAGGING
LOSSES THRU FEEDER: 0.0 KW 0.0 KVAR 0.0 KVA

LOAD TO: P-1361 Bus FEEDER AMPS: 52.8 VOLTAGE DROP: 3. %VD: 0.69
PROJECTED POWER FLOW: 35.0 KW 25.9 KVAR 43.5 KVA PF: 0.80 LAGGING
LOSSES THRU FEEDER: 0.3 KW 0.1 KVAR 0.3 KVA

==== BUS: P-1361 Bus DESIGN VOLTS: 480 BUS VOLTS: 472 %VD: 1.72
========== PU BUS VOLTAGE: 0.983 ANGLE: -2.8 DEGREES
NET BRANCH DIVERSITY LOAD: 34.7 KW 25.8 KVAR

LOAD FROM: P-1361 SS FEEDER AMPS: 52.8 VOLTAGE DROP: 3. %VD: 0.69
PROJECTED POWER FLOW: 34.7 KW 25.8 KVAR 43.2 KVA PF: 0.80 LAGGING
LOSSES THRU FEEDER: 0.3 KW 0.1 KVAR 0.3 KVA

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C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

BALANCED VOLTAGE DROP AND LOAD FLOW ANALYSIS

```
*****************************************************************************
VOLTAGE EFFECT ON LOADS MODELED
VOLTAGE DROP CRITERIA: BRANCH =  3.00 %   BUS =  5.00


==== BUS:  Booster Vfd    DESIGN VOLTS:     480 BUS VOLTS:     475 %VD:  1.08
========================= PU BUS VOLTAGE:  0.989       ANGLE:  -2.9 DEGREES

LOAD FROM:  MCC-N2          FEEDER AMPS: 280.4 VOLTAGE DROP:     0. %VD:  0.05
PROJECTED POWER FLOW:   207.2 KW    101.2 KVAR    230.6 KVA  PF:  0.90 LAGGING
LOSSES THRU FEEDER:       0.1 KW      0.1 KVAR      0.1 KVA

LOAD   TO:  P-1362 Bus      FEEDER AMPS: 280.4 VOLTAGE DROP:     8. %VD:  1.57
PROJECTED POWER FLOW:   207.2 KW    101.2 KVAR    230.6 KVA  PF:  0.90 LAGGING
LOSSES THRU FEEDER:       2.3 KW      3.7 KVAR      4.4 KVA


==== BUS:  P-1362 Bus     DESIGN VOLTS:     480 BUS VOLTS:     467 %VD:  2.65
========================= PU BUS VOLTAGE:  0.974       ANGLE:  -3.5 DEGREES
                NET BRANCH DIVERSITY LOAD:   204.9 KW    97.5 KVAR

LOAD FROM:  Booster Vfd     FEEDER AMPS: 280.4 VOLTAGE DROP:     8. %VD:  1.57
PROJECTED POWER FLOW:   204.9 KW     97.5 KVAR    227.0 KVA  PF:  0.90 LAGGING
LOSSES THRU FEEDER:       2.3 KW      3.7 KVAR      4.4 KVA


==== BUS:  FN-1362 Bus    DESIGN VOLTS:     480 BUS VOLTS:     466 %VD:  2.92
========================= PU BUS VOLTAGE:  0.971       ANGLE:  -2.0 DEGREES
                NET BRANCH DIVERSITY LOAD:     7.4 KW     5.4 KVAR

LOAD FROM:  EXH Fan Vfd     FEEDER AMPS:  11.3 VOLTAGE DROP:    10. %VD:  2.06
PROJECTED POWER FLOW:     7.4 KW      5.4 KVAR      9.1 KVA  PF:  0.80 LAGGING
LOSSES THRU FEEDER:       0.2 KW      0.0 KVAR      0.2 KVA


==== BUS:  C8-L6 13.8Kv   DESIGN VOLTS:       1 BUS VOLTS:       1 %VD: -3.00
========================= PU BUS VOLTAGE:  1.030       ANGLE:   0.0 DEGREES
              *** SWING  GENERATOR: C8-L6 13.8Kv      464.0 KW   269.1 KVAR

LOAD   TO:  Ug Rsr Pl E257  FEEDER AMPS:291888 VOLTAGE DROP:     0. %VD:  0.58
PROJECTED POWER FLOW:   464.0 KW    269.1 KVAR    536.4 KVA  PF:  0.87 LAGGING
LOSSES THRU FEEDER:       1.7 KW      3.1 KVAR      3.5 KVA
```

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C-Farm Electrical Distribution
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BALANCED VOLTAGE DROP AND LOAD FLOW BUS DATA SUMMARY
****

BUS NAME	BASE VOLT	PU VOLT	BUS NAME	BASE VOLT	PU VOLT
Ug Rsr Pl E257	13800.00	1.0242	XFMR C-T-1 Pri	13800.00	1.0240
XFMR C-T-1 Sec	480.00	0.9945	C-PDP-1 600A	480.00	0.9933
Xfmr Skid	480.00	0.9919	MCC-N1 800A	480.00	0.9921
C106-PP1 Bus	480.00	0.9811	Process Bldg	480.00	0.9814
C106-PP2 Bus	480.00	0.9916	FN-1361 Bus	480.00	0.9799
HC-1361 Bus	480.00	0.9799	UH-1362 Bus	480.00	0.9798
UH-1361 Bus	480.00	0.9805	Service Bldg	480.00	0.9882
C106-PP3 Bus	480.00	0.9880	CPR-1361 Bus	480.00	0.9876
Office Trl Bus	480.00	0.9908	Conex Tlr Bus	480.00	0.9897
Chiller Skid	480.00	0.9913	Exhaust Skid	480.00	0.9749
EXH Fan Vfd	480.00	0.9915	WRAM Tlr Bus	480.00	0.9872
MCC-N2	480.00	0.9897	Sluicer Skid	480.00	0.9850
Slurry Winch	480.00	0.9886	P-1361 SS	480.00	0.9897
P-1361 Bus	480.00	0.9828	Booster Vfd	480.00	0.9892
P-1362 Bus	480.00	0.9735	FN-1362 Bus	480.00	0.9708

BALANCED VOLTAGE DROP AND LOAD FLOW BRANCH DATA SUMMARY
****

FROM NAME	TO NAME	TYPE	VD%	AMPS	KVA	RATING%
Ug Rsr Pl E257	XFMR C-T-1 Pri	FDR	0.02	21.79	533.31	14.52
XFMR C-T-1 Pri	XFMR C-T-1 Sec	TX2	2.95	21.79	533.23	206.04
XFMR C-T-1 Sec	C-PDP-1 600A	FDR	0.12	610.69	504.91	72.70
C-PDP-1 600A	Xfmr Skid	FDR	0.14	59.26	48.93	39.50
C-PDP-1 600A	MCC-N1 800A	FDR	0.11	551.45	455.38	59.30
Xfmr Skid	Office Trl Bus	FDR	0.11	19.78	16.31	28.26
Xfmr Skid	Conex Tlr Bus	FDR	0.21	19.76	16.30	28.23
Xfmr Skid	WRAM Tlr Bus	FDR	0.46	19.71	16.25	28.16
MCC-N1 800A	Process Bldg	FDR	1.07	62.69	51.71	65.99
MCC-N1 800A	C106-PP2 Bus	FDR	0.06	17.89	14.76	89.45
MCC-N1 800A	Service Bldg	FDR	0.40	17.02	14.03	56.72
MCC-N1 800A	Chiller Skid	FDR	0.08	92.68	76.44	40.29
MCC-N1 800A	Exhaust Skid	FDR	1.72	13.88	11.45	46.27
MCC-N1 800A	EXH Fan Vfd	FDR	0.06	11.33	9.35	56.65
MCC-N1 800A	MCC-N2	FDR	0.24	332.56	274.31	53.64
MCC-N1 800A	Sluicer Skid	FDR	0.71	5.23	4.31	26.15
MCC-N1 800A	Slurry Winch	FDR	0.35	2.62	2.16	13.09
Process Bldg	C106-PP1 Bus	FDR	0.03	8.85	7.22	38.15
Process Bldg	FN-1361 Bus	FDR	0.15	11.23	9.16	64.52
Process Bldg	HC-1361 Bus	FDR	0.15	35.36	28.85	87.09
Process Bldg	UH-1362 Bus	FDR	0.16	4.71	3.85	40.64

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BALANCED VOLTAGE DROP AND LOAD FLOW BRANCH DATA SUMMARY
****

FROM NAME	TO NAME	TYPE	VD%	AMPS	KVA	RATING%
Process Bldg	UH-1361 Bus	FDR	0.10	4.72	3.85	40.67
Service Bldg	C106-PP3 Bus	FDR	0.01	5.94	4.88	19.81
Service Bldg	CPR-1361 Bus	FDR	0.06	11.14	9.15	37.13
EXH Fan Vfd	FN-1362 Bus	FDR	2.06	11.33	9.34	56.65
MCC-N2	P-1361 SS	FDR	0.00	52.88	43.51	35.26
MCC-N2	Booster Vfd	FDR	0.05	280.41	230.73	73.79
P-1361 SS	P-1361 Bus	FDR	0.69	52.88	43.51	35.26
Booster Vfd	P-1362 Bus	FDR	1.57	280.41	230.62	73.79

NOTE: FDR RATING% = % AMPS RATING BASED ON LIBRARY FLA OR BRANCH INPUT FLA
TX2 RATING% = % KVA RATING BASED ON TRANSFORMER FL KVA

30 BUSES

*** T O T A L S Y S T E M L O S S E S ***
20. KW 41. KVAR

Attachment E

Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

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ALL INFORMATION PRESENTED IS FOR REVIEW, APPROVAL
INTERPRETATION AND APPLICATION BY A REGISTERED ENGINEER ONLY

SKM POWER*TOOLS FOR WINDOWS
SHORT CIRCUIT ANALYSIS REPORT
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ALL PU VALUES ARE EXPRESSED ON A 100 MVA BASE

SWING GENERATORS

SOURCE NAME	VOLTAGE	ANGLE
C8-L6 13.8Kv	1.03	0.00

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********** P R E - F A U L T V O L T A G E P R O F I L E **********

BUS# NAME	BASE VOLTS	PU VOLTS	ANGLE (D)
Ug Rsr Pl E257	13800.00	1.0300	0.
XFMR C-T-1 Pri	13800.00	1.0300	0.
XFMR C-T-1 Sec	480.00	1.0564	-30.
C-PDP-1 600A	480.00	1.0564	-30.
Xfmr Skid	480.00	1.0564	-30.
MCC-N1 800A	480.00	1.0564	-30.
C106-PP1 Bus	480.00	1.0564	-30.
Process Bldg	480.00	1.0564	-30.
C106-PP2 Bus	480.00	1.0564	-30.
FN-1361 Bus	480.00	1.0564	-30.
HC-1361 Bus	480.00	1.0564	-30.
UH-1362 Bus	480.00	1.0564	-30.
UH-1361 Bus	480.00	1.0564	-30.
Service Bldg	480.00	1.0564	-30.
C106-PP3 Bus	480.00	1.0564	-30.
CPR-1361 Bus	480.00	1.0564	-30.
Office Trl Bus	480.00	1.0564	-30.
Conex Tlr Bus	480.00	1.0564	-30.
Chiller Skid	480.00	1.0564	-30.
Exhaust Skid	480.00	1.0564	-30.
EXH Fan Vfd	480.00	1.0564	-30.
WRAM Tlr Bus	480.00	1.0564	-30.
MCC-N2	480.00	1.0564	-30.
Sluicer Skid	480.00	1.0564	-30.
Slurry Winch	480.00	1.0564	-30.
P-1361 SS	480.00	1.0564	-30.
P-1361 Bus	480.00	1.0564	-30.
Booster Vfd	480.00	1.0564	-30.
P-1362 Bus	480.00	1.0564	-30.
FN-1362 Bus	480.00	1.0564	-30.

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********** F A U L T A N A L Y S I S R E P O R T **********

FAULT TYPE: 3PH
MODEL INDUCTION MOTOR CONTRIBUTION: YES
MODEL TRANSFORMER TAPS: YES
MODEL TRANSFORMER PHASE SHIFT: YES

==========

Ug Rsr Pl E257 VOLTAGE BASE LL: 13800.0 (VOLTS)
INI. SYM. RMS FAULT CURRENT: 3338.1 / -60. (AMPS/DEG)
THEVENIN EQUIVALENT IMPEDANCE: 0.638 +j 1.122 (PU)
THEVENIN IMPEDANCE X/R RATIO: 1.759

ASYM 1/2 CYCLES	RMS 3 CYCLES	INTERRUPTING AMPS 5 CYCLES	8 CYCLES
3430.7	3338.1	3338.1	3338.1

ASYM RMS FAULTED CURRENT (AMPS)
AT TIME = 0.5 CYCLES

---PHASE A---	---PHASE B---	---PHASE C---
3430.7	3430.7	3430.7

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Project W-320 / Tank 241-C-106 Sluicing
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```
XFMR C-T-1 Pri VOLTAGE BASE LL:                13800.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:    3281.3 /  -60. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    0.666 +j   1.132 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     1.701

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    3361.9       3281.3       3281.3       3281.3

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   3361.9               3361.9               3361.9
```

```
XFMR C-T-1 Sec VOLTAGE BASE LL:                 480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:    8872.2 /  -98. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    5.342 +j  13.288 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     2.487

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    9555.5       8872.2       8872.2       8872.2

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   9555.5               9555.4               9555.5
```

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Project W-320 / Tank 241-C-106 Sluicing
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C-PDP-1 600A

VOLTAGE BASE LL: 480.0 (VOLTS)
INI. SYM. RMS FAULT CURRENT: 8722.2 / -98. (AMPS/DEG)
THEVENIN EQUIVALENT IMPEDANCE: 5.448 +j 13.511 (PU)
THEVENIN IMPEDANCE X/R RATIO: 2.480

ASYM 1/2 CYCLES	RMS 3 CYCLES	INTERRUPTING AMPS 5 CYCLES	8 CYCLES
9389.1	8722.2	8722.2	8722.2

ASYM RMS FAULTED CURRENT (AMPS)
AT TIME = 0.5 CYCLES

---PHASE A---	---PHASE B---	---PHASE C---
9389.1	9389.1	9389.1

Xfmr Skid

VOLTAGE BASE LL: 480.0 (VOLTS)
INI. SYM. RMS FAULT CURRENT: 7579.3 / -91. (AMPS/DEG)
THEVENIN EQUIVALENT IMPEDANCE: 8.052 +j 14.705 (PU)
THEVENIN IMPEDANCE X/R RATIO: 1.826

ASYM 1/2 CYCLES	RMS 3 CYCLES	INTERRUPTING AMPS 5 CYCLES	8 CYCLES
7818.4	7579.3	7579.3	7579.3

ASYM RMS FAULTED CURRENT (AMPS)
AT TIME = 0.5 CYCLES

---PHASE A---	---PHASE B---	---PHASE C---
7818.4	7818.4	7818.4

Project W-320 / Tank 241-C-106 Sluicing
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```
MCC-N1 800A     VOLTAGE BASE LL:                    480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   8590.1 /  -98. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    5.582 +j  13.698 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     2.454

                 ASYM    RMS   INTERRUPTING AMPS
                 1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                     9230.0       8590.1       8590.1       8590.1

                ASYM    RMS   FAULTED CURRENT ( AMPS )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---        ---PHASE B---        ---PHASE C---
                    9230.0               9230.0               9230.0
-------------------------------------------------------------------------------

C106-PP1 Bus    VOLTAGE BASE LL:                    480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   3505.5 /  -64. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:   30.192 +j  20.059 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     0.664

                 ASYM    RMS   INTERRUPTING AMPS
                 1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                     3505.8       3505.5       3505.5       3505.5

                ASYM    RMS   FAULTED CURRENT ( AMPS )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---        ---PHASE B---        ---PHASE C---
                    3505.8               3505.8               3505.8
-------------------------------------------------------------------------------
```

Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

```
Process Bldg   VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:    3960.4 /  -68. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    25.374 +j  19.636 (PU)
               THEVENIN IMPEDANCE X/R RATIO:      0.774

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    3961.6       3960.4       3960.4       3960.4

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   3961.6               3961.6               3961.6
```

```
C106-PP2 Bus   VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:    7514.8 /  -85. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:     9.706 +j  13.846 (PU)
               THEVENIN IMPEDANCE X/R RATIO:      1.427

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    7606.1       7514.8       7514.8       7514.8

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   7606.1               7606.1               7606.1
```

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

```
FN-1361 Bus    VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   2556.9 /  -55. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:   45.166 +j  20.730 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     0.459

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    2556.9       2556.9       2556.9       2556.9

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   2556.9               2556.9               2556.9
-------------------------------------------------------------------------------

HC-1361 Bus    VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   3442.0 /  -64. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:   30.582 +j  20.678 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     0.676

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    3442.3       3442.0       3442.0       3442.0

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   3442.3               3442.3               3442.3
-------------------------------------------------------------------------------
```

Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

```
UH-1362 Bus    VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   1818.5 /  -48. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:   66.607 +j  21.112 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     0.317

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    1818.5       1818.5       1818.5       1818.5

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   1818.5               1818.5               1818.5
```

```
UH-1361 Bus    VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   2346.5 /  -52. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:   50.114 +j  20.521 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     0.409

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    2346.5       2346.5       2346.5       2346.5

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   2346.5               2346.5               2346.5
```

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

```
Service Bldg   VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:    3114.9 /  -52. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:   37.744 +j  15.476 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     0.410

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    3114.9       3114.9       3114.9       3114.9

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   3114.9               3114.9               3114.9
```

```
C106-PP3 Bus   VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:    2945.3 /  -51. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:   40.218 +j  15.612 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     0.388

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    2945.3       2945.3       2945.3       2945.3

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   2945.3               2945.3               2945.3
```

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C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

```
CPR-1361 Bus   VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:    2654.0 /  -49. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    45.166 +j  15.886 (PU)
               THEVENIN IMPEDANCE X/R RATIO:      0.352

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    2654.0       2654.0       2654.0       2654.0

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   2654.0               2654.0               2654.0
```

```
Office Trl Bus VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:    5871.9 /  -78. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    14.562 +j  16.007 (PU)
               THEVENIN IMPEDANCE X/R RATIO:      1.099

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    5891.2       5871.9       5871.9       5871.9

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   5891.2               5891.2               5891.2
```

Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

```
Conex Tlr Bus  VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:    4659.5 /  -69. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    21.073 +j  17.309 (PU)
               THEVENIN IMPEDANCE X/R RATIO:      0.821

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    4661.8       4659.5       4659.5       4659.5

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                      AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   4661.8               4661.7               4661.7
```

```
Chiller Skid   VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:    8115.8 /  -96. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:     6.322 +j  14.324 (PU)
               THEVENIN IMPEDANCE X/R RATIO:      2.266

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    8607.9       8115.8       8115.8       8115.8

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                      AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   8607.9               8607.9               8607.9
```

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

Exhaust Skid

```
VOLTAGE BASE LL:                    480.0 (VOLTS)
INI. SYM. RMS FAULT CURRENT:      768.0 /  -38. ( AMPS/DEG )
THEVENIN EQUIVALENT IMPEDANCE:  163.916 +j  22.448 (PU)
THEVENIN IMPEDANCE X/R RATIO:     0.137

 ASYM    RMS   INTERRUPTING AMPS
 1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
      768.0        768.0        768.0        768.0

ASYM    RMS   FAULTED CURRENT ( AMPS )
        AT TIME =     0.5 CYCLES
---PHASE A---        ---PHASE B---        ---PHASE C---
     768.0               768.0               768.0
```

EXH Fan Vfd

```
VOLTAGE BASE LL:                    480.0 (VOLTS)
INI. SYM. RMS FAULT CURRENT:     6458.7 /  -75. ( AMPS/DEG )
THEVENIN EQUIVALENT IMPEDANCE:   13.829 +j  13.993 (PU)
THEVENIN IMPEDANCE X/R RATIO:     1.012

 ASYM    RMS   INTERRUPTING AMPS
 1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
     6471.6       6458.7       6458.7       6458.7

ASYM    RMS   FAULTED CURRENT ( AMPS )
        AT TIME =     0.5 CYCLES
---PHASE A---        ---PHASE B---        ---PHASE C---
    6471.6              6471.6              6471.6
```

Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

```
WRAM Tlr Bus   VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   3025.2 /  -59. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:   36.698 +j  20.434 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     0.557

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    3025.2       3025.2       3025.2       3025.2

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   3025.2               3025.2               3025.2
-------------------------------------------------------------------------------

MCC-N2         VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   8121.7 /  -97. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    6.111 +j  14.402 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     2.357

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    8667.9       8121.7       8121.7       8121.7

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   8667.9               8667.9               8667.9
-------------------------------------------------------------------------------
```

Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

```
Sluicer Skid   VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:      621.2 /  -36. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:  203.499 +j  20.782 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     0.102

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                     621.2        621.2        621.2        621.2

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                    621.2                621.2                621.2
```

```
Slurry Winch   VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:      621.2 /  -36. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:  203.499 +j  20.782 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     0.102

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                     621.2        621.2        621.2        621.2

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                    621.2                621.2                621.2
```

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

P-1361 SS

VOLTAGE BASE LL: 480.0 (VOLTS)
INI. SYM. RMS FAULT CURRENT: 8103.4 / -97. (AMPS/DEG)
THEVENIN EQUIVALENT IMPEDANCE: 6.158 +j 14.421 (PU)
THEVENIN IMPEDANCE X/R RATIO: 2.342

ASYM RMS INTERRUPTING AMPS			
1/2 CYCLES	3 CYCLES	5 CYCLES	8 CYCLES
8639.4	8103.4	8103.4	8103.4

ASYM RMS FAULTED CURRENT (AMPS)
AT TIME = 0.5 CYCLES

---PHASE A---	---PHASE B---	---PHASE C---
8639.4	8639.4	8639.4

P-1361 Bus

VOLTAGE BASE LL: 480.0 (VOLTS)
INI. SYM. RMS FAULT CURRENT: 4504.3 / -78. (AMPS/DEG)
THEVENIN EQUIVALENT IMPEDANCE: 18.708 +j 21.114 (PU)
THEVENIN IMPEDANCE X/R RATIO: 1.129

ASYM RMS INTERRUPTING AMPS			
1/2 CYCLES	3 CYCLES	5 CYCLES	8 CYCLES
4521.5	4504.3	4504.3	4504.3

ASYM RMS FAULTED CURRENT (AMPS)
AT TIME = 0.5 CYCLES

---PHASE A---	---PHASE B---	---PHASE C---
4521.5	4521.5	4521.5

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
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Booster Vfd

VOLTAGE BASE LL: 480.0 (VOLTS)
INI. SYM. RMS FAULT CURRENT: 7998.5 / -97. (AMPS/DEG)
THEVENIN EQUIVALENT IMPEDANCE: 6.237 +j 14.611 (PU)
THEVENIN IMPEDANCE X/R RATIO: 2.342

ASYM RMS INTERRUPTING AMPS			
1/2 CYCLES	3 CYCLES	5 CYCLES	8 CYCLES
8528.1	7998.5	7998.5	7998.5

ASYM RMS FAULTED CURRENT (AMPS)
AT TIME = 0.5 CYCLES

---PHASE A---	---PHASE B---	---PHASE C---
8528.1	8528.1	8528.1

P-1362 Bus

VOLTAGE BASE LL: 480.0 (VOLTS)
INI. SYM. RMS FAULT CURRENT: 5324.2 / -94. (AMPS/DEG)
THEVENIN EQUIVALENT IMPEDANCE: 10.391 +j 21.485 (PU)
THEVENIN IMPEDANCE X/R RATIO: 2.068

ASYM RMS INTERRUPTING AMPS			
1/2 CYCLES	3 CYCLES	5 CYCLES	8 CYCLES
5573.4	5324.2	5324.2	5324.2

ASYM RMS FAULTED CURRENT (AMPS)
AT TIME = 0.5 CYCLES

---PHASE A---	---PHASE B---	---PHASE C---
5573.4	5573.4	5573.4

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C-Farm Electrical Distribution
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```
FN-1362 Bus    VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:      455.9 /  -35. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:  277.718 +j  23.438 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     0.084

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                     455.9        455.9        455.9        455.9

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                      AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                    455.9                455.9                455.9
```

****

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Project W-320 / Tank 241-C-106 Sluicing
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********** F A U L T A N A L Y S I S R E P O R T **********

FAULT TYPE: SLG
MODEL INDUCTION MOTOR CONTRIBUTION: YES
MODEL TRANSFORMER TAPS: YES
MODEL TRANSFORMER PHASE SHIFT: YES

==========

Ug Rsr Pl E257 VOLTAGE BASE LL: 13800.0 (VOLTS)
INI. SYM. RMS FAULT CURRENT: 1300.2 / -45. (AMPS/DEG)
THEVENIN EQUIVALENT IMPEDANCE: 7.030 +j 7.031 (PU)
THEVENIN IMPEDANCE X/R RATIO: 1.000
SEQUENCE EQUIVALENT IMPEDANCE Z1: 0.638 +j 1.122 (PU)
Z2: 0.638 +j 1.122 (PU)
Z0: 5.754 +j 4.787 (PU)

ASYM RMS INTERRUPTING AMPS			
1/2 CYCLES	3 CYCLES	5 CYCLES	8 CYCLES
1302.6	1300.2	1300.2	1300.2

ASYM RMS FAULTED CURRENT (AMPS)
AT TIME = 0.5 CYCLES

---PHASE A---	---PHASE B---	---PHASE C---
1302.6	0.0	0.0

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Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

```
XFMR C-T-1 Pri VOLTAGE BASE LL:                    13800.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:        1283.1 /  -45. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:        7.173 +j   7.075 (PU)
               THEVENIN IMPEDANCE X/R RATIO:         0.986
               SEQUENCE EQUIVALENT IMPEDANCE Z1:     0.666 +j   1.132 (PU)
                                             Z2:     0.666 +j   1.132 (PU)
                                             Z0:     5.842 +j   4.811 (PU)

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    1285.3       1283.1       1283.1       1283.1

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   1285.3                 0.0                  0.0
```

```
XFMR C-T-1 Sec VOLTAGE BASE LL:                     480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:        8902.0 /  -98. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:       16.024 +j  39.711 (PU)
               THEVENIN IMPEDANCE X/R RATIO:         2.478
               SEQUENCE EQUIVALENT IMPEDANCE Z1:     5.342 +j  13.288 (PU)
                                             Z2:     5.342 +j  13.288 (PU)
                                             Z0:     5.340 +j  13.134 (PU)

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    9581.3       8902.0       8902.0       8902.0

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   9581.3                 0.0                  0.0
```

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C-Farm Electrical Distribution
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C-PDP-1 600A

```
VOLTAGE BASE LL:                          480.0 (VOLTS)
INI. SYM. RMS FAULT CURRENT:            8649.9 /  -98. ( AMPS/DEG )
THEVENIN EQUIVALENT IMPEDANCE:            16.663 +j  40.798 (PU)
THEVENIN IMPEDANCE X/R RATIO:              2.448
SEQUENCE EQUIVALENT IMPEDANCE Z1:          5.448 +j  13.511 (PU)
                              Z2:          5.448 +j  13.511 (PU)
                              Z0:          5.768 +j  13.776 (PU)

 ASYM    RMS   INTERRUPTING AMPS
 1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
     9290.7       8649.9       8649.9       8649.9

ASYM    RMS   FAULTED CURRENT ( AMPS )
        AT TIME =     0.5 CYCLES
---PHASE A---        ---PHASE B---        ---PHASE C---
    9290.7                 0.0                  0.0
```

Xfmr Skid

```
VOLTAGE BASE LL:                          480.0 (VOLTS)
INI. SYM. RMS FAULT CURRENT:            6922.5 /  -87. ( AMPS/DEG )
THEVENIN EQUIVALENT IMPEDANCE:            30.079 +j  46.126 (PU)
THEVENIN IMPEDANCE X/R RATIO:              1.533
SEQUENCE EQUIVALENT IMPEDANCE Z1:          8.052 +j  14.705 (PU)
                              Z2:          8.052 +j  14.705 (PU)
                              Z0:         13.975 +j  16.716 (PU)

 ASYM    RMS   INTERRUPTING AMPS
 1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
     7036.6       6922.5       6922.5       6922.5

ASYM    RMS   FAULTED CURRENT ( AMPS )
        AT TIME =     0.5 CYCLES
---PHASE A---        ---PHASE B---        ---PHASE C---
    7036.6                 0.0                  0.0
```

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Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

```
MCC-N1 800A    VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   8430.6 /  -97. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:   17.466 +j  41.707 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     2.388
               SEQUENCE EQUIVALENT IMPEDANCE Z1:   5.582 +j  13.698 (PU)
                                             Z2:   5.582 +j  13.698 (PU)
                                             Z0:   6.301 +j  14.310 (PU)

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    9017.1       8430.6       8430.6       8430.6

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                      AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   9017.1                 0.0                  0.0
```

```
C106-PP1 Bus   VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   2377.0 /  -56. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:  144.242 +j  70.093 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     0.486
               SEQUENCE EQUIVALENT IMPEDANCE Z1:  30.192 +j  20.059 (PU)
                                             Z2:  30.192 +j  20.059 (PU)
                                             Z0:  83.859 +j  29.975 (PU)

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    2377.0       2377.0       2377.0       2377.0

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                      AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   2377.0                 0.0                  0.0
```

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

```
Process Bldg   VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:    2771.8 /  -60. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:  119.424 +j  68.204 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     0.571
               SEQUENCE EQUIVALENT IMPEDANCE Z1:  25.374 +j  19.636 (PU)
                                             Z2:  25.374 +j  19.636 (PU)
                                             Z0:  68.675 +j  28.932 (PU)

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    2771.8       2771.8       2771.8       2771.8

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   2771.8                 0.0                  0.0
```

```
C106-PP2 Bus   VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:    6642.8 /  -78. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:   38.707 +j  42.365 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     1.095
               SEQUENCE EQUIVALENT IMPEDANCE Z1:   9.706 +j  13.846 (PU)
                                             Z2:   9.706 +j  13.846 (PU)
                                             Z0:  19.296 +j  14.673 (PU)

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    6664.1       6642.8       6642.8       6642.8

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   6664.1                 0.0                  0.0
```

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

```
FN-1361 Bus     VOLTAGE BASE LL:                    480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   1635.1 /  -48. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:  221.381 +j  73.085 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     0.330
                SEQUENCE EQUIVALENT IMPEDANCE Z1:  45.166 +j  20.730 (PU)
                                              Z2:  45.166 +j  20.730 (PU)
                                              Z0: 131.050 +j  31.626 (PU)

                 ASYM    RMS   INTERRUPTING AMPS
                 1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                     1635.1       1635.1       1635.1       1635.1

                ASYM    RMS   FAULTED CURRENT ( AMPS )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---        ---PHASE B---        ---PHASE C---
                    1635.1                0.0                  0.0
```

```
HC-1361 Bus     VOLTAGE BASE LL:                    480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   2333.0 /  -56. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:  146.255 +j  72.853 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     0.498
                SEQUENCE EQUIVALENT IMPEDANCE Z1:  30.582 +j  20.678 (PU)
                                              Z2:  30.582 +j  20.678 (PU)
                                              Z0:  85.090 +j  31.498 (PU)

                 ASYM    RMS   INTERRUPTING AMPS
                 1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                     2333.0       2333.0       2333.0       2333.0

                ASYM    RMS   FAULTED CURRENT ( AMPS )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---        ---PHASE B---        ---PHASE C---
                    2333.0                0.0                  0.0
```

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

```
UH-1362 Bus     VOLTAGE BASE LL:                    480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   1120.6 /  -43. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:  331.836 +j  74.790 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     0.225
                SEQUENCE EQUIVALENT IMPEDANCE Z1:  66.607 +j  21.112 (PU)
                                              Z2:  66.607 +j  21.112 (PU)
                                              Z0: 198.622 +j  32.567 (PU)

                 ASYM    RMS   INTERRUPTING AMPS
                 1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                     1120.6       1120.6       1120.6       1120.6

                ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
                ---PHASE A---        ---PHASE B---        ---PHASE C---
                    1120.6                 0.0                  0.0
```

```
UH-1361 Bus     VOLTAGE BASE LL:                    480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   1482.1 /  -46. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:  246.871 +j  72.156 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     0.292
                SEQUENCE EQUIVALENT IMPEDANCE Z1:  50.114 +j  20.521 (PU)
                                              Z2:  50.114 +j  20.521 (PU)
                                              Z0: 146.644 +j  31.113 (PU)

                 ASYM    RMS   INTERRUPTING AMPS
                 1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                     1482.1       1482.1       1482.1       1482.1

                ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
                ---PHASE A---        ---PHASE B---        ---PHASE C---
                    1482.1                 0.0                  0.0
```

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

```
Service Bldg   VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   2008.9 /  -45. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:  183.147 +j  49.639 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     0.271
               SEQUENCE EQUIVALENT IMPEDANCE Z1:  37.744 +j  15.476 (PU)
                                             Z2:  37.744 +j  15.476 (PU)
                                             Z0: 107.660 +j  18.687 (PU)

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    2008.9       2008.9       2008.9       2008.9

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                      AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   2008.9                 0.0                  0.0
```

```
C106-PP3 Bus   VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   1884.9 /  -44. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:  195.892 +j  50.249 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     0.257
               SEQUENCE EQUIVALENT IMPEDANCE Z1:  40.218 +j  15.612 (PU)
                                             Z2:  40.218 +j  15.612 (PU)
                                             Z0: 115.456 +j  19.024 (PU)

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    1884.9       1884.9       1884.9       1884.9

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                      AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   1884.9                 0.0                  0.0
```

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

```
CPR-1361 Bus   VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   1677.2 /  -43. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:  221.381 +j  51.469 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     0.232
               SEQUENCE EQUIVALENT IMPEDANCE Z1:  45.166 +j  15.886 (PU)
                                             Z2:  45.166 +j  15.886 (PU)
                                             Z0: 131.050 +j  19.697 (PU)

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    1677.2       1677.2       1677.2       1677.2

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   1677.2                 0.0                  0.0
```

```
Office Tri Bus VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   4641.6 /  -69. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:   63.619 +j  51.937 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     0.816
               SEQUENCE EQUIVALENT IMPEDANCE Z1:  14.562 +j  16.007 (PU)
                                             Z2:  14.562 +j  16.007 (PU)
                                             Z0:  34.494 +j  19.924 (PU)

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    4643.7       4641.6       4641.6       4641.6

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   4643.7                 0.0                  0.0
```

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

```
Conex Tlr Bus  VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:    3372.7 /  -61. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    97.158 +j  57.749 (PU)
               THEVENIN IMPEDANCE X/R RATIO:      0.594
               SEQUENCE EQUIVALENT IMPEDANCE Z1:  21.073 +j  17.309 (PU)
                                             Z2:  21.073 +j  17.309 (PU)
                                             Z0:  55.012 +j  23.131 (PU)

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    3372.8       3372.7       3372.7       3372.7

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   3372.8                 0.0                  0.0
```

```
Chiller Skid   VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:    7698.2 /  -94. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    21.530 +j  44.593 (PU)
               THEVENIN IMPEDANCE X/R RATIO:      2.071
               SEQUENCE EQUIVALENT IMPEDANCE Z1:   6.322 +j  14.324 (PU)
                                             Z2:   6.322 +j  14.324 (PU)
                                             Z0:   8.886 +j  15.945 (PU)

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    8060.3       7698.2       7698.2       7698.2

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   8060.3                 0.0                  0.0
```

```
Exhaust Skid   VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:      455.4 /  -36. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:  833.128 +j  80.756 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     0.097
               SEQUENCE EQUIVALENT IMPEDANCE Z1: 163.916 +j  22.448 (PU)
                                             Z2: 163.916 +j  22.448 (PU)
                                             Z0: 505.297 +j  35.859 (PU)

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                     455.4        455.4        455.4        455.4

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                    455.4                 0.0                  0.0
```

```
EXH Fan Vfd    VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:     5166.1 /  -66. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:   59.948 +j  43.024 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     0.718
               SEQUENCE EQUIVALENT IMPEDANCE Z1:  13.829 +j  13.993 (PU)
                                             Z2:  13.829 +j  13.993 (PU)
                                             Z0:  32.290 +j  15.037 (PU)

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    5166.9       5166.1       5166.1       5166.1

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   5166.9                 0.0                  0.0
```

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```
WRAM Tlr Bus   VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:    1989.8 /  -52. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:  177.653 +j  71.697 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     0.404
               SEQUENCE EQUIVALENT IMPEDANCE Z1:  36.698 +j  20.434 (PU)
                                             Z2:  36.698 +j  20.434 (PU)
                                             Z0: 104.257 +j  30.829 (PU)

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    1989.8       1989.8       1989.8       1989.8

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                      AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   1989.8                 0.0                  0.0
```

```
MCC-N2         VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:    7718.0 /  -96. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:   20.391 +j  44.985 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     2.206
               SEQUENCE EQUIVALENT IMPEDANCE Z1:   6.111 +j  14.402 (PU)
                                             Z2:   6.111 +j  14.402 (PU)
                                             Z0:   8.168 +j  16.180 (PU)

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    8153.0       7718.0       7718.0       7718.0

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                      AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   8153.0                 0.0                  0.0
```

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```
Sluicer Skid   VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:      366.7 /  -34. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:   INFINITE
               THEVENIN IMPEDANCE X/R RATIO:       0.071
               SEQUENCE EQUIVALENT IMPEDANCE Z1: 203.499 +j  20.782 (PU)
                                             Z2: 203.499 +j  20.782 (PU)
                                             Z0: 630.045 +j  31.754 (PU)

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                     366.7        366.7        366.7        366.7

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                    366.7                 0.0                  0.0
```

```
Slurry Winch   VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:      366.7 /  -34. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:   INFINITE
               THEVENIN IMPEDANCE X/R RATIO:       0.071
               SEQUENCE EQUIVALENT IMPEDANCE Z1: 203.499 +j  20.782 (PU)
                                             Z2: 203.499 +j  20.782 (PU)
                                             Z0: 630.045 +j  31.754 (PU)

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                     366.7        366.7        366.7        366.7

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                    366.7                 0.0                  0.0
```

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Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
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```
P-1361 SS      VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   7694.5 /  -95. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:   20.568 +j  45.070 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     2.191
               SEQUENCE EQUIVALENT IMPEDANCE Z1:   6.158 +j  14.421 (PU)
                                             Z2:   6.158 +j  14.421 (PU)
                                             Z0:   8.251 +j  16.229 (PU)

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    8120.1       7694.5       7694.5       7694.5

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   8120.1                 0.0                  0.0
```

```
P-1361 Bus     VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   3220.8 /  -69. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:   91.629 +j  74.912 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     0.818
               SEQUENCE EQUIVALENT IMPEDANCE Z1:  18.708 +j  21.114 (PU)
                                             Z2:  18.708 +j  21.114 (PU)
                                             Z0:  54.213 +j  32.685 (PU)

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    3222.3       3220.8       3220.8       3220.8

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   3222.3                 0.0                  0.0
```

Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
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```
Booster Vfd     VOLTAGE BASE LL:                    480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   7547.6 /  -95. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:   21.040 +j  45.915 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     2.182
                SEQUENCE EQUIVALENT IMPEDANCE Z1:   6.237 +j  14.611 (PU)
                                              Z2:   6.237 +j  14.611 (PU)
                                              Z0:   8.565 +j  16.694 (PU)

                 ASYM    RMS   INTERRUPTING AMPS
                 1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                     7960.4       7547.6       7547.6       7547.6

                ASYM    RMS   FAULTED CURRENT ( AMPS )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---        ---PHASE B---        ---PHASE C---
                    7960.4                 0.0                  0.0
```

```
P-1362 Bus      VOLTAGE BASE LL:                    480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   4353.3 /  -91. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:   42.438 +j  76.594 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     1.805
                SEQUENCE EQUIVALENT IMPEDANCE Z1:  10.391 +j  21.485 (PU)
                                              Z2:  10.391 +j  21.485 (PU)
                                              Z0:  21.656 +j  33.624 (PU)

                 ASYM    RMS   INTERRUPTING AMPS
                 1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                     4485.3       4353.3       4353.3       4353.3

                ASYM    RMS   FAULTED CURRENT ( AMPS )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---        ---PHASE B---        ---PHASE C---
                    4485.3                 0.0                  0.0
```

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Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

```
FN-1362 Bus    VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:      268.1 /  -33. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    INFINITE
               THEVENIN IMPEDANCE X/R RATIO:       0.060
               SEQUENCE EQUIVALENT IMPEDANCE Z1: 277.718 +j  23.438 (PU)
                                             Z2: 277.718 +j  23.438 (PU)
                                             Z0: 863.949 +j  38.296 (PU)

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                     268.1        268.1        268.1        268.1

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---       ---PHASE B---       ---PHASE C---
                    268.1                0.0                 0.0
```

****

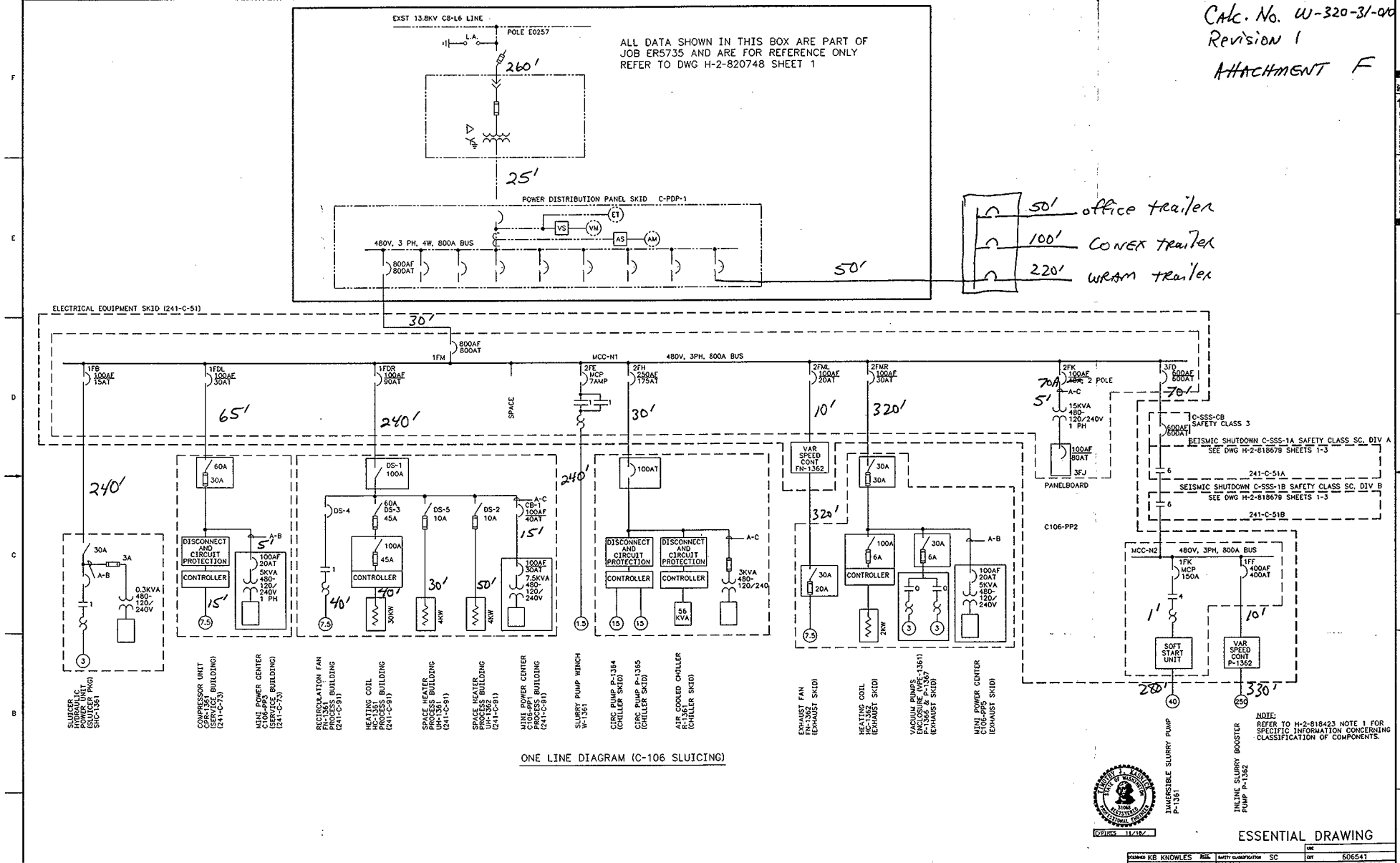
DATE: 7:21:1998 TIME:17:18: 6. 0
Project W-320 / Tank 241-C-106 Sluicing
C-Farm Electrical Distribution
Calc. No. W320-31-010 (Reference Drawing H-2-818680, SH 1, Rev. 1)

********** F A U L T A N A L Y S I S S U M M A R Y **********

BUS NAME	VOLTAGE L-L	AVAILABLE FAULT CURRENT 3 PHASE	X/R	LINE/GRND	X/R
Ug Rsr Pl E257	13800.	3338.1	1.8	1300.2	1.0
XFMR C-T-1 Pri	13800.	3281.3	1.7	1283.1	1.0
XFMR C-T-1 Sec	480.	8872.2	2.5	8902.0	2.5
C-PDP-1 600A	480.	8722.2	2.5	8649.9	2.4
Xfmr Skid	480.	7579.3	1.8	6922.5	1.5
MCC-N1 800A	480.	8590.1	2.5	8430.6	2.4
Process Bldg	480.	3960.4	0.8	2771.8	0.6
C106-PP1 Bus	480.	3505.5	0.7	2377.0	0.5
C106-PP2 Bus	480.	7514.8	1.4	6642.8	1.1
FN-1361 Bus	480.	2556.9	0.5	1635.1	0.3
HC-1361 Bus	480.	3442.0	0.7	2333.0	0.5
UH-1362 Bus	480.	1818.5	0.3	1120.6	0.2
UH-1361 Bus	480.	2346.5	0.4	1482.1	0.3
Service Bldg	480.	3114.9	0.4	2008.9	0.3
CPR-1361 Bus	480.	2654.0	0.4	1677.2	0.2
Office Trl Bus	480.	5871.9	1.1	4641.6	0.8
Conex Tlr Bus	480.	4659.5	0.8	3372.7	0.6
Chiller Skid	480.	8115.8	2.3	7698.2	2.1
Exhaust Skid	480.	768.0	0.1	455.4	0.1
EXH Fan Vfd	480.	6458.7	1.0	5166.1	0.7
WRAM Tlr Bus	480.	3025.2	0.6	1989.8	0.4
MCC-N2	480.	8121.7	2.4	7718.0	2.2
Sluicer Skid	480.	621.2	0.1	366.7	0.1
Slurry Winch	480.	621.2	0.1	366.7	0.1
Booster Vfd	480.	7998.5	2.3	7547.6	2.2
P-1361 SS	480.	8103.4	2.3	7694.5	2.2
P-1361 Bus	480.	4504.3	1.1	3220.8	0.8
P-1362 Bus	480.	5324.2	2.1	4353.3	1.8
FN-1362 Bus	480.	455.9	0.1	268.1	0.1
C106-PP3 Bus	480.	2945.3	0.4	1884.9	0.3

********** FAULT ANALYSIS REPORT COMPLETED **********

Calc. No. W-320-31-00
Revision 1
ATTACHMENT F



W320-31-011

Tank C-106 Load Determination, Feeder/Protection Sizing, Voltage Drop, Lighting Calculations and Conduit Sizing

Fluor Daniel Northwest	CALCULATION IDENTIFICATION AND INDEX	Page i of 34 Date 7/22/98

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

Discipline Electrical WO/Job No. Task Order N09 Calculation No. W320-31-011

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

Calculation Item TANK C-106 LOAD DETERMINATION, FEEDER/PROTECTION SIZING, VOLTAGE DROP, LIGHTING CALCULATIONS, & CONDUIT SIZING

These calculations apply to:

Dwg. No. See Continuation Sheet Rev. No.

Dwg. No. Rev. No.

Other (Study, CDR) Rev. No.

The status of these calculations is:

[] Preliminary Calculations

[X] Final Calculations

[] Check Calculations (On Calculation Dated)

[] Void Calculation (Reason Voided)

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

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

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	DE Larson 9-21-95	7/24/98	
Checked by	SA Najjar 9-21-95	TJ Kasnick 7/24/98	
Approved by	TJ Kasnick 9-27-95	TJ Kasnick 7/24/98	
Checked Against Approved Vendor Data	N/A	TJ Kasnick 7/24/98	

INDEX

Design Analysis Page No.	Description
i-ii	Calculation Identification and Index, Continuation sheets
~~iii~~ iv	Calculation Cross Index
1	Objectives
1-2	Design Inputs
2	Given Data
3	Assumptions
3	Methods of Analysis
3 - 4	References
4 - 33	Calculations
34	Conclusions
A-1 to A-31	Appendix A: Supporting Documentation

KEH 0378.00 (06/92) KEF072

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	DE Larson 9-21-95	[illegible] 7/24/98	
Checked by	SA Najjar 9-21-95		

These calculations apply to:

H-2-818673, Sheet 1, Rev. 0
H-2-818674, Sheet 1, Rev. 0
H-2-818674, Sheet 2, Rev. 0
H-2-818674, Sheet 3, Rev. 0
H-2-818674, Sheet 5, Rev. 0
H-2-818676, Sheet 1, Rev. 0
H-2-818676, Sheet 2, Rev. 0
H-2-818676, Sheet 3, Rev. 0
H-2-818676, Sheet 4, Rev. 0
H-2-818676, Sheet 5, Rev. 0
H-2-818677, Sheet 1, Rev. 0
H-2-818677, Sheet 2, Rev. 0
H-2-818678, Sheet 1, Rev. 0
H-2-818678, Sheet 2, Rev. 0
H-2-818678, Sheet 3, Rev. 0
H-2-818678, Sheet 4, Rev. 0
H-2-818678, Sheet 5, Rev. 0
H-2-818679, Sheet 3, Rev. 0
H-2-818680, Sheet 1, Rev. 0
H-2-818681, Sheet 1, Rev. 0
H-2-818681, Sheet 2, Rev. 0
H-2-818681, Sheet 3, Rev. 0
H-2-818690, Sheet 1, Rev. 0
H-2-818702, Sheet 1, Rev. 0
H-2-818702, Sheet 2, Rev. 0
H-2-818704, Sheet 1, Rev. 0
H-2-818704, Sheet 2, Rev. 0
H-2-818704, Sheet 3, Rev. 0
H-2-818704, Sheet 4, Rev. 0

CALCULATION CROSS INDEX (Typical)

Subject Calculation No.: W320-31-011

Subject Calculation Revision No.	Superceded by Calculation No.	These interfacing calculation/documents provide input to the subject calculation, and if revised may require revision of the subject calculation.		Results and conclusions of the subject calculation are used in these interfacing calculations and/or documents		Does the output interface calculation/ documents require revision?		Has the output interfacecalculation/ documents been revised?		Discipline manager's signature and date indicating evaluation complete.
		Calculation/Document No.	Revision No.	Calculation/Document No.	Revision No.	Yes	No	Yes		
0	N/A	H-2-818680	0	H-2-818673	0		X		X	
				H-2-818674, sh 1	0		X		X	
				H-2-818674, sh 2	0		X		X	
				H-2-818674, sh 3	0		X		X	
				H-2-818674, sh 4	0		X		X	
				H-2-818676, sh 1	0		X		X	
				H-2-818676, sh 2	0		X		X	
				H-2-818676, sh 3	0		X		X	
				H-2-818676, sh 4	0		X		X	
				H-2-818677, sh 1	0		X		X	
				H-2-818677, sh 2	0		X		X	
				H-2-818678, sh 1	0		X		X	
				H-2-818678, sh 2	0		X		X	
				H-2-818678, sh 3	0		X		X	
				H-2-818678, sh 4	0		X		X	
				H-2-818678, sh 5	0		X		X	
				H-2-818679, sh 1	0		X		X	
				H-2-818681, sh 1	0		X		X	
				H-2-818681, sh 2	0		X		X	

KEH 1975.00 (12/88)

CALCULATION CROSS INDEX (Typical)

Subject Calculation No.: *W320-31-011*

Subject Calculation Revision No.	Superceded by Calculation No.	These interfacing calculation/documents provide input to the subject calculation, and if revised may require revision of the subject calculation.		Results and conclusions of the subject calculation are used in these interfacing calculations and/or documents		Does the output interface calculation/ documents require revision?		Has the output interfacecalculation/ documents been revised?		Discipline manager's signature and date indicating evaluation complete.
		Calculation/Document No.	Revision No.	Calculation/Document No.	Revision No.	Yes	No	Yes		
				H-2-818681, sh 3	*0*		X		X	
				H-2-818690	*0*		X		X	
				H-2-818702, sh 1	*0*		X		X	
				H-2-818702, sh 2	*0*		X		X	
				H-2-818704, sh 1	*0*		X		X	
				H-2-818704, sh 2	*0*		X		X	
				H-2-818704, sh 3	*0*		X		X	
				H-2-818704, sh 4	*0*		X		X	
				H-2-818704, sh 5	*0*		X		X	

KEH 1975.00 (12/88)

DESIGN ANALYSIS

Client Numatec Hanford Corporation
Subject C-106 Load Determination, Feeder/Protection Sizing, Voltage Drop, Lighting Calculations, & Conduit Sizing
Location 200E, C Tank Farm

WO/Job No. Task Order N09
Date 9/13/95 By DE Larson
Checked 7/19/95 By TJ Kasnick
Revised 5/6/98 By Cris Carlson

1. OBJECTIVES

1.1 To determine the total connected load and estimate the maximum demand for the Tank 241-C-106 portion of Project W-320, Tank 241-C-106 Sluicing.

1.2 To size the feeder/branch circuit conductors, protection and conduits.

1.3 To calculate the voltages at motor terminals during normal running and starting conditions in order to ensure proper operation of pump motors.

1.4 To determine number of light fixtures required to provide adequate illumination levels.

1.5 To determine conduit sizes for cables used.

1.6 To determine adequacy of buried pullboxes (handholes).

2. DESIGN INPUTS

2.1 Function Design Criteria for Tank 241-C-106 Waste Retrieval, Project W-320, HNF-SD-W320-FDC-001 Rev. 5.

2.2 Attached Electrical One-Line Diagram, Drawing (DWG) H-2-818680.

2.3 NFPA-70, National Electrical Code (NEC), 1993 edition.

a. Branch circuit conductors shall be sized to carry at least 125% of the largest load plus the sum of other loads, for multiple load circuits.

b. Single conductor copper wires, with 90°C XHHW, 600 VAC insulation in buried raceway and conductor ampacity per Reference 6.1, NEC, Table 310-16 for 86°F (30°C) ambient temperature, shall be used.

c. Minimum conduit size shall be based on NEC Chapter 9, Tables 1 and 3B.

d. Motor rated full load amperes (FLA) shall be based on Reference 6.1, NEC, Table 430-150, except for the 250 HP motor which is based on vendor information, specifically that provided under Lawrence Pump P.O. 961744 / Westinghouse P.O. W-78259-Z4 / Reliance S.O. 897719.

e. Motor Circuit Protector (MCP) for motor protection and motor starters shall be sized per Reference 6.4.

2.4 MCC N1 main 800 amp incoming circuit breaker shall provide the main service disconnecting means to the C-Farm loads supplied via the Electrical Equipment Skid (EES), Building 241-C-51.

2.5 Effective impedance (Z_{eff}) at 85% Power Factor (PF), shown in NEC Chapter 9 Table 9, shall be used for voltage drop calculations.

3. GIVEN DATA

3.1 The 225 KVA transformer bank installed by the Equipment Removal Phase of Project W-320 is the source of power for these sluicing loads.

3.2 The 225 KVA distribution transformer %Z = 3.19, based on nameplate of the transformer.

3.3 Minimum allowable voltage at the motor terminals is 414 volts based on NEMA motor rating of 460 V ± 10%.

3.4 The EES housing 241-C-51 and Seismic Shutdown System missile shield enclosures 241-C-51A and 51B are air conditioned.

3.5 Motors shown on the Electrical One-Line Diagram, Drawing H-2-818680 are induction motors rated 460 VAC, 3ϕ, 60 Hz. Motor FLA are from the NEC, except for the 250 HP motor which is based on vendor information in CVI file #22668.

3.6 The Variable Speed Drive (VSD) controller for the 250 HP In-Line Booster pump motor has been furnished by Reliance Electric via Lawrence Pump (Procurement Specification W-320-P17). VSD controller maximum input current is 325 A. (150% Torque Limit for 60 SEC. maximum). See Attachment A, page A-8.

3.7 The 40 HP submersible (immersible) pump is started before the booster pump. The submersible (immersible) pump is interlocked with the booster pump so that the booster pump can only be started with adequate NPSH detected as the pressure switch exceeds the pressure switch setpoint. A "Soft Start" unit is to be used to limit torque effect to submersible pump hoses to prevent excess twisting.

3.8 Ambient temperature of pits 241-C-06A pump pit and 241-C-06C sluice pit are 59°C (138.2°F) based on HVAC calculations.

3.9 Ambient temperature of room 1 in the Process Building may reach 65.6°C (150° F) based on data provided by HVAC discipline.

4. ASSUMPTIONS

4.1 Estimated duration for this project is two years.

4.2 Transformer primary taps are set at 100% and secondary terminal voltage at no-load conditions is 480 V.

4.3 Demand factor (DF) for the booster and Immersible pumps motors is 80%. Other assumed demand factors may be found within the calculation.

4.4 "Soft-Start" unit used for 40 HP submersible pump, P-1361, is considered to have the same efficiency as a conventional motor starter. The basis for this is the description given in the Cutler Hammer document, "User's Manual Easy-Start Advantage EA Series." See Vendor Information file #22668.

4.5 Unless otherwise stated, PF = .95 and EFF = 0.95.

5. METHOD OF ANALYSIS

5.1 Hand calculations.

6. REFERENCES

6.1 Drawing H-2-818680, Sheet 1, Rev. 1, Electrical C-Farm One-Line Diagram.

6.2 NFPA-70, National Electrical Code, 1993 edition.

6.3 W320-31-010, C-106 Demand Load Analysis, Size Feeders, Voltage Drop and Fault study.

6.4 Westinghouse Cat. 25-000, Quick Selector 1993.

6.5 Additional References to Support C-Farm Demand Load Analysis:

a. Industrial Power Systems Handbook, Beeman, First Edition, Chapter 17 (Load and Cost Estimating Data).

b. Standard Handbook for Electrical Engineers, Fink and Beaty, Eleventh Edition, Chapter 18 (Demand and Diversity Factors).

c. The following assumptions were made for motor current calculations: PF=.95, Eff=.95.

d. ANSI C57, "Distribution, Power & Regulating Transformers"

6.6 Vendor Information file #22668.

7. CALCULATIONS

The following motor current values are from NEC Table 430-150, except for the 250 HP motor which is based on vendor information. Single phase 480 volt loads are calculated as I = VA/volts. Three phase 480 volt loads are calculated as I = VA / (volts x $\sqrt{3}$).

DESIGN ANALYSIS

Client Numatec Hanford Corporation
WO/Job No. Task Order N09
Subject C-106 Load Determination, Feeder/Protection Sizing, Voltage Drop, Lighting Calculations, & Conduit Sizing
Date 9/13/95 By DE Larson
Checked 7/19/95 By TJ Kasnick
Revised 5/6/98 By Cris Carlson
Location 200E, C Tank Farm

7.1 Connected/Peak Load Determination for MCC-N1 and MCC-N2

Load	Amperes	
Sluicer:		
3 HP Hydraulic Power Unit (SHC-1361)	4.8	
0.3 KVA Transformer (control power)	.6	(ph A-B)
Service Building:		
7.5 HP compressor unit (CPR-1361)	11.0	
5 KVA Mini Power Center (C106-PP3)	10.4	(ph A-B)
Process Building:		
7.5 HP Recirc Fan (FN-1361)	11.0	
30 KW heating coil (HC-1361)	36.1	
4 KW Space Heater (UH-1361)	4.8	
4 KW Space Heater (UH-1362)	4.8	
7.5 KVA Mini Power Center (C106-PP1)	15.6	(ph A-C)
Slurry Pump Winch: 1.5 HP (W-1361)	2.6	
Chiller Skid:		
15 HP Circ Pump (P-1364 or P-1365)	21.0	
56 KVA Air cooled chiller (R-1361)	70.3	
3.0 KVA Mini-Power Center (C106-PP4)	6.25	(ph A-C)
Exhaust Skid:		
7.5 HP Exhaust Fan (VSD efficiency = 90%) (FN-1362)	11.0	
3.0 KW heating coil (HC-1362)	3.6	
5 KVA Mini Power Center (C106-PP5)	10.4	(ph A-B)
3.0 HP Vacuum pump (P-1366 or P-1367)	4.8	
15 KVA Mini Power Panel (C106-PP2)(PF = 95%)	32.9	(ph B-C)
MCC-N2:		
40 HP Immersible Slurry Pump (P-1361)	52.0	
250 HP In-Line Booster Pump (P-1362) (with VSD efficiency = 95%)	287.0	

Max Total Load (C-phase) = ...579.6 A

Total Connected Load = 579.6 A x 480 V x $\sqrt{3}$ = 481.9 KVA

7.2 Estimated Demand Determination

The following discussion is for the determination of the adequacy of the planned transformer for the C-Farm portion of the project. Three situations are given in tabular form following. The first is the "normal" operating situation. This is the anticipated load that would be expected after sluicing operations are underway. The second situation given is the demand load under the "worst case" startup situation. This load will be experienced by the transformer for short durations only. The third situation described in the following tables is the loading that would be considered under "normal" demand operation. The method used for these three situations is that used by Kaiser Utilities to size transformers. It is based on ANSI C57. See attached Electric Service Request EUE95-054.

DESIGN ANALYSIS

Client Numatec Hanford Corporation
Subject C-106 Load Determination, Feeder/Protection Sizing, Voltage Drop, Lighting Calculations, & Conduit Sizing
Location 200E, C Tank Farm

WO/Job No. Task Order N09
Date 9/13/95 By DE Larson
Checked 7/19/95 By TJ Kasnick
Revised 5/6/98 By Cris Carlson

W-320 C-Farm Sluicing Operation Values - "Normal Demand"

Load	Amps	Connected Load (KVA)	DF	Demand (AMP)
Electrical Equipment Skid:				
Mini-Power Center	32.9	15.0	.30	9.87
Service Building:				
Mini-Power Center	10.4	5.0	.30	3.13
Compressor CPR-1361	11.0	8.8	.80	8.80
Process Building:				
Recirculation Fan	11.0	8.8	.80	8.80
Heating Coil	36.0	30.0	.80	28.87
Space Heating	9.6	8.0	.30	2.88
Mini-Power Center	15.6	7.5	.30	4.69
Chiller Skid:				
Circulation Pump 1 or 2	21.0	16.7	.80	16.80
Compressors/Fans	70.3	56.0	.80	56.24
Control Power	6.3	3.0	.30	1.88
Exhaust Skid:				
Heating Coil	3.6	3.0	.80	2.88
Exhaust Fan w/VSD	11.0	8.8	.80	8.80
Mini-Power Center	10.4	5.0	.30	3.13
Vacuum pump	4.8	3.8	.30	3.84
Sluicer Skid:				
Hydraulic Pump	4.8	3.8	.80	3.84
Mini-Power Center (control power)	0.6	0.3	.30	0.19
Slurry Booster Pump w/VSD	287.0	229.0	.80	229.60
Slurry Sub Pump w/soft-start	52.0	43.2	.80	41.60
Slurry Sub Pump Winch	2.6	2.1	.30	0.78
Construction Office Trailers (3):				
Space Heating/Heat Pump	30.1	25.0	.30	9.03
Lighting/Receptacles	30.1	25.0	.30	9.03

Total Demand Current = ... 454.68
Diversity Factor = ... 1.44
Estimated Current = ... 315.75
Estimated KVA = ... 262.5

DESIGN ANALYSIS

Client Numatec Hanford Corporation
Subject C-106 Load Determination, Feeder/Protection Sizing, Voltage Drop, Lighting Calculations, & Conduit Sizing
Location 200E, C Tank Farm

WO/Job No. Task Order N09
Date 9/13/95 By DE Larson
Checked 7/19/95 By TJ Kasnick
Revised 5/6/98 By Cris Carlson

W-320 Transformer Demand Loading - Sluicing in Normal Operation

Load	Amps	Connected Load (KVA)	DF	Demand (AMP)
Electrical Equipment Skid:				
Mini-Power Center	32.9	15.0	.30	9.87
Service Building:				
Mini-Power Center	10.4	5.0	.30	3.13
Compressor CPR-1361	11.0	8.8	.80	8.80
Process Building:				
Recirculation Fan	11.0	8.8	1.0	11.00
Heating Coil	36.0	30.0	.80	28.87
Space Heating	9.6	8.0	.30	2.88
Mini-Power Center	15.6	7.5	.30	4.69
Chiller Skid:				
Circulation Pump 1 or 2	21.0	16.7	.80	16.80
Compressors/Fans	70.3	56.0	1.0	70.30
Control Power	6.3	3.0	.30	1.88
Exhaust Skid:				
Heating Coil	3.6	3.0	.80	2.88
Exhaust Fan w/VSD	11.0	8.8	1.0	11.00
Mini-Power Center	10.4	5.0	.30	3.13
Vacuum pump	4.8		.30	3.84
Sluicer Skid:				
Hydraulic Pump	4.8	3.8	1.0	4.80
Mini-Power Center (control power)	0.6	0.3	.30	0.19
Slurry Booster Pump w/VSD	287.0	229.0	1.0	287.00
Slurry Sub Pump w/soft-start	52.0	43.2	1.0	52.00
Slurry Sub Pump Winch	2.6	2.1	.00	0.00
Construction Office Trailers (3):				
Space Heating/Heat Pump	30.1	25.0	.30	9.03
Lighting/Receptacles	30.1	25.0	.30	9.03

Total Demand Current = ... 541.12
Diversity Factor = ... 1.44
Estimated Current = ... 375.78
Estimated KVA = ... 312.42

Summary of transformer loading:

"Normal" Demand ≈ 262.5 KVA ÷ 225 KVA ≈ 117% of Nameplate Rating.

"Peak" Demand on startup ≈ 481.9 KVA ÷ 225 KVA ≈ 214% of Nameplate.

"Normal" Sluicing Operation ≈ 312.4 ÷ 225 KVA ≈ 139% of Nameplate.

Therefore, the 225 KVA transformer is adequate based on:

1) For "Normal" Operation, 130% of demand (or less) is acceptable per Electrical Utilities engineer, Dan Ford, and IEEE 57.91 & 92. See attachment.

2) Duration of "Worst Case" is less than 5 minutes for each occurrance. Project design life is only 2 years. Small losses of the transformer's 30 year design life expectancy are acceptable.

7.3 Breaker, Starter, Feeder and Conduit Sizing

7.3.1 Main feeder from C-PDP-1 into Electrical Equipment Skid (EES)

A lockable 800 ampere circuit breaker (service entrance rated) at the input to MCC-N1 is the main disconnect means for 241-C-51 (EES).

Feeder Sizing is in accordance with NEC 220-10, 240-21, 430-2, 430-22, 430-24 and 430-28 using actual loads listed in 7.1.

Please see the following table for feeder size evaluation. Single phase 480 V loads are considered as adding equally to all three phases. This is a conservative allowance. Motor ampacity values have been obtained from NEC Table 430-150. Non-motor loads have been evaluated at 480 volts. Non-motor continuous loads have their full load ampacity values multiplied by 1.25 in accordance with NEC 220-3.

DESIGN ANALYSIS

Client Numatec Hanford Corporation
Subject C-106 Load Determination, Feeder/Protection Sizing, Voltage Drop, Lighting Calculations, & Conduit Sizing
Location 200E, C Tank Farm

WO/Job No. Task Order N09
Date 9/13/95 By DE Larson
Checked 7/19/95 By TJ Kasnick
Revised 5/6/98 By Cris Carlson

Load	Amperes	
Sluicer:		
3 HP Hydraulic Power Unit (SHC-1361)	4.8	
0.3 KVA Transformer (control power)	.6	(ph A-B)
Service Building:		
7.5 HP compressor unit (CPR-1361)	11.0	
5 KVA Mini Power Center (C106-PP3)	10.4	(ph A-B)
Process Building:		
7.5 HP Recirc Fan (FN-1361)	11.0	
30 KW heating coil (HC-1361)	36.1	
4 KW Space Heater (UH-1361)	4.8	
4 KW Space Heater (UH-1362)	4.8	
7.5 KVA Mini Power Center (C106-PP1)	15.6	(ph A-C)
Slurry Pump Winch: 1.5 HP (W-1361)	2.6	
Chiller Skid:		
15 HP Circ Pump (P-1364 or P-1365)	21.0	
56 KVA Air cooled chiller (R-1361)	70.3	
3.0 KVA Mini-Power Center (C106-PP4)	6.25	(ph A-C)
Exhaust Skid:		
7.5 HP Exhaust Fan (VSD efficiency = 90%) (FN-1362)	11.0	
3.0 KW heating coil	3.6	
5 KVA Mini Power Center (C106-PP5)	10.4	(ph A-B)
3.0 HP Vacuum pump (P-1366 or P-1367)	4.8	
15 KVA Mini Power Panel (C106-PP2)(PF = 95%)	32.9	(ph B-C)
MCC-N2:		
40 HP Immersible Slurry Pump (P-1361)	52.0	
250 HP In-Line Booster Pump (P-1362) (with VSD efficiency = 95%)	287.0	

Max Total Load (C-phase) = ...579.6 A

Total Connected Load = 579.6 A x 480 V x $\sqrt{3}$ = 481.9 KVA

An 800 ampere main breaker is required to protect the loads. The feeder must be capable of carrying 579.6 amperes. A choice has been made to use 3-350 kcmil conductors per phase from NEC Table 310-16. Install as three sets in 3 inch conduits to MCC-N1. Install 1/0 ground conductor in each conduit per NEC Table 250-95.

Down-stream feeder conductors shall be 800 AMP rated @ 90°C:

1) Need 3-350 kcmil per phase.
2) Install three 350 kcmil conductors and 1#1/0 ground, in each of three 3" conduits.

Note: The three 3" conduits are extensions of conduits previously installed under ERS portion of project.

7.3.2 The 250 HP In-Line Booster Pump (P-1362) and VSD Controller (VSD molded case disconnect included with controller provided by booster pump vendor).

VSD Feeder:

VSD controller maximum input current = 325 A. (See Attachment "A", Page A-8) Per NEC 430-2, required feeder capacity = 1.0 x 325 A ≈ 325 A. Per NEC Table 310-16, use 3-500 kcmil conductors with 1#1/0 ground wire in a 3½" conduit (upsized to 4" conduit to aid in cable pulling).

Motor Feeder:

Booster pump motor FLA = 273 A. Per NEC 430-22, required feeder ampacity = 1.25 x 273 = 341 A. Per NEC Table 310-16, use 3-500 kcmil conductors with 1#1/0 ground wire (NEC Table 250-95) in 3½" conduit (upsized to 4" conduit to aid in cable pulling).

See 7.3.14 for "In-Pit" segment of motor feeder.

7.3.3 The 40 HP Immersible Slurry Pump (P-1361)

Motor Feeder:

Immersible pump motor FLA = 52.0 A. The required feeder ampacity = 1.25 x 52.0 A = 65.0 A. Use of 3#6 AWG (ampacity = 65 A) is adequate based on ampacity. Use of 3#1/0 with 1#4 ground wire in 2" conduit for conservatism will satisfy requirements.

Install 1#1/0 AWG per phase from MCC-N2 to pump pit 241-C-06A.

Note: Larger conductor size was used because motor was originally planned to be larger. Moisture sensor cables are routed with P-1361 wires so derating is required. Eighty per cent of 3#1/0 gives capability of 120 amps. (.8 X 150 amps = 120 amps)

A reduced voltage solid-state starter mounted within MCC-N2 shall be used for immersible pump operation. See 7.3.14 for "In-Pit" segment of motor feeder.

7.3.4 The 1.5 HP Winch (W-1361)

Motor starter line and load side feeder conductors:

Winch motor FLA = 2.6 A. The required feeder ampacity = 1.25 x 2.6 A = 3.25 A. Use 3#10 with 1#12 ground wire in 3/4" conduit (upsized to 1" conduit for conservatism). Note that this feeder will be routed with other feeders (See Power Conduit Block Diagram in the appendix).

Use 7 A MCP and NEMA Size 1, Full Voltage Reversing (FVR) starter.

7.3.5 Chiller Skid

Feeder circuit breaker "line and load side" Conductors:

The chiller load from above consists of the items listed below. Since the items are all mounted on a vendor supplied skid, there is no need to size individual load supply conductors. However, the feeder to the Chiller skid does need to be sized.

Loads:

15 HP Circ Pump (P-1364 or P-1365) FLA =	21.0 A.
56 KVA Comp pkg (70.3 X 1.25) FLA =	87.9 A.
3 KVA Mini-Power Panel (C106-PP4) (ph A-C)(1.25) =	7.8 A.
Total = ...	116.7 A.

Per NEC Table 310-16, use 3#1 AWG conductors with 1#6 AWG ground wire is adequate. For conservatism, a set of 3#4/0 conductors has been used (conduit C106-3P211). These conductors are capable of 230 amperes at 75° C. Circuit breaker size has been selected as 225 amp frame with 175 amp trip.

7.3.6 Mini-Power Panel

No feeder required because unit is supplied with MCC-N1.

7.3.7 Service Building (241-C-73)

Loads:

7.5 HP compressor motor (CPR-1361)(1.25)	13.75 A
5 KVA Mini-Power Center (C106-PP3)(ph A-B)(1.25)	13.00 A
Total = ...	26.75 A

Per NEC Table 310-16, use 3#10 AWG conductors with 1#10 AWG ground wire in a 1" conduit. A 100 AF breaker with a 30 AT will be used per NEC Table 310-16. The 7.5 HP compressor motor will require a minimum of 3#14 AWG, but use 3#10 AWG with 1#10 ground wire exceeding requirements of DOE 6430.1a. Fused disconnect will house 30 amp fuses to protect the motor supply conductors. The Mini-Power Panel is existing. See calculation W-320-31-015.

7.3.8 Process Building (241-C-91)

Loads:

7.5 HP Recirc Fan (FN-1361)(1.25)	13.75 A
30 KW heating coil (HC-1361)(1.25)	45.10 A
4 KW Space Heater (UH-1361)(1.25)	6.00 A
4 KW Space Heater (UH-1362)(1.25)	6.00 A
7.5 KVA Mini-Power Panel (C-106-PP1)(ph A-C)(1.25)	19.50 A
Total = ...	90.35 A

Per NEC Table 310-16, use 3#3 AWG conductors. This has been upsized to the more common size of 3#2 with 1#8 ground wire in a 1.5" conduit. A circuit breaker of 100 AF with a 90 AT will be adequate. Process building loads and protection are summarized below:

Load	Size of Supply Wire	90°C Amp Rating of Wire	Size of Protection
FN-1361	3#10	23.2	100AF w/ 17.5AT
HC-1361	3#4	55.1	45 A fuse
UH-1361	3#12	17.4	10 A fuse
UH-1362	3#12	17.4	10 A fuse
C106-PP-1	3#8	31.9	100AF/30AT CB

Loads in room #1 of the Process building are in a high ambient condition (150° F). A derating factor of .58 has been applied to the 90°C ampacity rating of the supply conductors to these loads per NEC Table 310-16.

7.3.9 Sluicer Hydraulic Power Unit

Sluicer (SHC-1361):

3 HP motor (hydraulic power unit)(1.25)	6.0 A
0.3 KVA Trans (sluicer control power)(ph A-B)(1.25)	0.8 A
Total = ...	6.8 A

Per NEC Table 310-16, use 3#12 with 1#12 ground wire in a 1.5" conduit. Loads on the sluicer skid are vendor supplied and wired. A 100 AF with 15 AT circuit breaker shall be used to protect the sluicer.

7.3.10 Exhaust Fan VSD (FN-1362)

Exhaust Fan: 7.5 HP (with VSD efficiency = 90%) 12.2 A

VSD controller maximum input current = 12.2 A. Per NEC 430-2, required feeder capacity = 1.15 x 12.2 A ≈ 14 A. Per NEC Table 310-16, use 3#12 AWG conductors with 1#12 ground wire in a 3/4" conduit. A 100 AF with 20 AT shall be used to protect the wiring.

7.3.11 Exhaust Skid

Loads:

3.0 KW heating coil @ 480V (1.25)	4.5 A
5 KVA Mini-Power Panel (C-106-PP5)(1.25)	13.0 A
3.0 HP vacuum pumps (P-1366 or P-1367)(1.25)	6.0 A
Total = ...	23.5 A

Per NEC Table 310-16, use of 3#10 AWG shall be adequate with 1#10 ground wire in a minimum 1" conduit. Loads on the exhaust skid are vendor supplied and wired. A circuit breaker with 100 AF and 30 AT shall be used to protect the wiring.

7.3.12 Seismic Shutdown System Missile Enclosure

Loads are air conditioner and receptacles:

$$I = \frac{1320}{120} = 11 \text{ A}; \quad 11 \text{ A} \times 1.25 = 14 \text{ A capacity.}$$

Use 2#10 with 1#10 ground wire in a 3/4" conduit per Calculation W320-31-022 (upsized to 1" conduit for conservatism). The Seismic systems are supplied from C106-PP2 at the EES. 30 A circuit breakers shall be used to protect the wiring.

7.3.13 Typical 120 VAC branch circuit conductor loaded up to 1,500 VA

$$I = \frac{1500}{120} = 12.5 \text{ A}; \quad 12.5 \text{ A} \times 1.25 = 15.625 \text{ A capacity with a 20 A circuit breaker.}$$

Use 2#12 with 1#12 ground wire in minimum 3/4" conduit.

7.3.14 "In-Pit" Cord Sizing

NEC article 40 defines the requirements for the "In Pit" cords. NEC article 430-22 states that branch circuit conductors supplying a single motor shall have an ampacity not less than 125 percent of the motor full-load current rating.

Per Reference Information 40 HP motor FLA = 52.0 A. The 1993 NEC Table 430-150 does not include values for motors of 250 HP. Reliance Electric information shows that the 250 HP motor FLA is 273 amps.

The cords will be in free air within the pump pit. NEC Table 400-5(B) for Type G, portable power cord will be utilized. The Submersible and In-Line Booster pump cords are a thermoset cable that, if assumed equivalent to Type G, will need derating for high ambient conditions using similar correction factors to those in NEC Table 310-16.

Per Project W-320 Motor Cooling Evaluation dated 6/7/95 (see attachments), the ambient temperature in the C-Farm pump pit will be 138°F (59°C). Per NEC Table 310-17, a correction factor of 0.58 will apply. Since this is considered cord (not cable in conduit), the calculation of the desired derating factor is based on the cable manufacturer's recommendation. Per the Rockbestos company, the

following formula is used for determining an acceptable derating factor (see Attachment).

$$TCF=\sqrt{\frac{(Tc2-Ta2)}{(Tc1-Ta1)}\times\frac{(234.5+Tc1)}{(234.5+Tc2)}}$$

Tc1 = Maximum conductor temperature used to determine base ampacity.
Ta1 = Ambient temperature used to determine base ampacity (30°C per NEC Table 400-5(b).
Tc2 = Maximum conductor temperature used to determine adjusted ampacity (90°C for Rockbestos Firewall III for 40 year qualified life).
Ta2 = Ambient temperature used to determine adjusted ampacity; 0.3°C additional is used as margin.

The cords for the pumps fall under the F category, i.e. no more than 3 current carrying conductors. The 90°C column is used, because rating of the terminations in the pump terminal boxes will be defined to be 90°C.

$$TCF=\sqrt{\frac{(90-(59+0.3))}{(90-30)}\times\frac{(234.5+90)}{(234.5+90)}}=0.71$$

(Since pump is rated for 90° C operation, we may safely use 90° wire.)

<u>For sizing the 40 HP Immersible Pump cord:</u>
(52.0 A X 1.25) / 0.71 = 91.6 A; per NEC Table 400-5(B) a minimum size of #4 AWG is required, use #4 AWG with 1#4 or larger ground wire.

<u>For sizing the 250 HP Booster Pump cord:</u>
(273 A X 1.25) / 0.71 = 480.6 A; per NEC Table 400-5(B), use twin sets of #4/0 with 1#3 or larger ground wire.

Rockbestos Firewall III XHHW P62-0104 is a #1/0 AWG cable with an overall diameter of 1.22" (Vendor furnished by procurement specification W-320-P17 for Immersible Pump).

Rockbestos Firewall III XHHW P62-0404 is a #4/0 cable with an overall diameter of 1.54."

7.4 Steady State Voltage Drop Evaluation

Voltage drop considerations for the C-Farm portion of the W-320 project begin at the power source, C-PDP-1, and continue to the load. Calculations given below, which consider the supply transformer, are intended to validate that the transformer may be set at the 0% tap.

7.4.1 %VD on Transformer Bank

$$I_{PU} = \frac{312\ KVA}{225\ KVA} = 1.39 \quad \text{(Total Worst Case Dem/Xfmr Sz)} \qquad \text{[from 7.2]}$$

$$\%\ VD = \%Z \times I_{PU} = 3.19 \times 1.39 = 4.4\%$$

7.4.2 %VD on 250'of #2 AWG copper conductor from pole E257 in steel conduit

$$\%\ VD = \frac{\sqrt{3} \times I \times Zeff/1000' \times L}{4.8}$$

$$\text{Where } I_{SEC} = \frac{312\ KVA}{\sqrt{3} \times 480\ V} \approx 375\ A \qquad \text{[from 7.2]}$$

$$I_{PRI} = \frac{312\ KVA}{\sqrt{3} \times 13{,}800} \approx 13.1\ A \qquad \text{[from 7.2]}$$

$$Z_{eff} = .20;\ L = .250\ \text{[Units of 1000']}$$

$$\%VD\ \text{Service Drop} = \frac{\sqrt{3} \times 13.1 \times .20 \times .250}{13.8} = \underline{0.08\%}$$

7.4.3 %VD on Transformer to C-PDP-1: Parallel 600 kcmil Feeders

$$Z_{eff} = 0.047 \div 2 = 0.0235,\ L = 0.032\ kft$$

$$\%VD\ 600\ kcmil\ feeder = \frac{\sqrt{3} \times 375 \times 0.0235 \times .032}{4.8} = \underline{0.1\%}$$

7.4.4 %VD on C-PDP-1 to MCC-N1: Triple 350 kcmil feeders

$Z_{eff} = 0.06 \div 3 = 0.02$, L = 0.045 kft

$$\%VD\ 350\ kcmil\ feeder = \frac{\sqrt{3} \times 375 \times 0.02 \times .045}{4.8} = \underline{0.12\%}$$

%VD for transformer primary feeder = 0.08%

%VD from transformer bank to EES = 4.4 + 0.1 + 0.12 ≈ 4.62%

Total %VD from pole to EES = 0.08 + 4.62 = 4.70%

Since the voltage drop under highest load conditions exceeds 5% prior to the evaluation of voltage drop across any branch circuit wiring, the supply transformer taps should be set at the lowest setting to boost the supply voltage by 5%. This should be adequate since peak demand is expected very infrequently.

7.4.5 %VD from MCC-N1 to SSA (55 ft of twin 350 kcmil feeders)

$Z_{eff} = 0.06 \div 2 = 0.03$, L = 0.055 kft

$$\%VD\ 350\ kcmil\ feeders = \frac{\sqrt{3} \times (287+52) \times 0.03 \times .055}{4.8} = \underline{0.21\%}$$

7.4.6 %VD from SSA to SSB (12 ft of twin 350 kcmil feeders)

$Z_{eff} = 0.06 \div 2 = 0.03$, L = 0.012 kft

$$\%VD\ 350\ kcmil\ feeders = \frac{\sqrt{3} \times (287+52) \times 0.03 \times .012}{4.8} = \underline{0.04\%}$$

7.4.7 %VD from SSB to MCC-N2 (50 ft of twin 350 kcmil feeders)

$Z_{eff} = 0.06 \div 2 = 0.03$, L = 0.050 kft

$$\%VD\ 350\ kcmil\ feeders = \frac{\sqrt{3} \times (287+52) \times 0.03 \times .050}{4.8} = \underline{0.18\%}$$

See Sketch on page following that summarizes voltage drops:

DESIGN ANALYSIS

Client Numatec Hanford Corporation

WO/Job No. Task Order N09

Subject C-106 Load Determination, Feeder/Protection Sizing, Voltage Drop, Lighting Calculations, & Conduit Sizing

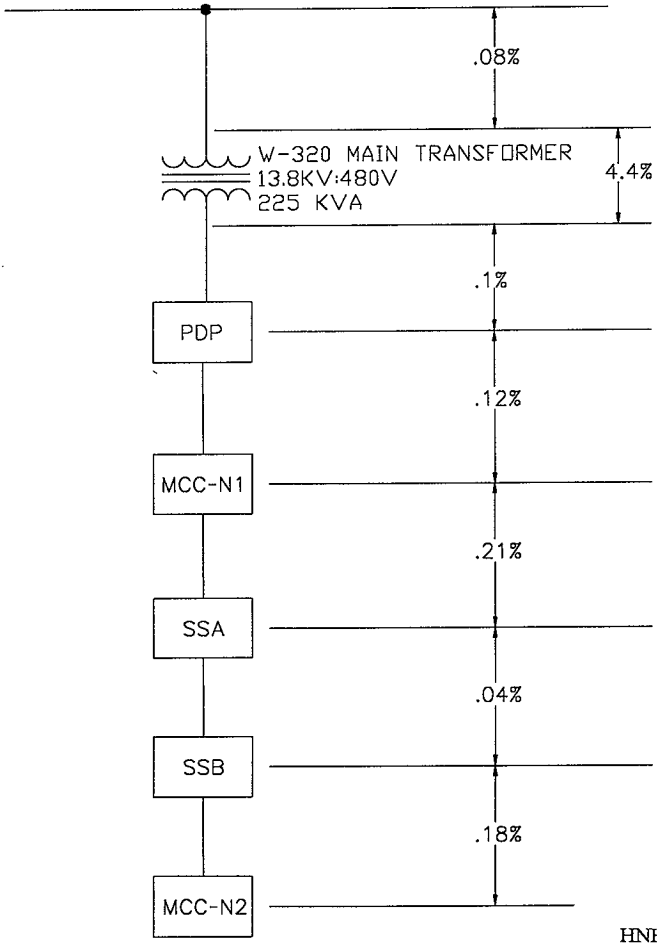
Date 9/13/95 By DE Larson

Checked 7/19/95 By TJ Kasnick

Location 200E, C Tank Farm

Revised 5/6/98 By Cris Carlson

VOLTAGE DROP - C-FARM



CADFILE: N:\ELEC\CALCS\31-011\31-011.DWG

7.4.8 <u>%VD from VSD Controller to Pump P-1362 Motor Terminal Block (300' of 500 kcmil copper motor feeder in steel conduit)</u>

Motor FLA = 273 A; Zeff = .05 ohms; L = 0.3 kft

$$\text{Total \%VD} = \frac{\sqrt{3} \times 273 \times .05 \times .3}{4.8} = 1.48\%$$

<u>%VD from Pump P-1362 Motor Terminal Block to Pump P-1362 (20' of twin 4/0 through pump pit cover block</u>

$$\text{Total \%VD} = \frac{\sqrt{3} \times 273 \times .037 \times .02}{4.8} = 0.07\%$$ [from 7.314]

<u>Summary:</u>

Total %VD at motor terminals = .12 + .21 + .04 + .18 + 1.48 + .07
= <u>2.10%</u>

Motor terminal voltage = 480 (1 - 0.0210) ≈ 469.9 V

Minimum permissible voltage = 414 V

7.4.9 <u>%VD on Immersible Pump P-1361 Feeder (#1/0 copper feeder in steel conduit - 300' to pump pit and 60' down into Tank C-106)</u>

Motor FLA = 52 A; Z_{eff} for #1/0 AWG = .13; L = .30 + .06 = .36

$$\text{\%VD} = \frac{\sqrt{3} \times 52 \times .13 \times .36}{4.8} = 0.88\%$$

Total %VD at motor terminals = .12 + .21 + .04 + .18 + .88 = 1.43%

Motor terminal voltage = 480 (1 - .0143) ≈ 473.1 V

Minimum permissible voltage = 414 V

7.5 % Voltage Dip During Submersible Pump Startup

Initially, all anticipated loads operating. "Peak" values used for current value.

7.5.1 Total Current Supplied: [from 7.2]

$I_{SURGE} = (6 \times I_{P-1361}) + (I_{Peak} - I_{P-1361} - I_{P-1362})$

$I_{SURGE} = (6 \times 52) + (375 - 52 - 273) = 362$ A

7.5.2 %VD on Feeders up to EES (MCC-N2) with $I_{SURGE} = 362$ A

$$\%VD \text{ 350 kcmil feeders to MCC-N1} = \frac{\sqrt{3} \times 362 \times 0.02 \times .045}{4.8} = \underline{0.12\%}$$

Total feeder length of 350 kcmil feeders MCC-N1 to MCC-N2 is 117 ft.

$$\%VD \text{ 350 kcmil feeders to MCC-N2} = \frac{\sqrt{3} \times 362 \times 0.03 \times .117}{4.8} = \underline{0.46\%}$$

Total %VD to MCC-N2 = .12% + .46% = .58%

7.5.3 %VD on Immersible Pump Feeder

Z_{eff} for #1/0 = .13; L = .360; I = 312 A (starting)

$$\%VD = \frac{\sqrt{3} \times 312 \times .13 \times .360}{4.8} = 5.27\%$$

Total %VD at submersible pump motor terminals = 5.27 + .58 = 5.85%

Motor terminal voltage = 480 (1 - .0585) ≈ 452 V

Minimum permissible voltage = 414 V. The starting of the immersible pump (P-1361) represents the worst case condition that need be considered. The condition reperesented is very conservative since the immersible pump is started with a soft start unit and so should not have as large an inrush as was used in this calculation. No other motor starting need be considered. To be sure that starting will not be a problem we will consider voltage drop upstream of MCC-N1 as well.

7.5.4 %VD on Submersible Pump Feeder including VD Across Supply Transformer

%VD on pole to transformer feeder:

Primary Current = Secondary Current X Xfmr turns ratio

I = 362 X (480/13,800) = 12.6 amps

$$\%VD = \frac{\sqrt{3} \times 12.6 \times .20 \times .250}{13.8} = 0.08\%$$

%VD across supply transformer:

I_{BASE} = Transformer VA / (480 V X $\sqrt{3}$)

I_{BASE} = 225,000 / (480 V X $\sqrt{3}$) = 270.6 A

I_{PU} = I/I_{BASE} = 362 / 270.6 = 1.34

%VD = I_{PU} X Transformer %Z = 1.34 X 3.19 = 4.27%

%VD across 600 kcmil feeders to PDP:

$$\%VD = \frac{\sqrt{3} \times 362 \times .024 \times .032}{4.8} \approx 0.10\%$$

Total %VD ≈ 0.08% + 4.27% + 0.10% + 5.85 ≈ 10.3% [from 7.5.3]

Initially, the "soft start" unit was utilized to limit the torque effect of the submersible pump as it hangs down into the tank. Additionally, the "soft start" unit may be configured to limit the starting current to compensate for the high voltage drop across the supply transformer.

7.6 % Voltage Dip With Booster Pump Starting

7.6.1 %VD to MCC N1 from PDP:

I = (325) + (375-325) = 375 A [from 7.3.14 & 7.4.2]

$$\%VD = \frac{\sqrt{3} \times 375 \times .02 \times .045}{4.8} \approx 0.12\%$$

7.6.2 %VD to MCC N1 to MCC N2:

$I = (325) + (375-325) = 375$ A [from 7.3.2 & 7.4.2]

$$\%VD = \frac{\sqrt{3} \times 375 \times .03 \times .117}{4.8} \approx 0.47\%$$

7.6.3 %VD on 500 kcmil and #4/0 Feeders:

$$\%VD = \frac{\sqrt{3} \times (325) \times [(.05 \times .3) + ((.074/2) \times .02)]}{4.8} = 1.85\%$$

Total %VD ≈ 0.12 + .47 + 1.85 ≈ 2.44%

Motor terminal voltage = 480 (1 - 0.0244) ≈ 468 V

Minimum permissible voltage = 414 V

7.7 Outdoor Lighting Calculations

Each entrance needs 3 footcandles of lighting. Total area that needs to be illuminated is approximately 6' x 3' = 18 ft^2.

The fixture selected for outdoor use is the Voigt SOX-35 Wall-Most. The manufacturer's data may be used to determine whether this fixture is adequate for our needs. The Footcandle Isolux diagram shows the footcandles available from Voight SOX-55 at a height of 15 ft. This must be adjusted to obtain values for the SOX-35 at 10 feet.

To adjust for the lower lamp output, the footcandles will be multiplied by 0.6. This is obtained from the ratio of the lumen output of the lamps. The Westinghouse Lighting Handbook provides guidance for adjusting for the height difference. Per page 2-14 of the 1969 Westinghouse Lighting Handbook, "Footcandles for other mounting heights than the one shown are obtained by multiplying the values given on the curves by the ratio of the square of the present mounting height to the square of the new mounting height."

This adjustment factor will be $(15^2 / 10^2) = 2.25$.

We will consider an area 3 ft away from the wall. The chart shows this as approximately 7 footcandles.

Using the adjustment factors, 7 footcandles x 2.25 x 0.6 = 9.5 footcandles.

A similar analysis for the SOX-18 (18W) lights used for the Process Bldg shows that there is adequate light at the many entrances by the Process Bldg.

The lower lamp lumen output is adjusted from the 55 watt data by multiplying by .225, the ratio of the lamp lumens. Using the adjustment factors:

7 footcandles X 2.25 X .225 = 3.543 footcandles.

Outdoor fixture selected will give adequate light over doorways.

7.8 Indoor Lighting Calculations

Inside Lighting: Per IES, an average of 50 (approximately) footcandles is adequate. The Zonal-Cavity Method will be used to determine the number of fixtures. There are two buildings that need be considered here, the Electrical Equipment Skid (241-C-51) and the Process Building (241-C-91).

Room Cavity Ratio (RCR) = [5 x h x (L + W)] / (L x W)

where h = height of light
L = room length
W = room width

RCR = [5 x 8 x (13 + 7)] / (13 x 7) = 8.8

Using the Crouse-Hinds photometric data (see attachments), with an assumed ceiling reflectance of 80% and an assumed wall reflectance of 50%, the coefficient of utilization is 0.25. Footcandle values of 20-30-50 will be utilized for areas of high contrast or large size per IESNA Figure 11.1.

7.8.1 Electrical Equipment Skid

of fixtures = (FC x AREA) / (# of lamps x lumens/lamp x CU x MF)

# of fixtures = (30 x 11 X 9) / (2 x 3200 x .25 x .9) = 2.06

Use two fixtures. The actual size of the room is effectively reduced since the electrical cabinets are pseudo-walls.

7.8.2 Process Building

Due to the geometry of the Process Building, two areas must be considered, Room 1 and Room 2. The dimensions of these two rooms may be obtained from drawings H-2-818455 sheet 3 and H-2-818451 sheet 1.

Room 2:

# of fixtures = (FC x AREA) / (# of lamps x lumens/lamp x CU x MF)

# of fixtures = ((30 x 8 X 4)+ (30 x 13 x 5)) / (2 x 3200 x .25 x .9)

= 2.02

Therefore, use two fixtures in second part of Room 2.

Room 1:

Room 1 of the Process Building needs less light. It is intended that this room be occupied on a rare basis. Visual tasks are only occasionally performed here. Fifteen footcandles should be adequate.

# of fixtures = (FC x AREA) / (# of lamps x lumens/lamp x CU x MF)

# of fixtures = ((15 x 9 X 8)+ (15 x 10 x 13)) / (2 x 3200 x .25 x .9)

= 2.1

Therefore, use two fixtures in Room 1.

7.9 Conduit Fill

7.9.1 General

Three categories of conduits are used for the C-Farm installation, Power, Instrument (signal) and Control. The three categories are intended to be separate and distinct in the interests of safety and to minimize the propagation of electrical noise onto the signal wiring.

Conduit fill of power cabling shall be considered first. To minimize the number of conduits necessary, power cables will be combined. This is restricted by Note 8 to the ampacity tables of NEC article 310.

The attached conduit block diagrams shows how cables will be combined. Some variation exists between these documents and official design documents. Combining cable routes with #10 AWG conductors within them will allow the use of less conduits.

7.9.2 Specific Power Conduits

Conduit Numbers C106-3P201, C106-3P202, and C106-3P203 are three inch conduits that are extensions of stub-outs installed under the ERS portion of the project. Each is intended to carry 4-350 kcmil conductors of type XHHW-2. Per NEC Chapter 9 Table 3B, three inch conduits may carry up to 5-350 kcmil conductors.

The following table shows the C-Farm loads, the size feeder to the load and the minimum required conduit size. Power conduits will also include a ground conductor to conform with DOE's 6430.1A, 1639-1. Those loads that share conduits will be evaluated separately.

Load	Feeder Size	Minimum Conduit Size/Actual
Sluicer (SHC-1361)	4-#12 AWG	1/2" (3P226 1")
Service Building (241-C-73)	4-#10 AWG	1/2" (3P210 1")
Process Building (241-C-91)	3-#2, 1-#6 AWG	1-1/4" (3P001 1.5")
Slurry Pump Winch (W-1361)	4-#12 AWG	1/2" (3P224 1")
Chiller Skid	3-#4/0, 1-#2 AWG	2" (3P211 2")
Exhaust Fan (FN-1362)	4-#12 AWG	1/2" (3P213 1")
Exhaust Skid / Exhaust Fan	8-#10 AWG	1/2" (3P225 1")
Immersible Slurry Pump	3-#1/0, 1-#4, 3-#4 AWG	1-1/2" (3P223 2")
Booster Pump	3-500 kcmil 1-#2 AWG	3" (3P222 4")

All conduits for each of these feeders is larger than the minimum.

7.9.3 Shared Power Conduits

The Exh Fan, Exhaust Skid, & Winch all share a conduit. (C106-3P218)

The derating factor of 70% is applied. The conductors are checked to verify they have the required capacity.

Exh Fan: 70% X 30 A = 21 A, which is satisfactory.
Exhaust Skid: 70% X 40 A = 28 A; which is satisfactory.
Winch: 70% X 30 = 21, which is satisfactory.

The Exhaust Fan & Exhaust Skid share a conduit. (C106-3P225)

The derating factor of 80% is applied.

Exhaust Skid: 80% X 40 A = 32 A, which is satisfactory.
Exhaust Fan: 80% X 30 A = 24 A, which is satisfactory.

7.9.4 Control Conduits

The smallest control conduit used is ¾" in diameter. Per NEC Chapter 9 Table 3B, this can carry 24-#14 AWG conductors. See the attached Block Diagram. The most conductors in any conduit is 24-#14 AWG and 3-#12 for the winch limit switches. By inspection, these conductors will not overfill the 1.5" conduit (C106-3C018) planned for this purpose.

7.9.5 Instrument Conduits

The NEC defines the number of allowable conductors in a conduit in Chapter 9 Table 1. This will be followed when evaluating the % fill of our instrument conduits. Refer to drawing H-2-818676 sheets 1-4 as an aid in following this evaluation.

The formula used to evaluate the fill of a conduit is:

% Fill = sum of Cable Area(s) / conduit area

= sum of (π X $D^2/4$)/ Conduit Area

Conduit Areas are in NEC Chapter 9 Table 4, third column.

The type of instrument cable being used is Rockbestos. See attached catalog sheet for specifics on each type. The following evaluation is done for each of the larger conduits.

Conduit C106-3S021: Wire Runs W106-90, 91, 92 & 93

1 triad @ .09 in^2 + 1 triad @ .09 in^2 + 1 pair @ .08 in^2 + 2 pair @ .31 in^2= .57 in^2

.57 in^2 / 40% = 1.43 in^2

This translates to a diameter = 1.35"; Use a 1.5" conduit.

Fill = 27.5%

Conduit C106-3S019: Wire Runs W106-92A, 93F, 96, 97A, 154B & 154C

1 pair @ .08 in^2 + 2 pair @ .31 + 16 pair @ 1.13 in^2 + 3 pair @ .34 in^2 + 2 #14 @ .028 in^2 + 2 #14 @ .028 in^2 = 1.92 in^2

1.92 in^2 / 40% = 4.79 in^2

This translates to a diameter = 2.47"; Use a 3" conduit.

Fill = 25.6%

Conduit C106-3S027: Wire Runs W106-88, 88A & 89A

1 triad @ .09 in^2 +1 triad @ .09 in^2 + 2 pair @ .16 in^2 = .34 in^2

.34 in^2 / 40% = .85 in^2

This translates to a diameter = 1.04"; Use a 2.5" conduit.

Fill = 7.0%

Conduit C106-3S028: Wire Runs W106-95 & 95A

Wire Run #--95A is part of the 4 pair cable of Wire Run #-95.

4 pair @ .41 in^2

.41 in^2 / .53 = .77 in^2

This translates to a diameter of 1"; Use a 1½" conduit.

Fill = 20.1%

Conduit C106-3S029: Wire Runs W106-95 & 95A, & 154

Wire Run #-95A is part of the 4 pair cable of Wire Run #-95.

4 pair @ .41 in^2 + 1 pair @ .08 in^2 = .49 in^2

.49 in^2 / .31 = 1.58 in^2

This translates to a diameter = 1.41"; Use a 1.5" conduit.

Fill = 24.1%

DESIGN ANALYSIS

Client Numatec Hanford Corporation
Subject C-106 Load Determination, Feeder/Protection Sizing, Voltage Drop, Lighting Calculations, & Conduit Sizing
Location 200E, C Tank Farm

WO/Job No. Task Order N09
Date 9/13/95 By DE Larson
Checked 7/19/95 By TJ Kasnick
Revised 5/6/98 By Cris Carlson

Conduit C106-3S031: Wire Runs W106-84, 85, 87, 87A, 87B, 97B, 154, 154A, 154B, 158, 159 & 169

Wire Run #-84 3 pair @ .24 in^2
Wire Run #-85 2 pair @ .31 in^2
Wire Run #-87 1 #-14 @ .20 in^2
Wire Run #-87A 8 trd @ .64 in^2
Wire Run #-87B 8 trd @ .64 in^2
Wire Run #-97B 1 pair @ .08 in^2
Wire Run #-154 1 pair @ .08 in^2
Wire Run #-154A 2#14 @ .03 in^2
Wire Run #-154B 2#14 @ .03 in^2
Wire Run #-158 1 pair @ .08 in^2
Wire Run #-159 1 pair @ .08 in^2
Wire Run #-169 1 pair @ .08 in^2

Total Area.....2.49 in^2

2.49 in^2 /.40 = 6.23 in^2

This translates to a diameter of 2.82 inches; Use a 3" conduit.

Fill = 37.9 %

Conduit C106-3S032: Wire Runs W106-81, 81A, 84, 85, 86, 137, 154A, 158 & 159

Wire Run #-81 4#14 @ .06 in^2
Wire Run #-81A 3#14 @ .04 in^2
Wire Run #-84 3 pair @ .24 in^2
Wire Run #-85 2 pair @ .31 in^2
Wire Run #-137 Belden 1049A @ .20 in^2
Wire Run #-154A 2#14 @ .03 in^2
Wire Run #-158 1 pair @ .08 in^2
Wire Run #-159 1 pair @ .08 in^2
Total Area.....1.04 in^2

1.04 in^2 / 40% = 2.6 in^2

This translates to a diameter = 1.82 "; Use a 3" conduit.

Fill = 13.9%

DESIGN ANALYSIS

Client Numatec Hanford Corporation
Subject C-106 Load Determination, Feeder/Protection Sizing, Voltage Drop, Lighting Calculations, & Conduit Sizing
Location 200E, C Tank Farm

WO/Job No. Task Order N09
Date 9/13/95 By DE Larson
Checked 7/19/95 By TJ Kasnick
Revised 5/6/98 By Cris Carlson

Conduit C106-3S036: Wire Runs W106-94, 95, & 95A

Wire Run #-95A is part of the 4 pair cable of Wire Run #-95.

Wire Run #-94 1 pair #16 @ .08 in^2

Wire Run #-955 4 pair @ .41 in^2

Total area = .49 in^2

.49 in^2 /.31 = 1.58 in^2

This translates to a diameter = 1.41"; Use a 1.5" conduit.

Fill = 24.1%

Conduit C106-3S033: Wire Runs W106-82

2 pair @ .31 in^2

Total area = .31 in^2

.31 in^2 /.53 = .58 in^2

This translates to a diameter = .85"; Use a 1.5" conduit.

Fill = 15%

Conduit C106-3S016: Wire Runs W106-70, 92A, 93F, 96, 97A, 97B, 154C & 169

Wire Run #-70	1 pair	@	.08 in^2
Wire Run #-92A	1 pair	@	.08 in^2
Wire Run #-93F	2 pair	@	.31 in^2
Wire Run #-96	16 pair	@	1.13 in^2
Wire Run #-97A	3 pair	@	.34 in^2
Wire Run #-97B	1 pair	@	.08 in^2
Wire Run #-154C	2 #14	@	.03 in^2
Wire Run #-169	1 pair	@	.08 in^2
Total area.....			2.13 in^2

2.13 in^2 /.4 = 5.4 in^2

This translates to a diameter = 2.6"; Use a 3" conduit.

Fill = 28.4%

DESIGN ANALYSIS

Client Numatec Hanford Corporation
Subject C-106 Load Determination, Feeder/Protection Sizing, Voltage Drop, Lighting Calculations, & Conduit Sizing
Location 200E, C Tank Farm

WO/Job No. Task Order N09
Date 9/13/95 By DE Larson
Checked 7/19/95 By TJ Kasnick
Revised 5/6/98 By Cris Carlson

Conduit C106-3S018: Wire Runs W106-92A, 93F, 96, 97A & 154C

Wire Run #-92A 1 pair @ .08 in^2
Wire Run #-93F 2 pair @ .31 in^2
Wire Run #-96 16 pair @ 1.13 in^2
Wire Run #-97A 3 pair @ .34 in^2
Wire Run #-154C 2#14 @ .03 in^2
Total Area.....1.89 in^2

1.89 in^2 / .4 = 4.73 in^2

This translates to a diameter of 2.5"; Use a 3" conduit.

Fill = 25.2%

Conduit C106-3S030: Wire Runs W106-87, 87A, 87B, 137, & 154B

Wire Run #-87 1#14 @ .01 in^2
Wire Run #-87A 8 triads @ .64 in^2
Wire Run #-87B 8 triads @ .64 in^2
Wire Run #-137 Belden 1049A @ .20 in^2
Wire Run #-154B 2#14 @ .03 in^2
Total area..... .1.52 in^2

1.52 in^2 /.4 = 3.8 in^2

This translates to a diameter = 2.2"; Use a 3" conduit.

Fill = 20%

Conduit C106-3S037: Wire Runs W106-87, 87A & 87B

Wire Run #-87 1#14 @ .01 in^2
Wire Run #-87A 8 triads @ .64 in^2
Wire Run #-87B 8 triads @ .64 in^2
Total area.....1.29 in^2

1.29 in^2 /.40 = 3.2 in^2

This translates to a diameter = 2.03"; Use a 3" conduit.

Fill = 17.2%

Remaining conduit runs are short and contain few cables.

7.10 Pullbox Sizing

Six pullboxes are used for the W-320 C-Farm installation work. They must all be checked to see whether they have been sized properly per NEC 370-28. The pullboxes will be tested to determine whether they satisfy the NEC rules for # 4 and larger cables (NEC 370-16). This will be a conservative test. If this criteria is not satisfied, the electricians will need to add another row in the boxes. The boxes are rather deep and so this should present no problem. All pulls are considered as being made into the farm since this is necessary to avoid the spread of contamination.

7.10.1 Power Pullboxes

Refer to drawing H-2-818674 Sheet 3.

Pullbox 7B

All conduits are considered to be in one row. The conductors for the following size conduits pass straight through: 4", 2", 1.5", 1" and 1".

8 X 4" = 32"

Box is 42" x 42"; pullbox has 42" available for pulling. Box size is satisfactory.

Pullbox 8B

There are angle pulls into the C-Farm. Conduit sizes are 4", 2", 1.5", 1", 1". Straight pulls are for small conduits and need not be evaluated.

6 X 4" + 2" + 1.5" + 1" + 1" = 29.5"

Box is 42" x 42"; pullbox has 42" available for pulling. Box size is satisfactory.

7.10.2 Control Pullboxes

Pullbox 7A

Both conduits are for straight pulls and for angle pulls. Conduit sizes are 1.5" and 1".

Straight Pull: 8 X 1.5" = 12"; minimum inside size is 2'-0".

Angle pull: 6 X 1.5" + 1" = 10."; minimum inside size is 2'-0".

Box is 24" x 36"; box size is satisfactory.

Pullbox 8A

Conduits are 1.5" or three 1".

Straight Pull: 8 X 1.5" = 12"

Angle pull: 6 X 1" + 1" + 1" = 8"

Box is 24" x 36"; box size is satisfactory.

7.10.3 Instrument Pullboxes

Pullbox 7

Conduits are 3", 1.5", 1" and .75".

Straight Pull: 8 X 3" = 24"

Angle Pull: 6 X 3" + 1.5" + 1" + .75" = 21.25" (24" is opposite dimension.)

Angle Pull: 6 X 3" + 3" + 2" + 1.5" + .75" = 25.25" (36" is opposite dimension.) This does meet the test. Our largest instrument cable is a 16 pair. It's overall diameter is 1.20." The bending radius of this cable is our limiting factor.

8 X 1.20" = 9.6"

Box is 24" X 36"; There is room for the largest cable to bend. Box size is satisfactory.

Pullbox 8

Conduits are 2", 3", 3" and 1.5".

Straight Pull: 8 X 3" = 24"

Angle Pull: 6 X 3" + 3" + 1.5" + 2" = 24.5"

Box is 24" x 36"; Box size is unsatisfactory as oriented on the drawings unless another row is added for conduits in the box.

DESIGN ANALYSIS

Client Numatec Hanford Corporation
Subject C-106 Load Determination, Feeder/Protection Sizing, Voltage Drop, Lighting Calculations, & Conduit Sizing
Location 200E, C Tank Farm

WO/Job No. Task Order N09
Date 9/13/95 By DE Larson
Checked 7/19/95 By TJ Kasnick
Revised 5/6/98 By Cris Carlson

8. CONCLUSIONS

8.1 Total connected load ≈ 481.9 KVA.

Maximum estimated demand for sluicing project ≈ 481.9 KVA (Startup)

Estimated NORMAL demand on transformer bank ≈ 262.5 KVA. (Operation)

8.2 The planned double 600 kcmil feeder to C-PDP-1 and the triple 350 kcmil feeders to the EES are adequate for the C-Farm sluicing demand.

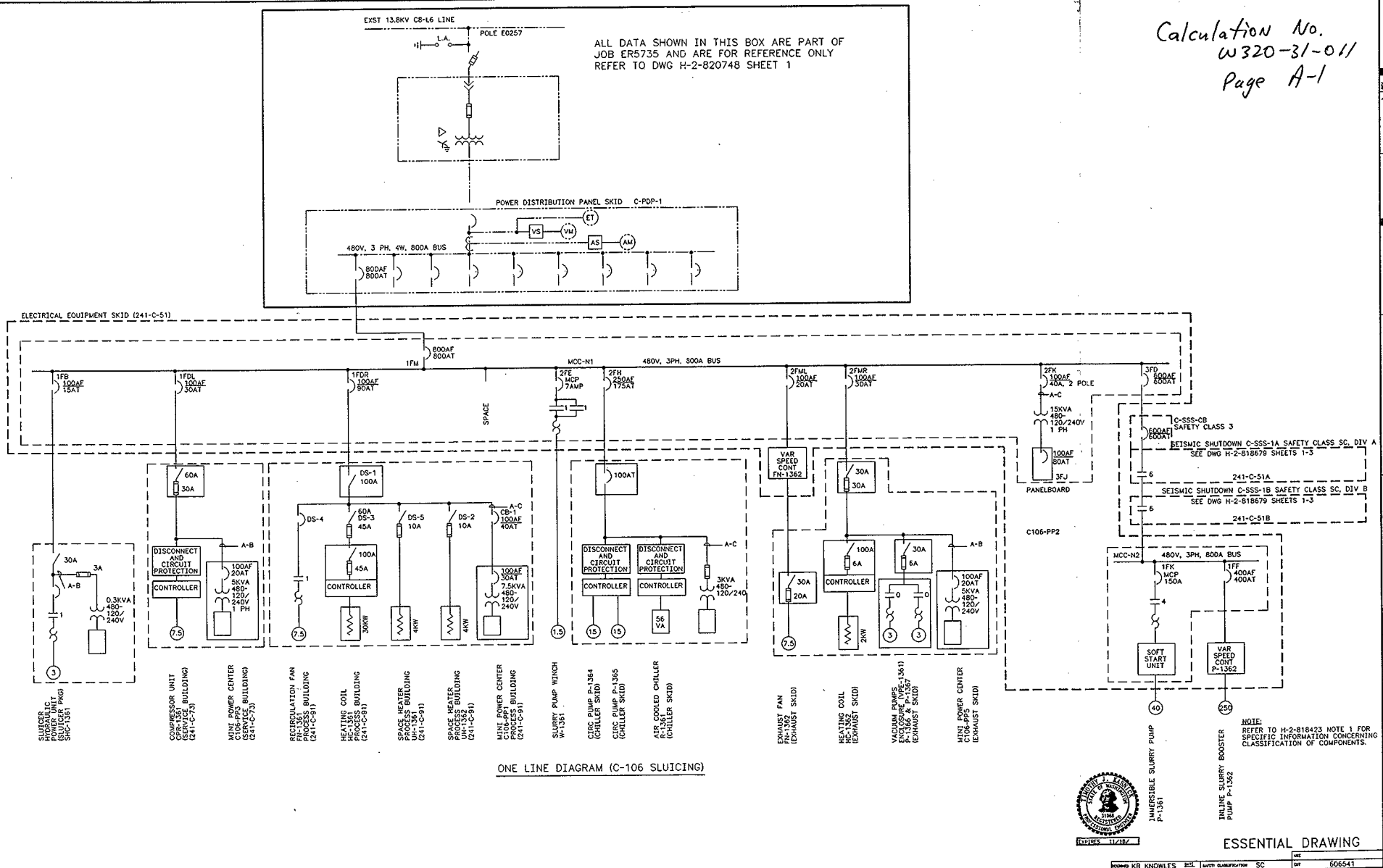
8.3 500 kcmil feeder for the 250 HP VSD motor is adequate to maintain proper terminal voltage level during motor starting with the soft start option of VSD.

8.4 The C-Farm distribution to Submersible Pump P-1361 is adequate. Use of the soft start unit will aid in starting.

8.5 A single outdoor light fixture is adequate over the door. Four two-lamp fixtures are required inside the Process Building.

8.6 Pullbox sizes shown on the drawings are adequate.

Calculation No. W320-31-011
Page A-1



ONE LINE DIAGRAM (C-106 SLUICING)

EUE 93-054

ELECTRIC SERVICE REQUEST

(For Utilities Use Only) ~~087~~
Request Number ~~EUE 93-064 R1~~

Project Number W320
Project Engineer F.W. (Rick) Bradshaw Phone 373-2692
Description (Attach Drawings)
Tank C-106 Sluicing: C-Farm electrical supply
H-2-818680

Originator T.J. Kasnick Date 7/18/95
Title/Org. Lead Electrical Engineer
Telephone 373-3021
Facility Rep. Roger Taft
[X] WHC [X] KEH [] PNL [] BCS
Loc./MSIN S2-47

ADDITION [X] REMOVAL [] Service Location North side of C-Farm

Request For: Normal Power [X] Alternate Power []
Stand-by Power [] Emergency Power []

(Stand-by or Emergency requests must be accompanied by applicable sections of PSE, PSAR, NSAR, SAR or OSR and must also include a completed ESR supplemental form.)

Dates Service Required: August 1995
(temporary) (permanent)

Design Status: Preconceptual [] Conceptual [] Functional [] Definitive [X]

Existing Service (if any): Volts [] 1Ø [] 3Ø [] Other [] Y [] Δ

Desired New or Additional Service: 480 Volts [] 1Ø [X] 3Ø [] Other [] Y [] Δ

CONNECTED LOAD	EXISTING	NEW	(For Utilities Use Only)
Process Heat	KW	32.5 KW	
Water Heat	KW	KW	
Space Heat	KW	33 KW	
Air Conditioning	HP	5 HP	
Refrigeration	HP	60 HP	
Lighting (Including Receptacles)	KW	51 KW	
Motors	HP	390 HP	
Other	KW	16 KW	
Average Demand	KW		

Largest Existing Motor (if any):
250 HP, 480 Volts, 3 Phase; Purpose: Slurry Booster pump (VSD)

(For Utilities Use Only)
Recommendations: USE ORIGINAL SERVICE SPECIFIED IN ORIGINAL ESR EUE93-087, REQUIRING A ≈ 225 KVA PAD MTD. XFMR. THIS SUPERCEDES ESR EUE93-087

Meter Requried? [X] Yes [ ] No Area Engineer DL Ford
Date 7/21/95

RETURN TO: ELECTRICAL UTILITIES ENGINEERING, MSIN S2-12, WHC

Calculation W320-31-011
Page A-2

BC-6000-320 (05/93) WEF081

W-320 C-Farm
SLUICING

LOAD	CONN LOAD	DF	DEM (KW)
COMP. SKID SERVICE BLDG.	4.13	0.80	3.31
MINI POWER CEN. (SERV. BLDG.)	10.00	0.30	3.00
MINI POWER CENTER	25.00	0.30	7.50
RECIRC. FAN (PROCESS BLDG)	6.20	0.80	4.96
HEATING COIL (PROCESS BLDG)	35.00	0.80	28.00
MINI POWER CEN. (PROC. BLDG)	10.00	0.30	3.00
PUMP 1 (CHILLER SKID)	8.27	0.80	6.61
PUMP 2 (CHILLER SKID)	8.27	0.80	6.61
COMP. & FAN (CHILLER SKID)	71.00	0.80	56.80
MINI POWER CEN. (CHIL. SKID)	5.00	0.30	1.50
HEATING COIL (EXAUST SKID)	3.50	0.80	2.80
MINI POWER CEN. (EXAUST SKID)	5.00	0.30	1.50
EXAUST FAN (EXAUST SKID)	6.20	0.80	4.96
UNINTERUPTABLE POWER SUPPLY	15.00	0.60	9.00
SLURRY PUMP WINCH	0.83	0.30	0.25
SLURRY PUMP	82.66	0.80	66.13
	TOTAL DEMAND LOAD		205.93
	DIVERSITY FACTOR		1.44
	ESTIMATED LOAD		143.00

Calculation W320-31-011
Page A-3

REFERENCES:

1. INDUSTRIAL POWER SYSTEMS HANDBOOK, BEEMAN, FIRST ED. CHAPTER 17 (LOAD AND COST ESTIMATING DATA

2. STANDARD HANDBOOK FOR ELECTRICAL ENGINEERS, FINK AND BEATY ELEVENTH EDITION, CHAPTER 18 (DEMAND AND DIVERSITY FACTORS)

TJ Kasnick 12/6/94
C:\W320\ERS\W-320-CF.WK1

Project W320: Tank C-106 Sluicing >> C-FARM

LOAD	HP	CONN LOAD (KVA)	DF	DEM (KVA)
ELECTRICAL EQUIPMENT SKID:				
MINI-POWER CENTER		15.00	0.30	4.50
SERVICE BUILDING:				
MINI-POWER CENTER		5.00	0.30	1.50
COMPRESSOR SKID	7.50	6.20	0.80	4.96
PROCESS BUILDING:				
RECIRCULATION FAN	7.50	6.20	0.80	4.96
HEATING COIL		30.00	0.80	24.00
SPACE HEATING		8.00	0.30	2.40
MINI-POWER CENTER		5.00	0.30	1.50
CHILLER SKID:				
CIRCULATION PUMP 1	10	8.27	0.80	6.61
CIRCULATION PUMP 2	10	8.27	0.80	6.61
COMPRESSORS/FANS		71.00	0.80	56.80
MINI-POWER CENTER		5.00	0.30	1.50
EXHAUST SKID:				
HEATING COIL		2.50	0.80	2.00
EXAUST FAN (WITH VSD)	7.50	6.20	0.80	4.96
MINI-POWER CENTER		5.00	0.30	1.50
VACUUM PUMP	0.75	0.62	0.80	0.50
SLUICER SKID:				
HYDRAULIC PUMP	5	4.13	0.80	3.31
MINI-POWER CENTER		1.00	0.30	0.30
SLURRY BOOSTER PUMP (WITH VSD)	250	206.65	0.80	165.32
SLURRY SUBMERSIBLE PUMP (SOFT START	75	61.99	0.80	49.60
SLURRY SUBMERSIBLE PUMP WINCH	2	1.65	0.30	0.50
CONSTRUCTION OFFICE TRAILERS (3)				
SPACE HEATING/HEAT PUMP		25.00	0.30	7.50
LIGHTING/RECEPTACLES		25.00	0.30	7.50
		TOTAL DEMAND LOAD		358.32
		DIVERSITY FACTOR		1.44
		ESTIMATED LOAD		248.83

Calculation W320-31-011
Page A-4

REFERENCES:

1. INDUSTRIAL POWER SYSTEMS HANDBOOK, BEEMAN, FIRST ED. CHAPTER 17 (LOAD AND COST ESTIMATING DATA)
2. STANDARD HANDBOOK FOR ELECTRICAL ENGINEERS, FINK AND BEATY ELEVENTH EDITION, CHAPTER 18 (DEMAND AND DIVERSITY FACTORS)
3. THE FOLLOWING ASSUMPTIONS WERE MADE: PF = .95, EFF = .95

TJ Kasnick 7/18/95

C:\S320\ERS\W-320-CF.WK2

Project W320: Tank C-106 Sluicing >> C-FARM

LOAD	HP	CONN LOAD (KVA)	DF	DEM (KVA)
ELECTRICAL EQUIPMENT SKID:				
MINI-POWER CENTER		15.00	0.30	4.50
SERVICE BUILDING:				
MINI-POWER CENTER		5.00	0.30	1.50
COMPRESSOR SKID	7.50	6.20	0.80	4.96
PROCESS BUILDING:				
RECIRCULATION FAN	7.50	6.20	1.00	6.20
HEATING COIL		30.00	0.80	24.00
SPACE HEATING		8.00	0.30	2.40
MINI-POWER CENTER		5.00	0.30	1.50
CHILLER SKID:				
CIRCULATION PUMP 1	10	8.27	0.80	6.61
CIRCULATION PUMP 2	10	8.27	0.80	6.61
COMPRESSORS/FANS		71.00	1.00	71.00
MINI-POWER CENTER		5.00	0.30	1.50
EXHAUST SKID:				
HEATING COIL		2.50	0.80	2.00
EXAUST FAN (WITH VSD)	7.50	6.20	1.00	6.20
MINI-POWER CENTER		5.00	0.30	1.50
VACUUM PUMP	0.75	0.62	0.80	0.50
SLUICER SKID:				
HYDRAULIC PUMP	5	4.13	1.00	4.13
MINI-POWER CENTER		1.00	0.30	0.30
SLURRY BOOSTER PP (VSD)	250	206.65	1.00	206.65
SLURRY SUBMERSIBLE PUMP (SOFT START	75	61.99	1.00	61.99
SLURRY SUBMERSIBLE PUMP WINCH	2	1.65	0.00	0.00
CONSTRUCTION OFFICE TRAILERS (3)				
SPACE HEATING/HEAT PUMP		25.00	0.30	7.50
LIGHTING/RECEPTACLES		25.00	0.30	7.50
		TOTAL DEMAND LOAD DURING STARTUP (APPROX. 5 MIN)		429.06

Calculation W320-31-011
Page A-5

Transformer loading =========> 191%

REFERENCES:

1. INDUSTRIAL POWER SYSTEMS HANDBOOK, BEEMAN, FIRST ED. CHAPTER 17 (LOAD AND COST ESTIMATING DATA)
2. STANDARD HANDBOOK FOR ELECTRICAL ENGINEERS, FINK AND BEATY ELEVENTH EDITION, CHAPTER 18 (DEMAND AND DIVERSITY FACTORS)
3. THE FOLLOWING ASSUMPTIONS WERE MADE: PF = .95, EFF = .95

TJ Kasnick 7/18/95

C:\W320\ERS\W-320-CF.WK8

Project W320: Tank C-106 Sluicing >> C-FARM

LOAD	HP	CONN LOAD (KVA)	DF	DEM (KVA)	
ELECTRICAL EQUIPMENT SKID:					
MINI-POWER CENTER		15.00	0.30	4.50	
SERVICE BUILDING:					
MINI-POWER CENTER		5.00	0.30	1.50	
COMPRESSOR SKID	7.50	6.20	0.80	4.96	
PROCESS BUILDING:					
RECIRCULATION FAN	7.50	6.20	1.00	6.20	
HEATING COIL		30.00	0.80	24.00	
SPACE HEATING		8.00	0.30	2.40	
MINI-POWER CENTER		5.00	0.30	1.50	
CHILLER SKID:					
CIRCULATION PUMP 1	10	8.27	0.80	6.61	
CIRCULATION PUMP 2	10	8.27	0.80	6.61	
COMPRESSORS/FANS		71.00	1.00	71.00	
MINI-POWER CENTER		5.00	0.30	1.50	
EXHAUST SKID:					
HEATING COIL		2.50	0.80	2.00	
EXAUST FAN (WITH VSD)	7.50	6.20	1.00	6.20	
MINI-POWER CENTER		5.00	0.30	1.50	
VACUUM PUMP	0.75	0.62	0.80	0.50	
SLUICER SKID:					
HYDRAULIC PUMP	5	4.13	1.00	4.13	
MINI-POWER CENTER		1.00	0.30	0.30	
SLURRY BOOSTER PP (VSD)(85.2/.937)	91	75.22	1.00	75.22	SS
SLURRY SUBMERSIBLE PP (SS)(47.9/.95	50	41.33	1.00	41.33	
SLURRY SUBMERSIBLE PUMP WINCH	2	1.65	0.00	0.00	
CONSTRUCTION OFFICE TRAILERS (3)					
SPACE HEATING/HEAT PUMP		25.00	0.30	7.50	
LIGHTING/RECEPTACLES		25.00	0.30	7.50	
		TOTAL DEMAND LOAD WHEN SLUICING IN OPERATION		276.96	

Calculation W320-31-011
Page A-6

Transformer loading ==========> 123%

REFERENCES:

1. INDUSTRIAL POWER SYSTEMS HANDBOOK, BEEMAN, FIRST ED. CHAPTER 17 (LOAD AND COST ESTIMATING DATA)
2. STANDARD HANDBOOK FOR ELECTRICAL ENGINEERS, FINK AND BEATY ELEVENTH EDITION, CHAPTER 18 (DEMAND AND DIVERSITY FACTORS)
3. THE FOLLOWING ASSUMPTIONS WERE MADE: PF = .95, EFF = .95

TJ Kasnick 7/18/95

C:\W320\ERS\W-320-CF.WK9

TRANSFORMER NAME PLATE DATA

KVA: 225 CONT. RISE 65°C

SER: 95J877059

STYLE: VSEE514LTN

HV: 13800 LV: 480Y277
HV: AL LV: AL
HV: BIL: 95 LV BIL: 30

TAP:
1. 14490
2. 14145
3. 13800
4. 13455
5. 13110

MFG. DATE: JUN. 95

IMPEDANCE 3.19

GAL. OIL 148

WT. LBS 3210

CLASS: OA 60 HERTZ THREE PHASE

BOB CAINE
373-6949

7

INVERTRON VGI

A-C DRIVES

SPECIFICATIONS

Controller Ratings

Controller Model Number	HP/KW Rating(1)	Input Voltage	Input KVA	Input Amps	Maximum Output Amps
8ED1125	125 HP	460	131	160	150(2)
8ED1150	150 HP	460	144	200	180(2)
8ED1200	200 HP	460	192	255	240(2)
8ED1250	250 HP	460	240	325	300(2)
8ED1300	300 HP	460	288	380	360(2)
8ED1350	350 HP	460	336	435	420(3)
8ED1400	400 HP	460	394	490	480(4)
–	500–1200 HP	Contact Reliance Electric			
8ED3150	90 KW	380	117	200	180(2)
8ED3200	125 KW	380	159	255	240(2)
8ED3250	150 KW	380	192	325	300(2)
8ED3300	185 KW	380	243	380	360(2)
8ED3350	220 KW	380	279	435	420(3)
8ED3400	250 KW	380	324	490	480(4)

SERVICE CONDITIONS

Elevation ..... to 3300 ft (1000 meters)
Ambient Temperature Range:
- Cabinet ..... –10°C to 40°C (14°F to 104°F)
- Chassis ..... –10°C to 55°C (14°F to 131°F)

Atmosphere ..... Non-Condensing Relative Humidity 5 to 95%

A-C Line Voltage Variation plus or minus 10%
A-C Line Frequency Variation ..... 50 Hz ± 2 Hz or 60 Hz ± 2 Hz
Storage Temperature ..... –40°C to 65°C (–40°F to 149°F)

(1) NEMA B induction motor rating only. Application load and speed requirements must be considered to properly size the motor and controller.
(2) Load rating is 100% continuous, or 150% for 1 minute.
(3) Load rating is 100% continuous, or 125% for 1 minute.
(4) Load rating is 100% continuous, or 110% for 1 minute.
(5) % of base speed with proper adjustment of slip compensation.

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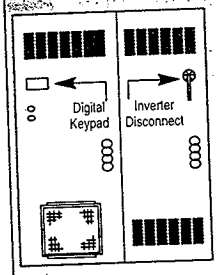
APPLICATION DATA

Pulse Width Modulation (PWM) ..... Flux regulated sine wave
Displacement Power Factor 0.96
Long Term Frequency Stability:
With Digital Keypad ..... .01% of base frequency
With Optional Analog Input ..... .1% of base frequency
Communications ..... RS232/RS422, via any ASCII terminal (optional)
Speed Reference Inputs ..... 0–10 VDC (+/–) Analog
0–20 mA Analog
4–20 mA Analog
2KHz–1MHz (Pulse Train)
Control Inputs ..... 24 VDC Standard
115 VAC Optional

PROGRAMMABLE ADJUSTMENTS

Acceleration Time ..... Linear 1 to 3277 sec.
Deceleration Time ..... Linear 1 to 3277 sec.
Volts/Hertz ..... Selectable
Minimum Frequency ..... 0 Hz
Maximum Frequency ..... 200 Hz
Slip Compensation(5) ..... 0.5% Speed Regulation
Current Limit 20%–100%
Manual Torque Boost ..... 0 to 30% of Rated Voltage

DIMENSIONS AND WEIGHTS



Dimensions for 150–400 HP and 90–250 KW Controllers		
Height in/mm	Width in./mm	Depth in./mm
86.6/2200	66.9/1700	24/609

WEIGHT
lbs 1300
kgs 590

Note: Contact Reliance for dimensions of controls above 400 HP

Effective February 1, 1994

RELIANCE ELECTRIC

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TEFC
E•MASTER • THREE-PHASE

HP	Synch RPM	Frame Size	Full Load RPM	Amps @ 460V		Torque (Ft-Lbs)			Full Load		NEMA Code
				Full Load	Locked Rotor	Full Load	Break Down	Locked Rotor	Nom. Eff.	Power Factor	
25	3600	284TS	3533	29.3	181	37.2	98.0	62.0	91.0	87.5	G
	1800	284T	1766	31.0	180	74.3	180	149	92.4	81.7	G
	1200	324T	1178	32.2	174	111	250	205	91.7	79.1	F
	900	326T	879	33.7	177	149	345	230	90.2	76.6	G
30	3600	286TS	3529	35.7	217	44.6	120	75.0	91.0	86.2	G
	1800	286T	1764	37.0	216	89.3	210	175	92.4	82.1	G
	1200	326T	1178	39.2	214	134	305	255	91.7	78.0	G
	900	364T	879	39.9	210	179	422	255	91.0	77.4	F
40	3600	324TS	3551	48.4	280	59.2	144	94.0	91.7	84.0	F
	1800	324T	1773	49.5	282	119	281	205	93.0	81.1	G
	1200	364T	1182	49.4	289	178	415	335	93.0	81.2	G
	900	365T	880	53.1	288	239	585	365	91.0	76.9	G
50	3600	326TS	3550	59.3	357	74.0	183	130	92.4	84.9	G
	1800	326T	1769	61.9	340	148	340	240	93.0	81.1	F
	1200	365T	1181	61.9	362	222	520	425	93.0	81.1	G
	900	404T	880	65.0	362	298	775	460	91.7	78.5	G
60	3600	364TS	3556	69.8	433	88.6	250	154	93.0	86.3	G
	1800	364T	1778	73.4	428	177	445	300	93.6	81.5	G
	1200	404T	1182	70.5	415	267	655	410	93.6	85.1	F
	900	405T	880	77.5	420	358	860	535	91.7	78.9	F
75	3600	365TS	3551	84.2	538	111	307	186	93.0	89.7	G
	1800	365T	1779	87.0	542	221	555	400	94.1	85.5	G
	1200	405T	1181	87.9	542	333	815	530	93.6	85.2	G
	900	444T	886	94.0	542	444	1025	600	93.6	79.7	G
100	3600	405TS	3567	115	725	147	411	220	93.6	86.9	G
	1800	405T	1780	116	710	145	735	475	94.5	85.3	G
	1200	444T	1187	121	710	443	1115	725	94.1	82.2	G
	900	445T	886	123	695	593	1335	825	93.6	81.0	F
125	3600	444TS	3567	144	885	184	520	246	94.5	85.7	G
	1800	444T	1781	140	902	369	930	595	94.5	88.4	G
	1200	445T	1185	149	860	554	1303	860	94.1	83.3	F
	900	445T	885	154	885	741	1700	1044	94.1	80.8	G
150	3600	445TS	3567	168	1075	221	600	310	94.5	88.1	G
	1800	445T	1785	170	1070	441	1120	650	95.0	86.8	G
	1200	445T	1186	176	1085	664	1628	1097	95.0	84.1	G
	900	447T	886	177	1070	889	2085	1295	94.5	83.8	G
200	3600	445TS	3573	225	1450	294	810	445	95.0	87.5	G
	1800	445T	1784	225	1440	589	1540	965	95.0	87.3	G
	1200	447T	1188	230	1395	884	2150	1295	95.0	85.6	F
250	3600	447TS	3570	278	1825	368	1025	600	95.0	88.5	G
	1800	447T	1784	279	1820	736	1900	1140	95.4	87.9	G
	1200	449T	1187	280	1825	1105	2800	1660	95.4	87.4	G
300	1800	449TS	1783	335	2115	883	2356	1309	95.4	87.6	G

This performance data is for standard designs and should be used for estimating purposes only.
Actual ratings may vary slightly from this data.

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The following table shows the maximum heat dissipation at rated current for the controllers.

All soft start losses shall be as heat loss.

Figure 5.1
Maximum Heat Dissipation

SMC PLUS Controller Current Size	24A	35A	54A	97A	135A
Maximum Watts	110	150	200	285	410

For NEMA Type 12 or non-ventilated enclosures, it is recommended that a by-pass contactor be used. This will allow the controller to start the motor. Once up to full voltage, the controller would be by-passed. Note that the features of the controller would no longer be available. See Page 8-3 for this configuration.

Per NEC Table 430-150, a 75 HP motor draws 96 amperes: KVA total = $VI\sqrt{3}$
KVA total = (460 volts)(96 amps) $\sqrt{3}$ = 76,485.12 VA

Mounting

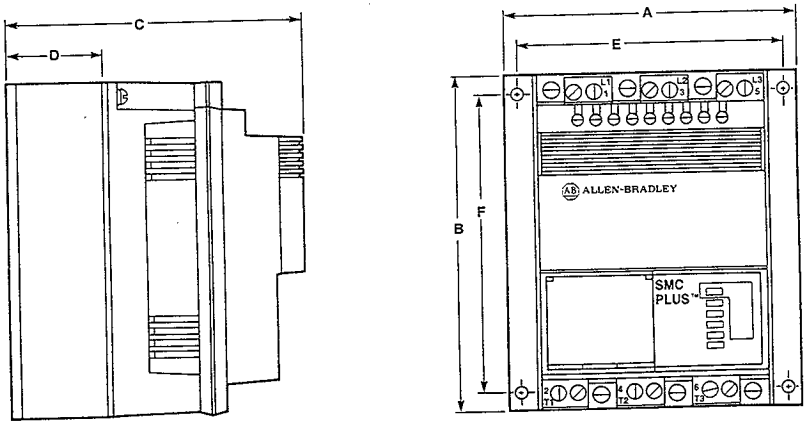
The controller is convection cooled except for the 97A and 135A fan cooled unit. It is important to locate the controller in a position which allows free air flow vertically through the power module. The controller must be mounted with heatsink fins in a verticle plane and have a minimum of 6 inches free space above and below the controller. See Figures 5.2, 5.3 and 5.4.

$$Eff = \frac{Output}{Input}$$

$$Eff = \frac{76,485.12 \text{ VA}}{76,485.12 + 285 \text{ VA}}$$

$$Eff = .996 \text{ or } 99.6\% \text{ eff}$$

Figure 5.2
Dimension Drawings (24A Controller)



Unit	A width	B height	C depth	D	E	F	Approx. Ship. Wt.
Millimeter	155	180	160	50	140	160	4.5 kg
Inch	6-3/32	7-3/32	6-5/16	1-31/32	5-33/64	6-5/16	10 lbs

All dimensions are approximate and are not to be used for construction purposes. Refer to nearest Sales Office or the Sales Department at Milwaukee, Wisconsin, for complete dimension drawings.

THE ROCKBESTOS COMPANY
20 Bradley Park Road, P.O. Box 1102, East Granby, CT 06026-1102 USA (203) 653-6300

June 21, 1995

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Dan Larson
Hanford Nuclear

FAX: (509) 373-3343

In response to your request for an ampacity correction factor for ampacities calculated using the Neher McGrath Method (similar to that shown in NEC Table 310-16), the following factor may be used:

Formula derived from IEEE S-135 Vol. 1, equation 5 (See Attachment)

$$TCF = \sqrt{\frac{(Tc2-Ta2)}{(Tc1-Ta1)} \cdot \frac{(234.5+Tc1)}{(234.5+Tc2)}}$$

Where: Tc1= maximum conductor temperature used to determine base ampacity

Ta1= ambient temperature used to determine base ampacity

Tc2= maximum conductor temperature used to determine adjusted ampacity

Ta2= ambient temperature used to determine adjusted ampacity

If you need any additional information, please let me know.

Sincerely,

Robert Konnik
Application/Design Engineer

RLK/ja

E005095

A member of The Marmon Group of companies

06-21-95 03:21 PM FROM ROCKBESTOS 101

GIVEN

$$I = \sqrt{\frac{T_C - (T_A + \text{DELTA } T_D)}{R_{DC}(1+Y_C)R_{CA}}}$$

BASIC NEHER-MCGRATH FORMULA FROM NEC ARTICLE 310-15

$$I' = \sqrt{\frac{T_C' - (T_A' + \text{DELTA } T_D')}{R_{DC}'(1+Y_C')R_{CA}'}}$$

$$\frac{I'}{I} = \frac{\sqrt{\dfrac{T_C' - (T_A' + \text{DELTA } T_D')}{R_{DC}'(1+Y_C')R_{CA}'}}}{\sqrt{\dfrac{T_C - (T_A + \text{DELTA } T_D)}{R_{DC}(1+Y_C)R_{CA}}}}$$

$$\frac{I'}{I} = \sqrt{\frac{T_C' - (T_A' + \text{DELTA } T_D')}{T_C - (T_A + \text{DELTA } T_D)} \times \frac{R_{DC}(1+Y_C)R_{CA}}{R_{DC}'(1+Y_C')R_{CA}'}}$$

SPECIAL CASE 1

IF $R_{DC} = R_{DC}'$ (SAME CONDUCTOR AND CONDUCTOR TEMPERATURE)
AND $Y_C = Y_C'$ (SAME CONDUCTOR IN SAME CONFIGURATION, FR
AND $R_{CA} = R_{CA}'$ (SAME INSTALLATION CONFIGURATION, CABLE, ETC.)

THEN:

$$\frac{I'}{I} = \sqrt{\frac{T_C' - (T_A' + \text{DELTA } T_D')}{T_C - (T_A + \text{DELTA } T_D)}}$$

SUBCASE A

IF DELTA T_D AND DELTA $T_D' = 0$ (NEGLIGIBLE DIELECTRIC LOSSES)

THEN:

$$\frac{I'}{I} = \sqrt{\frac{(T_C' - T_A')}{(T_C - T_A)}}$$

OR (SOLVING FOR T_C')

$$T_C' = \left(\frac{I'}{I}\right)^2 \cdot (T_C - T_A) + T_A'$$

NOTE: THIS CASE CAN ONLY BE USED IF ALL ASSUMPTIONS ARE MET.

SPECIAL CASE 2

IF $Y_C = Y_C'$
AND $R_{CA} = R_{CA}'$

AND GIVEN:

$$R_{DC} = \frac{(F + T_C)}{(F + T_C')} R_{DC}'$$

THEN:

$$\frac{I'}{I} = \sqrt{\frac{T_C' - (T_A' + \text{DELTA } T_D')}{T_C - (T_A + \text{DELTA } T_D)} \times \frac{(F + T_C)}{(F + T_C')}}$$

SUBCASE A

IF DELTA T_D AND DELTA $T_D' = 0$
AND $F = 234.5$ (FOR 100% IACS COPPER)

THEN:

$$\frac{I'}{I} = \sqrt{\frac{(T_C' - T_A')}{(T_C - T_A)} \times \frac{(234.5 + T_C)}{(234.5 + T_C')}}$$

OR (SOLVING FOR T_C')

$$T_C' = \left(\frac{I'}{I}\right)^2 \cdot (T_C - T_A) \cdot \frac{(234.5 + T_C')}{(234.5 + T_C)} + T_A'$$

Rev. 5 November 1988

SUBJECT: BENDING RADII & INSTALLATION PRACTICES

These are the general rules concerning bending radii and general installation practices for our products. The bending radii recommended below are calculated from minimum radii specified in ICEA Standards applicable to the cable components.

I. Recommended bending radii for permanent training during installation when no significant pulling tension is required -- in accordance with Table I Column A. These bending radii limits do not apply to conduit bends, sheaves or other curved surfaces around which cable may be pulled under tension while being installed.

II. Recommended minimum bending radii for cables being installed under pulling tensions -- in accordance with Table I Column B.

Note: For both I and II, a component may be a single conductor or twisted pair or triad including any covering or jacket. Foil laminate shields over components or cable are not to be considered as metallic shielding and can be neglected for these determinations.

TABLE I

Cable Type	Column A	Column B
A. Non-metallic sheath cable-no shields		
9 and fewer components	4 x component O.D.	8 x component O.D.
10-19 components	8 x " "	12 x " "
more than 19 components	12 x " "	16 x " "
B. Cable with braid or wire shielded components		
9 and fewer components	6 x components O.D.	10 x component O.D.
10-19 components	10 x " "	14 x " "
more than 19 components	14 x " "	18 x " "
C. Cables with metallic tape shielded components		
Cables with metallic tape shield components		
9 and fewer components	12 x component O.D.	14 x component O.D.
10-19 components	24 x " "	28 x " "
more than 19 components	36 x " "	42 x " "

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06-21-95 03:21 PM FROM ROCKERESTOS P05

Cable Type	Column A	Column B
D. *Cables with braid or wire shields over assembly (overall)--------	6 x cable O.D.	10 x cable O.D.
E. *Cables with metallic tape shields over assembly (overall)--------	8 x cable O.D.	12 x cable O.D.
F. ALS (Gardex) Cables - smooth		
Cable Dia. 0.750" and less----	10 x cable O.D.	12 x cable O.D.
" " 0.751" to 1.50"----	12 x " "	14 x " "
" " 1.501" to larger---	15 x " "	18 x " "
G. **ALS (Gardex) Cables - Corrugated and Interlocked Armored cables----------	7 x cable O.D.	10 x cable O.D.
H. Coaxial Cables ----------	8 x cable O.D.	12 x cable O.D.
J. Composite Cables ----------	minimum radii permitted for largest component within the cable will apply.	

* These bending radii apply regardless of component construction.

** If cable has metallic tape shield over core assembly, minimum bend radius Column A is changed to 8 x cable O.D., and Column B is changed to 12 x cable O.D.

III. Maximum pulling tensions - straight runs - in pounds - T

T = .008 x CMA for Single Conductors

T = .008 x N x CMA for Multiconductors Cables

T = .008 x N x CMA x K For Multiple Cables

CMA = Circular Mil Area of One Conductor
N = Number of Conductors*
K = Load Sharing Factor = .8

(*Do not include ground wires, drain wires or control conductor in power cables.)

Specify calculated T or 10,000 lbs., whichever is less.

When calculating maximum pulling tension for coaxial cables with high strength inner conductor, the conductor is considered as regular annealed copper of equal size. Recommended maximum pulling tensions for our Firewall coaxial product line has been calculated and are listed in Table II.

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IV. Maximum side wall pressure - lbs per ft. of bend radius

Coaxial cable	
-solid dielectric	200
-foam dielectric	150
Non-metallic sheath cables	
-non-shielded	1000
-shielded	500
ALS (Gardex) smooth & corrugated	400
Steel interlocked armor	500
Silicone insulated cable	300

V. Maximum pulling tension of III and IV above for all product except coaxial cable apply when pulling by gripping the conductors. When pulling with a basket-weave type pulling grip applied over a non-metallic sheath only, the maximum pulling tension should not exceed 1000 pounds.

Recommended method of pulling coaxial cable is by the basket weave type grip applied over the outer sheath, and maximum pulling tensions listed are based on this pulling method.

When the basket weave type grip method is used for pulling any type product, the section of cable which was under the grip should be cut off and discarded after pulling has been completed.

VI. Minimum installing temperature - all products:

-10°C (14°F)

VII. Some of the recommended pulling compounds for use with our products are listed below. Other available pulling compounds may work equally as well with our products. Suggest manufacturer be contacted for recommended use.

* Volclay Bentoniete - Whittaker Clark & Daniels, Inc. So. Plainfield, NJ

Y-er EAS - Electro Compound Co. Cleveland, Ohio

Slip-X-300- American Colloid Smokie, Ill.

Polywater Lub. A, C, G, J or H - Polywater Corp Still Water, Mn.

Ductlube - Utility Industries Somerdale, N.J.

Flaxsoap - Sherwin-Williams

Aqua-Gel - Ideal Industries Inc. Sycamore, IL

*Materials may dry out and harden with age. Not recommended where subsequent removal of cable is anticipated.

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foregoing, such deviations should be reviewed and approved by the Technical Department.

TABLE II

RECOMMENDED PULLING TENSIONS FOR COAXIAL CABLES

RSS #	Max. Tension in Lbs.
6-100/LE	20
100A/LE	10
101/LE	100
104/LE	25
105/LE	25
106/LE	60
107/LE	60
108/LE	120
109/LE	80
110A/LE	125
111/LE	45
112/LE	100
113/LE	30
114/LE	50
115/LE	100
116/LE	145
6-200	25
201	115
202	185
203	25
204	35
205	35
206	70
207	85
208	110
208B	80
208C	170
209	50
210	140
211	30
212	65
213	100
214	120
215	95

Prepared by E. D'Aquanno

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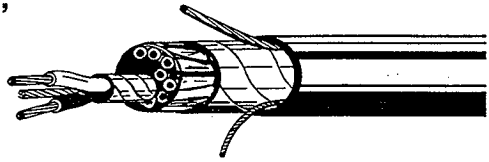
06-21-96 03:21 PM FROM ROCKESIOS P04

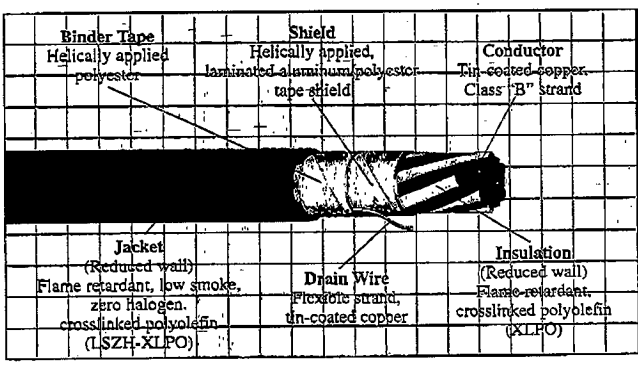
INSTRUMENTATION CABLE

FR-EP Instrumentation Cable UL Type TC
Flame-Retardant EP Insulation,
CPE Jacket
Multiple Shielded Pairs,
Triads or Conductors
With Overall Shield
600 Volts 90°C



Catalog No.	No. of Pairs	Insulation Thickness Inch	Jacket Thickness Inch	Overall Diameter Inch	Net Weight lbs/mft.	CALL 1-800-HOU-WIRE
18AWG Shielded Pairs with Overall Shield						
C1501803	2	.025	.045	.48	86	
C1501804	4	.025	.045	.61	158	
C1501808	8	.025	.080	.89	305	
C1501812	12	.025	.080	.99	418	
C1501816	16	.025	.080	1.10	531	
C1501820	20	.025	.080	1.22	691	
C1501824	24	.025	.080	1.35	747	
16AWG Shielded Pairs with Overall Shield						
C1501602	2	.025	.060	.62	127	
C1501603	3	.025	.060	.60	169	
C1501604	4	.025	.060	.67	202	
C1501606	6	.025	.060	.79	264	
C1501607	7	.025	.060	.79	305	
C1501608	8	.025	.080	.90	380	
C1501610	10	.025	.080	.97	460	
C1501612	12	.025	.080	1.07	551	
C1501616	16	.025	.080	1.20	698	
C1501624	24	.025	.080	1.48	993	
16AWG Shielded Triads with Overall Shield						
C1501604T	4	.025	.060	.70	261	
C1501606T	6	.025	.060	.88	411	
C1501608T	8	.025	.080	.96	530	
C1501612T	12	.025	.080	1.18	721	
18AWG Multiconductor Shielded						
C1501801	2C	.025	.060	.33	55	
C151801T	3C	.025	.060	.35	63	
16AWG Multiconductor Shielded						
C1501601	2C	.025	.060	.36	63	
C1501601T	3C	.025	.060	.40	80	
C151601Q	4C	.025	.060	.48	94	

* Tolerances −0% +10%.



Factory Mutual System

X-Link® TC

Instrumentation Cable

Multi-Conductor Shielded

(XLPO/LSZH-XLPO)

90°C*, 600 Volt
NEC Type TC
UL Listed

Spec. RSS-3-089

Scope

X-Link® TC is the smallest thermoset, UL-listed, Type TC Instrumentation cable available in the industry today. X-Link® TC is 30% to 40% smaller in diameter than standard 600 volt cable. It may be installed in wet and dry locations, indoors and outdoors, in metal trays, ducts, conduits, or in direct burial applications. It is ideal for applications in substations, cogeneration, waste/energy and industrial facilities to perform a variety of signaling, data acquisition and monitoring functions. *Designed for use on circuits where shielding from external electrostatic interference is not required.*

Features

- Thermoset insulation and jacket for enhanced thermal stability
- Small diameter & light weight
- Economical
- More cables per tray or conduit
- 600 volt rating allows cables to be run in trays without separation (300 vs 600 volt)
- Flame retardant
- Flexible
- Heat, sunlight, oil and abrasion resistant
- Easily pulled (low friction jacket)
- Tin-coated conductors for improved terminations and corrosion resistance
- Jackets have printed sequential footage markers for improved inventory control
- Jacket strippability facilitates termination
- Reduced halogen design
- Low smoke jacket
- Lead free jacket
- Superior insulation and jacket moisture resistance

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Performance Standards

- UL listed, Type TC (UL 1277) in accordance with the NEC - Article 340
- UL listed sunlight resistance
- Factory Mutual Reserach Corp. group "I" fire rated per "Specification Test Standard for Cable Fire Propagation, Class 3972"†
- Passes IEEE-383 70,000 BTU/hr vertical tray flame test and ICEA 70,000 BTU/hr vertical tray flame test (T-30-520)
- Single conductors pass UL VW-1 flame test
- Single conductors in accordance with performance requirements of ICEA S-66-524 and UL 44., Class XL
- Single conductors in accordance with AWM style No. 3502
- Jacket exceeds the requirements of UL Class XL/90°C and ICEA Publication T-33-655, Type II
- UL approved for 90°C operation in both wet and dry locations
- Cable components are in compliance with the maximum leachable lead level required by the EPA in 40CFR, Part 261
- Meets the requirements of UL Standard No. 1685 to allow for a UL "LS" designation for limited smoke

† 2/C #16 and larger

Construction

Conductor:
Tin-coated copper conductors. Class "B" strand (ASTM B-8 & B-33)

Insulation:
20 mils of flame retardant crosslinked polyolefin meeting performance requirements of ICEA S-66-524 and UL 44 Class XL

Circuit Identification:
Colored insulation per ICEA Method 1, Table K-2***

Fillers:
(Where required)

Shield System:
Helically applied aluminum/polyester laminated tape shield in continuous contact with flexible strand, tin-coated copper drain wire

Binder Tape:**
Helically applied polyester

Jacket:
Reduced wall, black, flame retardant, low smoke, zero halogen, crosslinked polyolefin jacket

* Rated 90°C for normal operation in wet and dry locations, 130°C for emergency overload conditions, and 250°C for short circuit conditions.

** Not required on 2, 3, and 4 conductor configurations

*** Also available in K-1 color identification

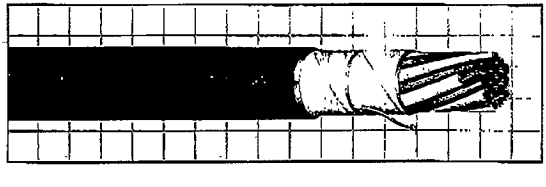
X-Link® TC
Instrumentation Cable

Multi-Conductor Shielded
(XLPO/LSZH-XLPO)

90°C*, 600 Volt
NEC Type TC
UL Listed

Factory Mutual System

Spec. RSS-3-089



16 AWG, 7 Strand

Product Code	Number of Conductors	Insulation Thickness (Inch)	(mm)	Insulated Conductor Diameter (Inch)	Drain Wire Size/ Stranding	Jacket Thickness (Mils)	Nominal Overall Diameter (Inch)	(mm)	Approximate Net Weight (Lbs/M')
I83-0021	2	.020	5.08	.10	18 AWG (16/s)	35	.27	6.86	45
I83-0031	3	.020	5.08	.10	18 AWG (16/s)	35	.29	7.37	60
I83-0041	4	.020	5.08	.10	18 AWG (16/s)	35	.31	7.87	70
I83-0051	5	.020	5.08	.10	18 AWG (16/s)	35	.37	9.40	95
I83-0071	7	.020	5.08	.10	18 AWG (16/s)	35	.40	10.16	120
I83-0091	9	.020	5.08	.10	18 AWG (16/s)	35	.46	11.68	150
I83-0121	12	.020	5.08	.10	18 AWG (16/s)	35	.51	12.95	190
I83-0151	15	.020	5.08	.10	18 AWG (16/s)	45	.59	14.99	240
I83-0191	19	.020	5.08	.10	18 AWG (16/s)	45	.61	15.49	290
I83-0271	27	.020	5.08	.10	18 AWG (16/s)	45	.73	18.54	395
I83-0371	37	.020	5.08	.10	18 AWG (16/s)	45	.81	20.57	520

18 AWG, 7 Strand

I84-0021	2	.020	5.08	.09	20 AWG (10/s)	35	.25	6.35	35
I84-0031	3	.020	5.08	.09	20 AWG (10/s)	35	.26	6.60	45
I84-0041	4	.020	5.08	.09	20 AWG (10/s)	35	.29	7.37	55
I84-0051	5	.020	5.08	.09	20 AWG (10/s)	35	.33	8.38	70
I84-0071	7	.020	5.08	.09	20 AWG (10/s)	35	.36	9.14	90
I84-0091	9	.020	5.08	.09	20 AWG (10/s)	35	.41	10.41	110
I84-0121	12	.020	5.08	.09	20 AWG (10/s)	35	.46	11.68	140
I84-0151	15	.020	5.08	.09	20 AWG (10/s)	35	.51	12.95	165
I84-0191	19	.020	5.08	.09	20 AWG (10/s)	45	.55	13.97	210
I84-0271	27	.020	5.08	.09	20 AWG (10/s)	45	.65	16.51	285
I84-0371	37	.020	5.08	.09	20 AWG (10/s)	45	.72	18.29	375

* Rated 90°C for normal operation in wet and dry locations, 130°C for emergency overload conditions, and 250°C for short circuit conditions.

HNF-2487, R
Pg E-58A

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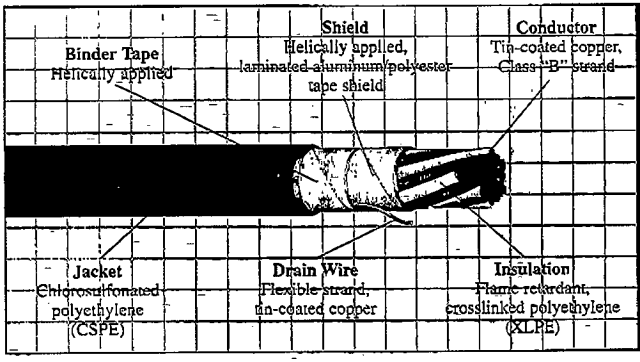

Firewall® III

Instrumentation Cable

Multi-Conductor Shielded

(XLPE/CSPE)

90°C*, 600 Volt
Class 1E Nuclear
NEC Type TC
UL Listed

Spec. RSS-3-021

Scope

Firewall® III Instrumentation Cable is a totally thermoset construction specifically designed for applications in power generation plants, substations and other similar locations. It is intended for use in harsh and demanding environments, including Class 1E Nuclear applications. It may be installed in trays, ducts, conduits or in direct burial applications to perform a variety of signaling and related functions. *Designed for use on circuits where shielding from external electrostatic interface is not required.*

Features

- Thermoset insulation and jacket for enhanced thermal stability
- Specially formulated insulation for superior long term water resistance
- Extremely flame retardant
- Nuclear qualified with a minimum 40-year thermal life expectancy at 90°C
- Radiation resistant (up to 200 megarads)
- Full traceability
- Excellent mechanical properties
- Tin-coated copper conductors for improved terminations and corrosion resistance
- All singles pass a wet dielectric (tank) test prior to cabling to verify electrical integrity
- All jackets have printed sequential footage markers for improved inventory control
- Easy strippability for installation ease

* Rated 90°C for normal operation in wet and dry locations, 130°C for emergency overload conditions, and 250°C for short circuit conditions.

** Not required on 2, 3 and 4 conductor configurations

Performance Standards

- Insulation in accordance with ICEA Standard S-66-524 and UL approved for 90°C applications in both wet & dry locations
- Jackets in accordance with ICEA Standard S-19-81 for heavy-duty chlorosulfonated polyethylene (CSPE)
- Class 1E qualified in accordance with IEEE-383 and IEEE-323 (Rockbestos Reports QR-5804 or QR-5805)
- Cable passes IEEE-383 70,000 BTU/hr vertical tray flame test as modified by NRC Reg. Guide 1.131
- Cable passes ICEA 210,000 BTU/hr vertical tray flame test (Standard T-29-520)
- Single conductors pass the vertical flame tests specified in IEEE-383 para. 2.5.6 (ICEA S-19-81 Section 6.19.6) and UL VW-1
- Quality Assurance program in accordance with 10 CFR 50 Appendix B
- UL Listed Type TC for cable tray installations (UL 1277)
- In accordance with the National Electrical Code - Article 340 (approved for Class 1, Division 2 hazardous locations)
- Cable components are in compliance with the maximum leachable lead level required by the EPA in 40 CFR, Part 261

Construction

Conductor:
Annealed, tin-coated copper. Class "B" strand (ASTM B-8 & B-33)

Insulation:
Proprietary heat, moisture and radiation resistant flame retardant crosslinked polyethylene

Circuit Identification:
Colored insulation per ICEA Method 1, Table K-1

Fillers:
(When required)

Shield System:
Helically applied aluminum/polyester laminated tape shield in continuous contact with a flexible strand, tin-coated copper drain wire

Binder Tape: **
Helically applied

Jacket:
Black, heavy-duty chlorosulfonated polyethylene (also available in neoprene and FR-XLPE)

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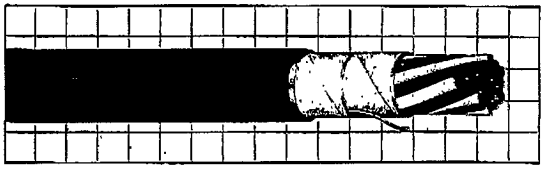
Firewall® III
Instrumentation Cable

Multi-Conductor Shielded
(XLPE/CSPE)
90°C*, 600 Volt
Class 1E Nuclear
NEC Type TC
UL Listed
Spec. RSS-3-021



16 AWG, 7 Strand

Product Code	Number of Conductors	Insulation Thickness (Inch)	Insulation Thickness (mm)	Insulated Conductor Diameter (Inch)	Drain Wire Size/ Stranding	Jacket Thickness (Mils)	Nominal Overall Diameter (Inch)	Nominal Overall Diameter (mm)	Approximate Net Weight (Lbs/M')
I46-0021	2	.025	6.35	.11	18 AWG (16/s)	45	.31	7.87	65
I46-0031	3	.025	6.35	.11	18 AWG (16/s)	45	.33	8.38	81
I46-3433	4	.025	6.35	.11	18 AWG (16/s)	45	.36	9.14	100
I46-3444	5	.025	6.35	.11	18 AWG (16/s)	45	.42	10.76	135
I46-3425	7	.025	6.35	.11	18 AWG (16/s)	45	.45	11.43	145
I46-3447	9	.025	6.35	.11	18 AWG (16/s)	45	.52	13.21	180
I46-3449	12	.025	6.35	.11	18 AWG (16/s)	60	.61	15.49	250
I46-3450	15	.025	6.35	.11	18 AWG (16/s)	60	.66	16.76	295
I46-3451	19	.025	6.35	.11	18 AWG (16/s)	60	.70	17.78	345
I46-5979	27	.025	6.35	.11	18 AWG (16/s)	60	.82	20.83	465
I46-5980	37	.025	6.35	.11	18 AWG (16/s)	80	.95	24.13	650

18 AWG, 7 Strand

I57-0021	2	.025	6.35	.10	20 AWG (10/s)	45	.29	7.37	55
I57-0031	3	.025	6.35	.10	20 AWG (10/s)	45	.31	7.87	65
I57-0041	4	.025	6.35	.10	20 AWG (10/s)	45	.33	8.38	80
I57-0051	5	.025	6.35	.10	20 AWG (10/s)	45	.38	9.65	105
I57-0071	7	.025	6.35	.10	20 AWG (10/s)	45	.41	10.41	110
I57-0091	9	.025	6.35	.10	20 AWG (10/s)	45	.47	11.94	140
I57-0121	12	.025	6.35	.10	20 AWG (10/s)	45	.52	13.21	170
I57-0151	15	.025	6.35	.10	20 AWG (10/s)	60	.61	15.49	225
I57-0191	19	.025	6.35	.10	20 AWG (10/s)	60	.63	16.00	260
I57-0271	27	.025	6.35	.10	20 AWG (10/s)	60	.75	19.05	350
I57-0371	37	.025	6.35	.10	20 AWG (10/s)	60	.83	16.00	450

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* Rated 90°C for normal operation in wet and dry locations. 130°C for emergency overload conditions, and 250°C for short circuit conditions.

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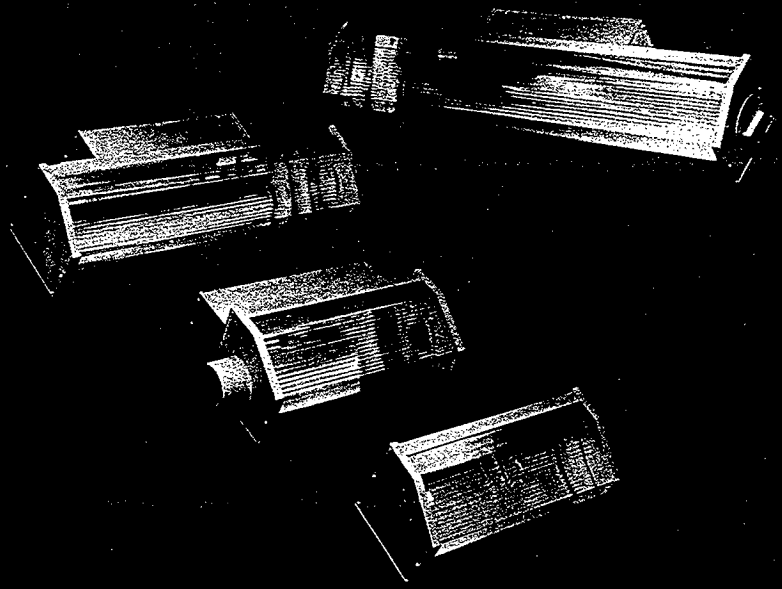
Voigt Wall-Most™

FAMILY OF OUTDOOR LUMINAIRES



Aesthetically styled in pure architectural form for all low pressure sodium lamps (18 watt, 35 watt, 55 watt, 90 watt, 135 watt, 180 watt).

Voigt Lighting Industries, Inc.

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Outdoor Energy-Dollar Saver Check-Chart

If You Now Use or Plan to Use	Use Voigt Wall-Most for Equivalent Lighting Results—Instead	Watts Saved for Each Unit Used	Annual Dollar Saving for Nightly Use (6¢/Kwhr)
1-300 Watt Incandescent Fish Bowl Unit	No. 0-36 (35 watt)	240	58
3-150 Watt Inc. Reflector Lamp Cluster	No. 0-36 (55 watt)	370	89
1-500 Watt Inc. Quartz Floodlight	No. 0-36 (55 watt)	420	101
1-1000 Watt Inc. Quartz Light	No. 0-39 (180 watt)	780	187
1-175 Watt Mercury Vapor Wall-Unit	No. 0-36 (55 watt)	125	30
1-400 Watt Mercury Vapor Wall-Unit	No. 0-38 (135 watt)	275	66
1-400 Watt Metal Halide Wall-Unit	No. 0-39 (180 watt)	245	59
1-250 Watt H.P.S. Wall-Unit	No. 0-38 (135 watt)	132	32

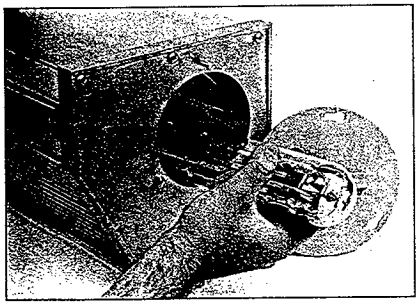
Whether you seek to
- Protect visitors in a parking lot
- Secure a fence against intruders
- Highlight a building entrance
- Provide visibility for your watchman

Pour light into a loading 18-wheeler

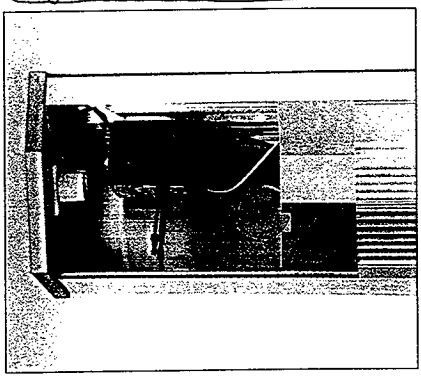
Or

Assure proper T.V. surveillance lighting

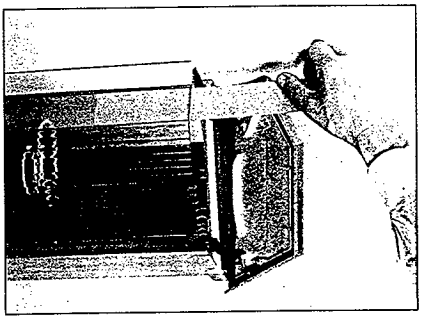
The Wall-Most family does it exceptionally well and attractively using fewer watts and often for a much smaller dollar outlay.



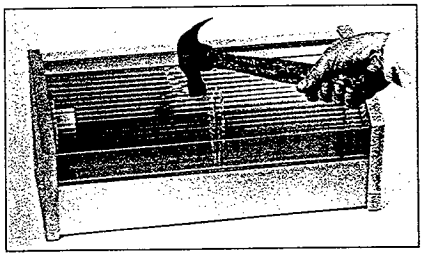
Relamping is accomplished through fully-gasketed door in end—keeping optical chamber sealed against bug and dirt entry.



Installation, even under adverse outdoor conditions, is remarkably easy; with all mounting bolts and wire splices fully accessible as lens & reflector slide out of the way.



Internally mounted uplight shield can be field installed or removed at any time (SD-1 shown with 0-36).



Polycarbonate lens resists breakage. Absence of ultraviolet in L.P.S. source eliminates lens embrittlement and yellowing over time.

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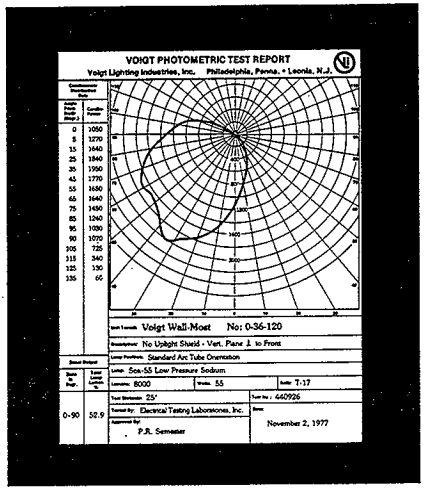
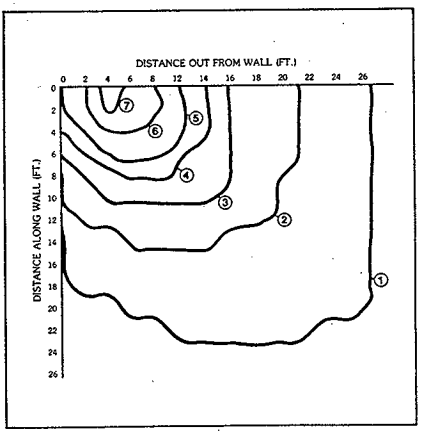


Wide beam spread of Wall-Most achieves coverage of large areas adjacent to buildings and mounting walls.



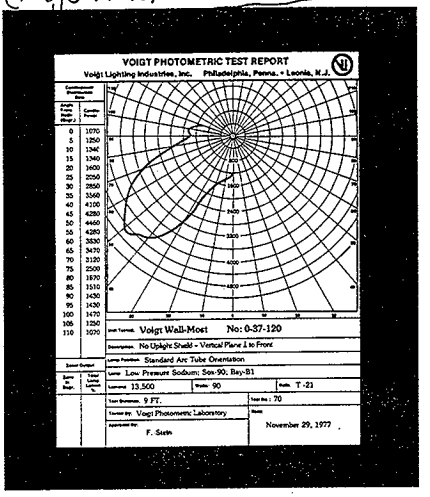
Footcandle Isolux

Top View of Footcandles on Ground From Single Unit.

Mounting Height - 15'-0"

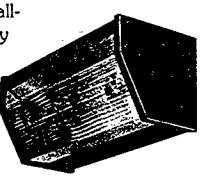
From: Voigt Wall-Most™ No. 0-36-120 with 55 watt Low Pressure Sodium Lamp.

(Data: Electrical Testing Laboratories Test No. 440926).



Larger (90 through 180 watts) Wall-Most have a more sharply defined distribution of light—to cover even larger areas. For 135 watts prorate data by multiplying factor of 1.67. For 180 watts multiply by 2.44.

Aesthetic elegance of Wall-Most can be enhanced by versions in black — or other architectural color finishes as desired. Simply specify color.



Additional Wall-Most notes.

Long luminous arc size, for all lamps, spreads the light over the entire Wall-Most lens face—reducing the viewing brightness—so that unit is comfortable to look at—even when viewed directly.

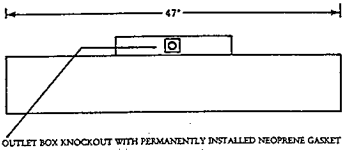
The yellow monochromatic light of Wall-Most does not attract bugs to your building. The light, however, does penetrate smoke, haze, fog & smog more forcefully than other sources of illumination.

Unique prismatic lens structure precisely designed for twin Arc L.P.S. source, significantly aids in control of light into efficient beam pattern; and optically disperses source for greater comfort.

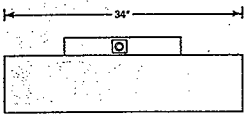
Lamp Specifications and Ordering Information

LOW PRESSURE SODIUM LAMPS ONLY (Order Separately)				
CATALOG NUMBER	Watts	Rated Life (Hours)	Initial & Maintained Lumen Output	Max. O.A. Length in Inches
SOX-18	18	18,000	1,800	8-1/2
SOX-35	35	18,000	4,800	12-3/16
SOX-55	55	18,000	8,000	16-3/4
SOX-90	90	18,000	13,500	20-3/4
SOX-135	135	18,000	22,500	30-1/2
SOX-180	180	18,000	33,000	44-1/8

Back View Mounting Details



0–39



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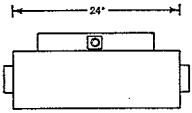
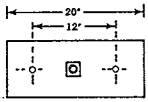


0–37



0–36

0–34

Table of Electrical Characteristics for Wall-Most

Low Pressure Sodium Lamps	180 WATTS					135 WATTS					90 WATTS					55 WATTS					35 WATTS				
Nominal Primary Voltage (Volts)	120	208	240	277	480	120	208	240	277	480	120	208	240	277	480	120	208	240	277	480	120	208	240	277	480
Starting Line Current (Amps)	2.0	1.15	1.0	0.85	0.5	1.8	1.04	0.9	0.8	0.45	1.2	0.7	0.6	0.5	0.4	0.95	0.55	0.48	0.41	0.3	0.8	0.46	0.4	0.35	0.2
Operating Line Current (Amps)	1.9	1.18	0.95	0.82	0.5	1.64	0.95	0.82	0.71	0.4	1.16	.67	.58	.50	.29	0.68	0.43	0.37	0.32	0.19	0.54	0.32	0.27	0.24	0.14
Open Circuit Current (Amps)	5.2	2.9	2.6	2.3	1.9	5.2	2.9	2.6	2.3	1.9	4.0	2.3	2.0	1.7	.9	2.5	1.45	1.25	1.1	.6	2.5	1.45	1.25	1.1	.6
Primary Dropout Voltage (Volts)	90	156	180	208	360	66	114	132	152	264	66	114	132	152	240	66	114	132	152	250	48	83	96	111	185
Ballast Power Initial (Watts)	40	40	40	40	40	43	43	43	43	43	35	35	35	35	35	25	25	25	25	25	25	25	25	25	25
Total Power Initial (Watts)	220	220	220	220	220	178	178	178	178	178	125	125	125	125	125	80	80	80	80	80	60	60	60	60	60
Power Factor	Over 90%					Over 90%					Over 90%					Over 90%					Over 90%				
Lamp Lumen Regulation	±5% at ±10% Voltage Regulation																								
Minimum Ambient Start Temp.	-20°F (Lower Temperature on Special Order)																								

Basic Wall-Most Specification and Ordering Information

CATALOG NUMBER	L.P.S. Nominal Lampwatts	Front View Silhouette	Dimensions in Inches A	B	C	D	Max. Out From Wall	Approx. Weight Lbs.
0-34-000*	18		10	8	-	-	8	15
0-36-000*	55 OR 35		20	8	-	-	8	21
0-37-000*	90		24	8	13½	17½	8	31
0-38-000*	135		34	8	13½	17½	8	39
0-39-000*	180		47	8	13½	17½	8	44

*Specify voltage required: 120, 208, 240, 277 or 480 i.e., No. 0-36-120.
Listed by Underwriters Laboratories, Inc.
Units carry IBEW label.

For additional technical or application data or actual demonstration of the Voigt Wall-Most contact Voigt Lighting Industries, Inc. Headquarters, or:

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Wall-Most with exposed portions wholly made of extruded and cast aluminum and transparent polycarbonate lens is the standard for strength and durability in outdoor wall mounted luminaires.

Optional Accessories

CATALOG NUMBER SUFFIX	Description
BLACK	Black Painted outside finish
CA2	Corner Adaptor for 0-34 + 0-36
COLOR	Painted Finish - specify color
ES	Emergency Lighting Socket for 15 watt Bayone Base, T-7 Inc. Lamp
F	Single Fuse
FF	Double Fuse
NB	Unit without ballast to allow remote mounting
PI	Internally Mounted Photocell (120 volts only)
PR	Twist-Lock Photocell Receptacle
SD-1	Internal Shield for 0-36
SD-2	Internal Shield for 0-37
SD-3	Internal Shield for 0-38
SD-4	Internal Shield for 0-39
TP	Vandal Resistant, Tamper-Proof Screws

For additional accessories information contact Voigt Engineering Department. Cost for optional accessories available on request.

Voigt Lighting Industries, Inc.

Headquarters Location
135 Fort Lee Road
Leonia, NJ 07605
201 461-2493

Manufacturing Location
7347 Melrose Street
Philadelphia, PA 19136

Fig. 11-1. Currently Recommended Illuminance Categories and Illuminance Values for Lighting Design — Targeted Maintained Levels

The following table is a consolidated listing of the IESNA's current illuminance recommendations. This listing is intended to guide the designer in selecting an appropriate illuminance.

Guidance is provided in two forms: (1), in Parts I, II and III as an *Illuminance Category*, representing a range of illuminances; and (2), in Parts IV, V and VI as an *Illuminance Value*. Illuminance categories are represented by letter designations A through I. Illuminance Values are given in *lux* with equivalents in *footcandles* and as such are intended as *target* values with deviations expected. These target values also represent *maintained* values.

This table has been divided into six parts for ease of use. Part I lists both Illuminance Categories and Illuminance Values for generic types of interior activities and normally is to be used when Illuminance Categories for a specific Area/Activity cannot be found in Parts II and III. Parts IV, V and VI provide target maintained Illuminance Values for outdoor facilities, sports and recreational areas, and transportation vehicles where special considerations apply as discussed.

In all cases the recommendations in this table are based on the assumption that the lighting will be properly designed to take into account the visual characteristics of the task.

I. Illuminance Categories and Illuminance Values for Generic Types of Activities in Interiors

Type of Activity	Illuminance Category	Ranges of Illuminances: Lux	Ranges of Illuminances: Footcandles	Reference Work-Plane
Public spaces with dark surroundings	A	20-30-50	2-3-5	General lighting throughout spaces
Simple orientation for short temporary visits	B	50-75-100	5-7.5-10	
Working spaces where visual tasks are only occasionally performed	C	100-150-200	10-15-20	
Performance of visual tasks of high contrast or large size	D	200-300-500	20-30-50	Illuminance on task
Performance of visual tasks of medium contrast or small size	E	500-750-1000	50-75-100	
Performance of visual tasks of low contrast or very small size	F	1000-1500-2000	100-150-200	
Performance of visual tasks of low contrast and very small size over a prolonged period	G	2000-3000-5000	200-300-500	Illuminance on task, obtained by a combination of general and local (supplementary lighting)
Performance of very prolonged and exacting visual task	H	5000-7500-10000	500-750-1000	
Performance of very special visual tasks of extremely low contrast and small size	I	10000-15000-20000	1000-1500-2000	

II. Commercial, Institutional, Residential and Public Assembly Interiors

Area/Activity	Illuminance Category
Accounting (see **Reading**)	
Air terminals (see **Transportation terminals**)	
Armories	C[1]
Art galleries (see **Museums**)	
Auditoriums	
Assembly	C[1]
Social activity	B
Banks (also see **Reading**)	
Lobby	
General	C
Writing area	D
Tellers'stations	E[3]
Barber shops and beauty parlors	E
Churches and synagogues .. (see chapter 17)[4]	
Club and lodge rooms	
Lounge and reading	D
Conference rooms	
Conferring	D
Critical seeing (refer to individual task)	
Court rooms	
Seating area	C
Court activity area	E[3]
Dance halls and discotheques	B
Depots, terminals and stations (see **Transportation terminals**)	

For footnotes, see end of table.

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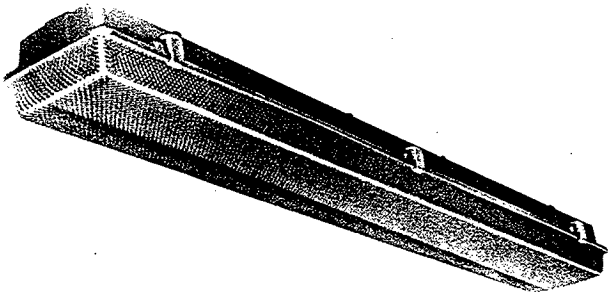
Calculation W320-31-011
Page A-27

NFW Fluorescent Industrial Lighting Fixtures

Wet Locations

Crouse-Hinds®



Application:

NFW fixtures are used:
- in non-hazardous locations where protection is required from wet, dirty and corrosive atmospheres
- where cleanliness and sanitation are prime factors, such as dairies, canneries, food processing plants, bottling plants, laboratories
- in dock areas for protection against salt spray

Features:

- One-piece high impact fiberglass housing provides durability and corrosion resistance
- Energy efficient ballast is standard
- One-piece prismatic acrylic lens for resistance to accidental damage
- Plastic latches apply positive, uniform pressure on gasketing to seal against dust and moisture. Six latches on four foot unit and twelve latches on eight foot unit
- Mounting lugs for ballast and channel are molded into housing

Standard Materials:

- Reflector housing and latches – reinforced fiberglass
- Prismatic lens – acrylic plastic
- Gasket – closed cell neoprene

Standard Finishes:

- Fiberglass – pearl gray
- Acrylic plastic – clear

Size Ranges:

- 4 and 8 foot lengths
- 2 and 4 lamp

Electrical Rating Ranges:

- 120 and 277 volt
- 60 hertz
- 40, 75, 110 watts

Compliances:

- UL Standard: 1570

Options:

The following special options are available from the factory by adding suffix to Cat. No.:

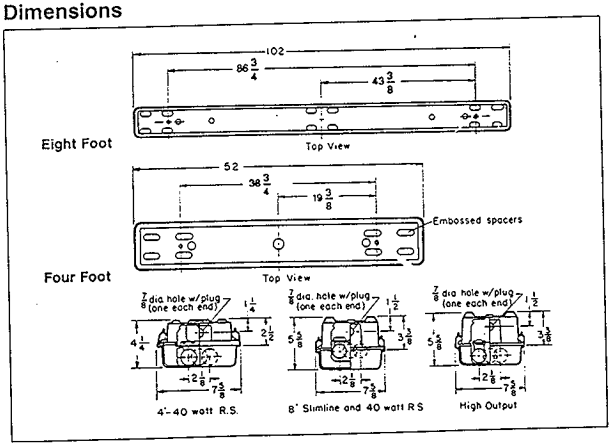
Description	Suffix to be Added to Fixture Cat. #
• Chain mounting assembly§	CMA
• Chain sets	CS
• Low temperature ballast – rated 0°F (40 & 75 watt) and –20°F (110 watt)	BY
• Fuse and holder (one per fixture)	FB
• Suitable for 220V 50Hz	Consult Crouse-Hinds

Line Voltage (60 hertz)	Watts	Length (Nominal-in Feet)	2 Lamp Cat. #	4 Lamp Cat. #
120	40	4	NFW4240	NFW8440*
		8		
	75	8	NFW8275	
	110	8	NFW82110	
277	40	4	NFW4240/277	NFW8440/277*
		8		
	75	8	NFW8275/277	
	110	8	NFW82110/277	

Lamps and Ballasts

Watts	Lamp	Ballast Type†
40	F40 (Med. Bi-Pin)	430 ma
75	F96T12 (Single Pin)	425 ma
110	F96T12HO (Recessed Double Contact)	800 ma

Dimensions



* Two pairs of 4' lamps in tandem.

† 40 and 110 watt ballasts are rapid start; 75 watt ballasts are instant start.

§ Chain sets not included. Order chain sets by adding CS to Cat. No.

5L Fluorescent Fixtures

Calculation W320-31-011
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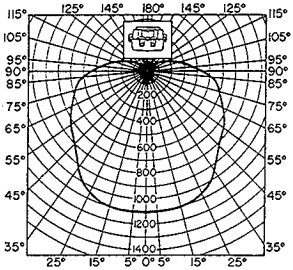
NFW & FMR Fluorescent Industrial Lighting Fixtures

Crouse-Hinds®

Photometric Data

Fixture: NFW4240

Lamp: 2-40/T-12
Zonal Degrees: 0-30 0-40 0-60 0-90 0-180
Zonal Lumens: 857 1394 2478 3678 4211
Total Bare Lamp Lumens: 3200 × 2 = 6400
To determine number and placement of fixtures, see Lighting Selector Guide, pages L-7 to L-12.



Angle	Candelas Along	Candelas Across
0	1166	1166
10	1141	1170
20	1100	1192
30	1013	1180
40	841	1104
50	631	957
60	429	761
70	249	616
80	107	497
90	18	350
100	14	220
110	12	161
120	8	79
130	5	30
140	3	15
150	2	7
160	1	3
170	1	1
180	0	0

Coefficient of Utilization

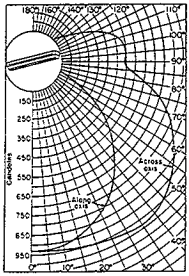
Effective Floor Cavity Reflectance 20%

% Reflectance Eff. Ceil.	Wall	Room Cavity Ratio 1	2	3	4	5
	50	.71	.61	.54	.47	.42
80	30	.68	.56	.47	.40	.35
	10	.64	.51	.42	.35	.30
	50	.69	.60	.52	.46	.41
70	30	.66	.55	.46	.40	.34
	10	.63	.50	.41	.35	.30
	50	.65	.56	.49	.43	.39
50	30	.62	.52	.44	.38	.33
	10	.60	.48	.40	.34	.29
	50	.61	.53	.46	.41	.37
30	30	.59	.40	.42	.36	.32
	10	.57	.46	.38	.33	.28
	50	.58	.50	.44	.39	.35
10	30	.56	.47	.40	.35	.30
	10	.54	.44	.37	.31	.27
0	0	.52	.42	.35	.30	.25

% Reflectance Eff. Ceil.	Wall	Room Cavity Ratio 6	7	8	9	10
	50	.38	.34	.31	.28	.26
80	30	.31	.27	.25	.22	.20
	10	.26	.23	.20	.18	.16
	50	.37	.33	.30	.28	.25
70	30	.30	.27	.24	.22	.20
	10	.26	.23	.20	.18	.16
	50	.35	.31	.29	.26	.24
50	30	.29	.26	.23	.21	.19
	10	.25	.22	.20	.18	.16
	50	.33	.30	.27	.25	.23
30	30	.28	.25	.23	.21	.19
	10	.24	.21	.19	.17	.16
	50	.31	.28	.26	.24	.22
10	30	.27	.24	.22	.20	.18
	10	.24	.21	.19	.17	.15
0	0	.22	.19	.17	.15	.14

Fixture: FMR4240

Lamp: 2-40/T-12
Zonal Degrees: 0-30 0-40 0-60 0-90 0-180
Zonal Lumens: 761 1300 2508 3826 4601
Total Bare Lamp Lumens: 3200 × 2 = 6400
To determine number and placement of fixtures, see Lighting Selector Guide, pages L-7 to L-12.



Angle	Candelas Along	Candelas Across
0	933	933
10	912	936
20	860	954
30	774	975
40	649	969
50	486	912
60	314	827
70	169	719
80	68	574
90	14	443
100	12	432
110	11	367
120	9	261
130	7	144
140	3	55
150	1	15
160	0	3
170	0	0
180	0	0

Coefficient of Utilization

Effective Floor Cavity Reflectance 20%

% Reflectance Eff. Ceil.	Wall	Room Cavity Ratio 1	2	3	4	5
	50	.69	.59	.51	.45	.40
80	30	.65	.53	.44	.38	.33
	10	.62	.48	.39	.33	.28
	50	.66	.56	.49	.43	.38
70	30	.63	.51	.43	.37	.32
	10	.59	.47	.38	.32	.27
	50	.61	.52	.45	.39	.35
50	30	.58	.48	.40	.34	.30
	10	.55	.44	.36	.30	.25
	50	.56	.48	.41	.36	.32
30	30	.54	.44	.37	.32	.28
	10	.51	.41	.34	.28	.24
	50	.51	.44	.38	.33	.30
10	30	.50	.41	.35	.30	.26
	10	.48	.38	.32	.27	.23
0	0	.45	.36	.29	.25	.21

% Reflectance Eff. Ceil.	Wall	Room Cavity Ratio 6	7	8	9	10
	50	.35	.32	.29	.26	.24
80	30	.29	.25	.23	.20	.18
	10	.24	.21	.18	.16	.15
	50	.34	.31	.28	.25	.23
70	30	.28	.25	.22	.20	.18
	10	.23	.20	.18	.16	.14
	50	.31	.28	.26	.24	.22
50	30	.26	.23	.21	.19	.17
	10	.22	.19	.17	.15	.14
	50	.29	.26	.24	.22	.20
30	30	.24	.22	.19	.18	.16
	10	.21	.18	.16	.14	.13
	50	.27	.24	.22	.21	.19
10	30	.23	.20	.18	.17	.15
	10	.20	.17	.15	.14	.12
0	0	.18	.16	.14	.12	.11

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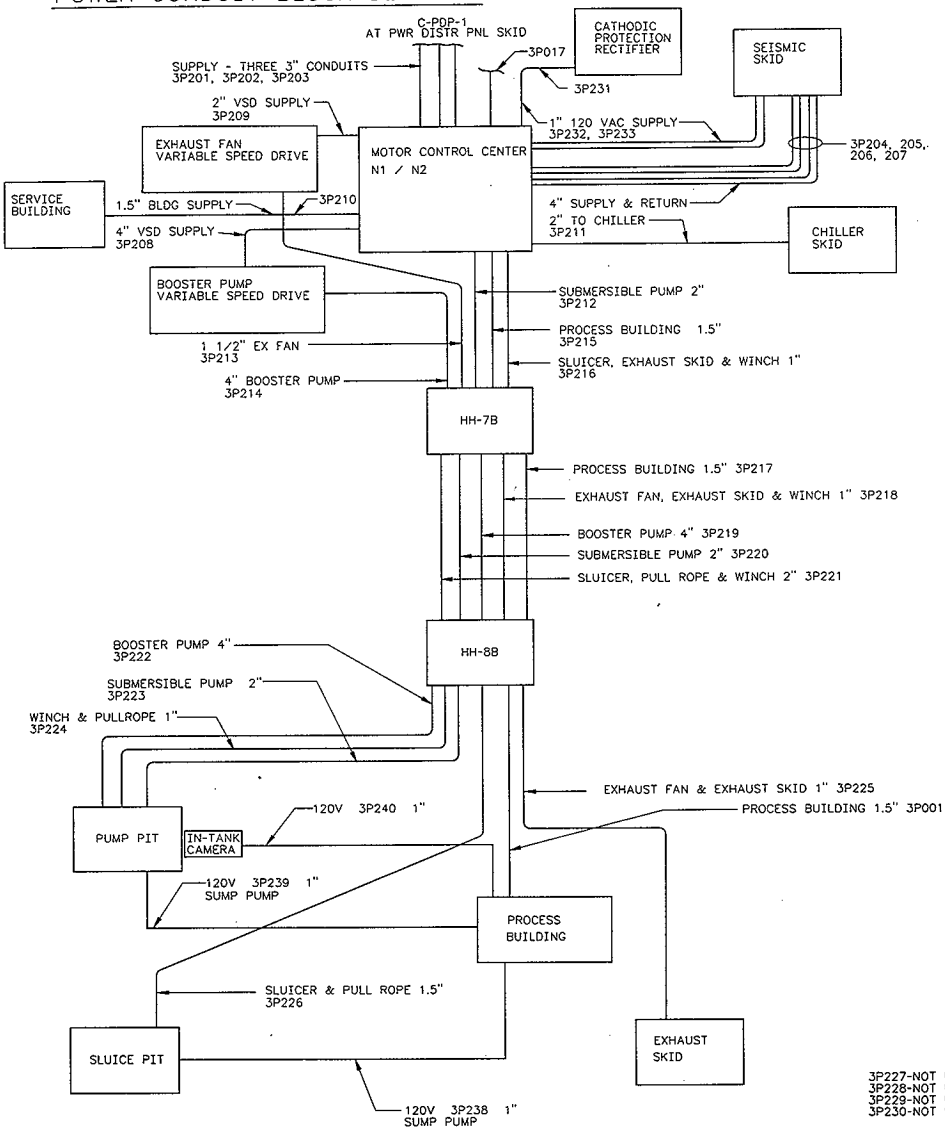
POWER CONDUIT BLOCK DIAGRAM

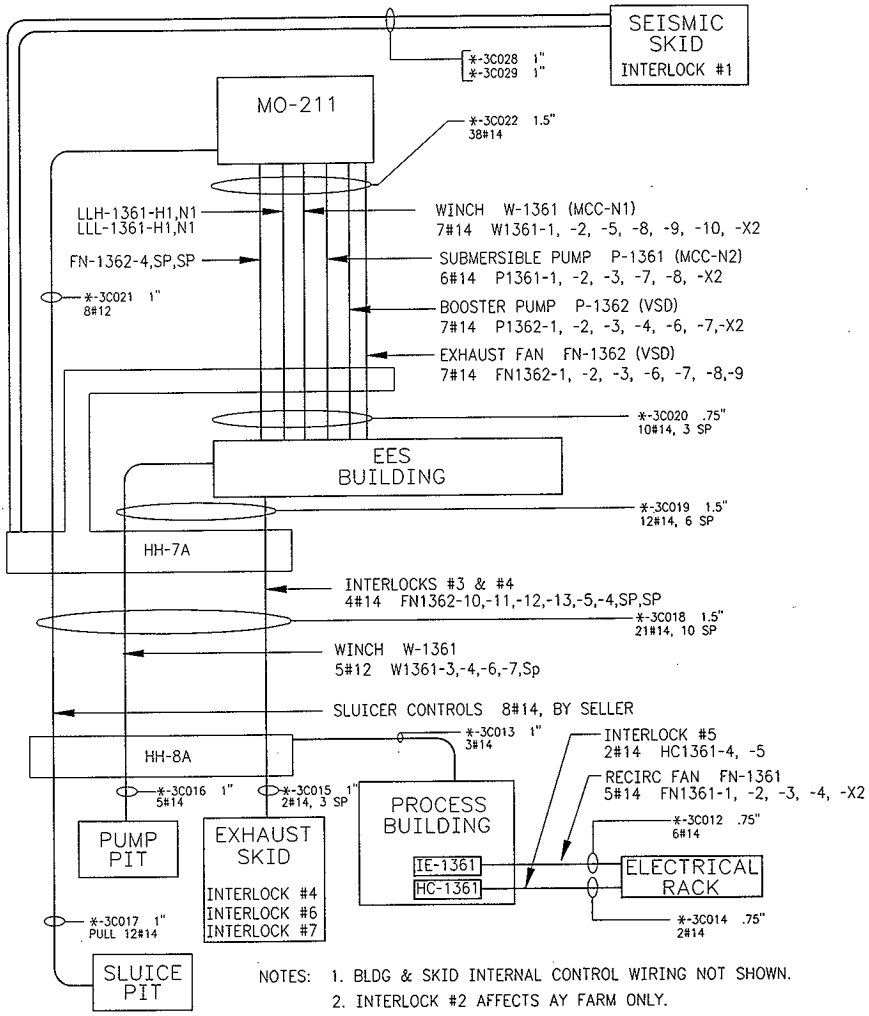


3P227-NOT USED
3P228-NOT USED
3P229-NOT USED
3P230-NOT USED

REVISION 4 9-01-95
CAD FILE C-BLOCK.DW

Calculation W320-31-071
Page A-30

C-FARM 120V CONTROL BLOCK DIAGRAM



NOTES: 1. BLDG & SKID INTERNAL CONTROL WIRING NOT SHOWN.
2. INTERLOCK #2 AFFECTS AY FARM ONLY.

REVISION: 2 9-21-95
CAD FILE K-BLOCK.DWG

C-FARM INSTRUMENT CABLE BLOCK DIAGRAM

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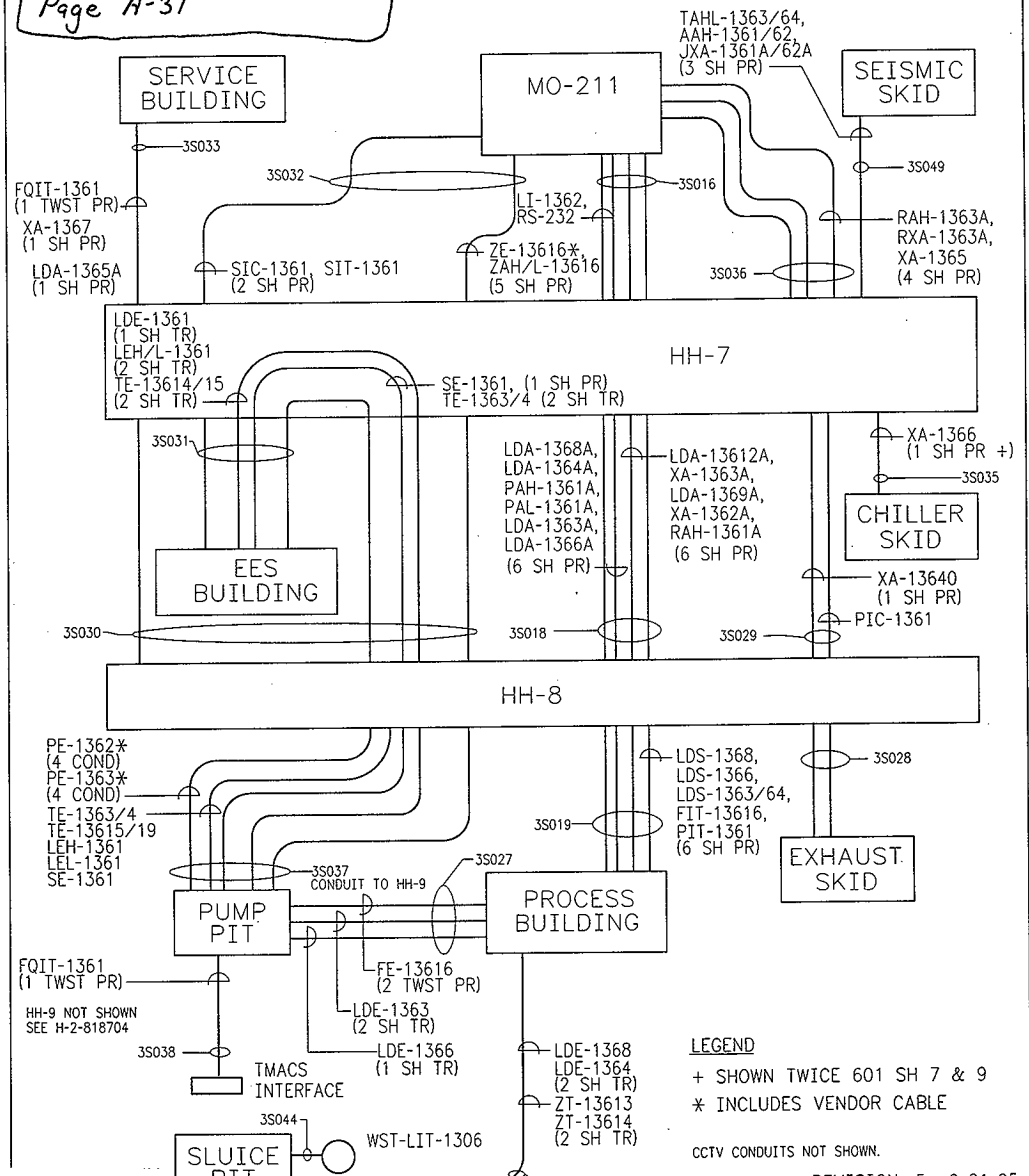

W320-31-016

AY-102 Demand Load Analysis, Size Feeders, Voltage Drop and Fault Study

Fluor Daniel Northwest	CALCULATION IDENTIFICATION AND INDEX	Page i of 3 Date 7/24/98

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

Discipline Electrical WO/Job No. Task Order N09 Calculation No. W320-31-016

Project No. & Name W320, Tank 241-C-106 Sluicing

Calculation Item AY-102 Demand Load Analysis, Size Feeders, Voltage Drop, and Fault Study

These calculations apply to:

Dwg. No. H-2-818693, Sheet 1 Rev. No. 1

Dwg. No. Rev. No.

Other (Study, CDR) Rev. No.

The status of these calculations is:

[] Preliminary Calculations

[X] Final Calculations

[] Check Calculations (On Calculation Dated)

[] Void Calculation (Reason Voided)

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

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

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	TJ Kasnick 8/7/95	TJ Kasnick 7/24/98	
Checked by	SA Najjar 8/7/95	[illegible] 7/24/98	
Approved by	TJ Kasnick 8/7/95	TJ Kasnick 7/24/98	
Checked Against Approved Vendor Data	N/A	TJ Kasnick 7/24/98	

INDEX

Design Analysis Page No.	Description
i	Calculation Identification and Index
ii	Calculation Cross Index
1	Objective
1-2	Design Inputs
3	Calculations
4	Findings and Conclusions
A-1 to A-5	Attachment A: Study Input Report
B-1 to B-7	Attachment B: Demand Load Analysis
C-1 to C-5	Attachment C: Size Feeders and Transformers
D-1 to D-8	Attachment D: Load Flow and Voltage Drop
E-1 to E-18	Attachment E: Short Circuit Analysis
F	Attachment F: Drawing H-2-818693

KEH 0378.00 (06/92) KEF072

CALCULATION CROSS INDEX (Typical)

Subject Calculation No.: W320-31-016

Subject Calculation Revision No.	Superceded by Calculation No.	These interfacing calculation/documents provide input to the subject calculation, and if revised may require revision of the subject calculation.		Results and conclusions of the subject calculation are used in these interfacing calculations and/or documents		Does the output interface calculation/ documents require revision?		Has the output interfacecalculation/ documents been revised?		Discipline manager's signature and date indicating evaluation complete.
		Calculation/Document No.	Revision No.	Calculation/Document No.	Revision No.	Yes	No	Yes		
0	N/A	H-2-818693	1	W320-31-017	~~0~~ 1 JM 5/24/98		X		X	

KEH 1975.00 (12/88)

1. OBJECTIVE

Determine the size of electrical distribution equipment necessary to support the loads required for Project W320, Tank 241-C-106 Sluicing, at Tank AY-102.

2. DESIGN INPUTS

2.1 Criteria and Source

Function Design Criteria For Tank 241-C-106 Waste Retrieval, Project W-320, HNF-SD-W320-FDC-001 Rev. 5.

2.2 Given or Known Data

The loads are shown on drawing H-2-818693, Sheet 1, Rev. 1. The size of motors and other equipment data are based on the Project W320 vendor information file #22668.

2.2.1 The Variable Speed Drives (VSD) are 95% efficient.

2.2.2 Motor currents, Full Load Amperes (FLA), which are based on the 1993 National Electrical Code (NEC) for the motor nameplate values except for the 250 HP motor which is based on vendor information, are tabulated as follows:

1) In-Line Booster pump (P-0622), at 250 HP (273 A), driven by VSD.
2) Submersible (Immersible) pump (P-0621), at 40 HP (52 A), driven by a soft starter.
3) Winch (W-0621), at 1.5 HP (2.6 A).
4) Pit 02E Chiller, at 10 amps.

2.2.3 Mini Power Panel is loaded to the 15 KVA transformer rating.

2.3 Assumptions

2.3.1 Transformer impedances used are typical NEMA three phase values.

2.3.2 The utility fault current values are assumed typical values derived from previous projects and data obtained from the utilities department.

2.4 Method to be Used

2.4.1 The FDNW approved (for design use) software: SKM Power Tools, version 3.4.0.1, 1995-1997.

2.5 References/Sources

2.5.1 Drawing H-2-818693, Sheet 1, Rev. 1, Electrical AY-Farm One-Line Diagram

2.5.2 NFPA 70, National Electrical Code (NEC), 1993 edition.

2.5.3 ANSI C2, National Electrical Safety Code, (NESC) 1990.

2.5.4 U.S. Department of Energy (DOE), order DOE 6430.1A, General Design Criteria

2.5.5 Vendor information file #22668.

3. CALCULATIONS

3.1 Attachment A: Input Report: This is the feeder, transformer, and generation input data that is used by the studies below.

3.2 Attachment B: Demand Load Analysis: This analysis calculates the total system loads based upon system bus load inputs and summarizes them on a bus by bus basis, including total system load and power factor.

3.3 Attachment C: Size Feeders and Transformers: This analysis provides the NEC Code sized feeders and transformers to meet the minimum load requirements of the Demand Load Analysis Study - Total Connected Load, and the evaluation of a fixed-size feeder to the MCC. Impedance and capacity information for the feeders and transformers were taken directly from the Dapper library, which represents typical values found in the industry. Conduit sizes determined are the minimum size required.

3.4 Attachment D: Load Flow and Voltage Drop: This analysis calculates the exact system operating voltages, loads flows, and system losses.

3.5 Attachment E: Short Circuit Analysis: This analysis calculates the system short circuit fault currents. The calculations are based upon typical Hanford 13.8 Kv utility fault current contributions, plus those from any motors running within the system.

4. FINDINGS AND CONCLUSIONS

4.1 Refer to Attachment C for system equipment sizing. Refer to other Attachments for various design information related to the distribution system equipment.

4.2 Refer to drawing H-2-818693 for one-line diagram of the electrical distribution equipment necessary to support the loads.

Attachment A

Project W-320 / Tank 241-C-106 Sluicing
AY-Farm Electrical Distribution
Calc. No. W320-31-016 (Reference Drawing H-2-818693, SH 1, Rev. 1)
Fri Jul 24 08:35:17 1998 Page 1

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SKM POWER*TOOLS FOR WINDOWS
INPUT DATA REPORT
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ALL PU VALUES ARE EXPRESSED ON A 100 MVA BASE.

Project W-320 / Tank 241-C-106 Sluicing
AY-Farm Electrical Distribution
Calc. No. W320-31-016 (Reference Drawing H-2-818693, SH 1, Rev. 1)

FEEDER INPUT DATA

FEEDER FROM NAME	FEEDER TO NAME	QTY /PH	VOLTS L-L	LENGTH	FEEDER SIZE	TYPE	DUCT	INSUL
Pole El	XFMR Pri	1	13800	3.0 FT	1	C	N	BARE
+/- Impedance:	0.1320 + J 0.1355		OHMS/M	Length	0.00021 + J 0.00021			PU
ZO Impedance:	0.2408 + J 0.2798		OHMS/M	Length	0.00038 + J 0.00044			PU
XFMR Sec	AY-PDP-1 800A	2	480	50.0 FT	350	C	M	THWN
+/- Impedance:	0.0390 + J 0.0500		OHMS/M	Length	0.4232 + J 0.5425			PU
ZO Impedance:	0.1229 + J 0.1231		OHMS/M	Length	1.33 + J 1.34			PU
AY-PDP-1 800A	AY102-PP1 Bus	1	480	50.0 FT	4	C	M	THWN
+/- Impedance:	0.3000 + J 0.0600		OHMS/M	Length	6.51 + J 1.30			PU
ZO Impedance:	0.9455 + J 0.1478		OHMS/M	Length	20.52 + J 3.21			PU
AY-PDP-1 800A	Tap Bus Asmbly	2	480	50.0 FT	350	C	M	THWN
+/- Impedance:	0.0390 + J 0.0500		OHMS/M	Length	0.4232 + J 0.5425			PU
ZO Impedance:	0.1229 + J 0.1231		OHMS/M	Length	1.33 + J 1.34			PU
Group Cntlr	Pit Chillr Bus	1	480	110.0 FT	10	C	M	THWN
+/- Impedance:	1.14 + J 0.0630		OHMS/M	Length	54.43 + J 3.01			PU
ZO Impedance:	3.59 + J 0.1552		OHMS/M	Length	171.53 + J 7.41			PU
Tap Bus Asmbly	Group Cntlr	1	480	2.0 FT	2/0	C	M	THWN
+/- Impedance:	0.1000 + J 0.0540		OHMS/M	Length	0.0868 + J 0.0469			PU
ZO Impedance:	0.3152 + J 0.1330		OHMS/M	Length	0.2736 + J 0.1154			PU
Group Cntlr	Imrs SS	1	480	1.000 FT	1/0	C	M	THHN
+/- Impedance:	0.1200 + J 0.0550		OHMS/M	Length	0.0521 + J 0.0239			PU
ZO Impedance:	0.3782 + J 0.1355		OHMS/M	Length	0.1641 + J 0.0588			PU
Group Cntlr	Winch Bus	1	480	120.0 FT	12	C	M	THHN
+/- Impedance:	1.90 + J 0.0680		OHMS/M	Length	98.96 + J 3.54			PU
ZO Impedance:	5.99 + J 0.1675		OHMS/M	Length	311.87 + J 8.72			PU
Boostr VSD	P-0622 Bus	1	480	120.0 FT	500	C	M	THWN
+/- Impedance:	0.0290 + J 0.0480		OHMS/M	Length	1.51 + J 2.50			PU
ZO Impedance:	0.0914 + J 0.1182		OHMS/M	Length	4.76 + J 6.16			PU

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Project W-320 / Tank 241-C-106 Sluicing
AY-Farm Electrical Distribution
Calc. No. W320-31-016 (Reference Drawing H-2-818693, SH 1, Rev. 1)

FEEDER INPUT DATA

FEEDER FROM NAME	FEEDER TO NAME	QTY /PH	VOLTS L-L	LENGTH	FEEDER SIZE	DESCRIPTION TYPE	DUCT	INSUL
Imrs SS	P-0621 Bus	1	480	200.0 FT	1/0	C	M	THWN
+/- Impedance:	0.1200 + J 0.0550	OHMS/M	Length	10.42	+ J	4.77		PU
ZO Impedance:	0.3782 + J 0.1355	OHMS/M	Length	32.83	+ J	11.76		PU
Tap Bus Asmbly	Boostr VSD	1	480	10.0 FT	500	C	M	THWN
+/- Impedance:	0.0290 + J 0.0480	OHMS/M	Length	0.1259	+ J	0.2083		PU
ZO Impedance:	0.0914 + J 0.1182	OHMS/M	Length	0.3967	+ J	0.5131		PU

Fri Jul 24 08:35:18 1998
Project W-320 / Tank 241-C-106 Sluicing
AY-Farm Electrical Distribution
Calc. No. W320-31-016 (Reference Drawing H-2-818693, SH 1, Rev. 1)

TRANSFORMER INPUT DATA

PRIMARY RECORD NO NAME		VOLTS L-L	* SECONDARY RECORD NO NAME		VOLTS L-L	FULL-LOAD KVA	NOMINAL KVA
XFMR Pri	D	13800.0	XFMR Sec	YG	480.00	172.50	150.00

Pos. Seq. Z%: 1.94 + J 4.07 12.93 + j 27.13 PU
Zero Seq. Z%: 1.94 + J 4.07 12.93 + j 27.13 PU
Taps Pri. -5.00 % Sec. 0.000 % Phase Shift (Pri. Leading Sec.): 30.00 Deg.

Fri Jul 24 08:35:18 1998
Project W-320 / Tank 241-C-106 Sluicing
AY-Farm Electrical Distribution
Calc. No. W320-31-016 (Reference Drawing H-2-818693, SH 1, Rev. 1)

GENERATION DATA

BUS NAME	GENERATION	VOLT	SIZE	InitKW	MaxKVAR	TYPE
Pole E1	C8-L6 13.8Kv	1.03 pu				SB

Three Phase Contribution: 3219.00 AMPS X/R : 1.75
Line to Earth Contribution: 1260.00 AMPS X/R : 1.0000
Pos sequence impedance (100 MVA base) 0.6448 + J 1.13 PU
Zero sequence impedance (100 MVA base) 5.75 + J 4.79 PU

Attachment B

Project W-320 / Tank 241-C-106 Sluicing
AY-Farm Electrical Distribution
Calc. No. W320-31-016 (Reference Drawing H-2-818693, SH 1, Rev. 1)

DATE: 7:24:1998
TIME: 8:34:53.83

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*** SOLUTION COMMENTS ***
==========

LOAD ANALYSIS INCLUDES ALL LOADS.

DATE: 7:24:1998 TIME: 8:34:53.83 PAGE 2
Project W-320 / Tank 241-C-106 Sluicing
AY-Farm Electrical Distribution
Calc. No. W320-31-016 (Reference Drawing H-2-818693, SH 1, Rev. 1)

LOAD SUMMARY

****

LOAD SCHEDULE FOR Pole E1 13800. VOLTS LINE TO LINE
SOURCE OF PWR SOURCE BUS

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
BRANCH LOADS							
XFMR Pri	294.7	12.3	294.7	12.3	351.4	14.7	88.81
TOTALS	294.7	12.3	294.7	12.3	351.4	14.7	88.81

LOAD SCHEDULE FOR XFMR Pri 13800. VOLTS LINE TO LINE
SOURCE OF PWR Pole E1

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
BRANCH LOADS							
XFMR Sec	294.7	12.3	294.7	12.3	351.4	14.7	88.81
TOTALS	294.7	12.3	294.7	12.3	351.4	14.7	88.81

LOAD SCHEDULE FOR XFMR Sec 480. VOLTS LINE TO LINE
SOURCE OF PWR XFMR Pri

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
BRANCH LOADS							
AY-PDP-1 800A	294.7	354.5	294.7	354.5	351.4	422.7	88.81
TOTALS	294.7	354.5	294.7	354.5	351.4	422.7	88.81

LOAD SCHEDULE FOR AY-PDP-1 800A 480. VOLTS LINE TO LINE
SOURCE OF PWR XFMR Sec

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
BRANCH LOADS							
Tap Bus Asmbly	279.9	336.7	279.9	336.7	336.6	404.9	89.14
AY102-PP1 Bus	15.0	18.0	15.0	18.0	15.0	18.0	80.00
TOTALS	294.7	354.5	294.7	354.5	351.4	422.7	88.81

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Project W-320 / Tank 241-C-106 Sluicing
AY-Farm Electrical Distribution
Calc. No. W320-31-016 (Reference Drawing H-2-818693, SH 1, Rev. 1)

LOAD SUMMARY

****

LOAD SCHEDULE FOR Tap Bus Asmbly 480. VOLTS LINE TO LINE
SOURCE OF PWR AY-PDP-1 800A

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
BRANCH LOADS							
Group Cntlr	53.6	64.4	53.6	64.4	64.4	77.4	81.70
Boostr VSD	227.0	273.0	227.0	273.0	283.7	341.2	90.30
TOTALS	279.9	336.7	279.9	336.7	336.6	404.9	89.14

LOAD SCHEDULE FOR Pit Chillr Bus 480. VOLTS LINE TO LINE
SOURCE OF PWR Group Cntlr

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
GENERAL LOADS	8.3	10.0	8.3	10.0	8.3	10.0	90.00
TOTALS	8.3	10.0	8.3	10.0	8.3	10.0	90.00

LOAD SCHEDULE FOR Group Cntlr 480. VOLTS LINE TO LINE
SOURCE OF PWR Tap Bus Asmbly

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
BRANCH LOADS							
Pit Chillr Bus	8.3	10.0	8.3	10.0	8.3	10.0	90.00
Imrs SS	43.2	52.0	43.2	52.0	54.0	65.0	80.30
Winch Bus	2.2	2.6	2.2	2.6	2.7	3.2	80.00
TOTALS	53.6	64.4	53.6	64.4	64.4	77.4	81.70

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Project W-320 / Tank 241-C-106 Sluicing
AY-Farm Electrical Distribution
Calc. No. W320-31-016 (Reference Drawing H-2-818693, SH 1, Rev. 1)

LOAD SUMMARY

****

LOAD SCHEDULE FOR Imrs SS 480. VOLTS LINE TO LINE
SOURCE OF PWR Group Cntlr

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
BRANCH LOADS							
P-0621 Bus	43.2	52.0	43.2	52.0	54.0	65.0	80.30
TOTALS	43.2	52.0	43.2	52.0	54.0	65.0	80.30

LOAD SCHEDULE FOR Winch Bus 480. VOLTS LINE TO LINE
SOURCE OF PWR Group Cntlr

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
LARGEST KVA MTR	2.2	2.6	2.2	2.6	2.7	3.2	80.00
TOTALS	2.2	2.6	2.2	2.6	2.7	3.2	80.00

LOAD SCHEDULE FOR AY102-PP1 Bus 480. VOLTS LINE TO LINE
SOURCE OF PWR AY-PDP-1 800A

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
GENERAL LOADS	15.0	18.0	15.0	18.0	15.0	18.0	80.00
TOTALS	15.0	18.0	15.0	18.0	15.0	18.0	80.00

LOAD SCHEDULE FOR Boostr VSD 480. VOLTS LINE TO LINE
SOURCE OF PWR Tap Bus Asmbly

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
BRANCH LOADS							
P-0622 Bus	227.0	273.0	227.0	273.0	283.7	341.2	90.30
TOTALS	227.0	273.0	227.0	273.0	283.7	341.2	90.30

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Project W-320 / Tank 241-C-106 Sluicing
AY-Farm Electrical Distribution
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LOAD SUMMARY

****

LOAD SCHEDULE FOR P-0622 Bus 480. VOLTS LINE TO LINE
SOURCE OF PWR Boostr VSD

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
LARGEST KVA MTR	227.0	273.0	227.0	273.0	283.7	341.2	90.30
TOTALS	227.0	273.0	227.0	273.0	283.7	341.2	90.30

LOAD SCHEDULE FOR P-0621 Bus 480. VOLTS LINE TO LINE
SOURCE OF PWR Imrs SS

ITEM DESCRIPTION	CONNECTED KVA	LOAD AMPS	DEMAND KVA	LOAD AMPS	DESIGN KVA	LOAD AMPS	% P F
END USE LOADS							
LARGEST KVA MTR	43.2	52.0	43.2	52.0	54.0	65.0	80.30
TOTALS	43.2	52.0	43.2	52.0	54.0	65.0	80.30

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Project W-320 / Tank 241-C-106 Sluicing
AY-Farm Electrical Distribution
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TOTAL SOURCE LOAD SUMMARY

LOAD DESCRIPTION TYPE	UNITS	CONNECTED LOAD	DEMAND LOAD	DESIGN LOAD	POWER FACTOR %
GENERAL LOADS	KW	19.5	19.5	19.5	
	KVAR	12.6	12.6	12.6	
	KVA	23.2	23.2	23.2	83.92 LAGGING
KVA TYPE MTR	KW	36.4	36.4	36.4	
	KVAR	27.0	27.0	27.0	
	KVA	45.4	45.4	45.4	80.29 LAGGING
LARGEST KVA MTR	KW	204.9	204.9	256.2	
	KVAR	97.5	97.5	121.9	
	KVA	227.0	227.0	283.7	90.30 LAGGING
TOTAL LOADS	KW	260.8	260.8	312.1	
	KVAR	137.2	137.2	161.6	
	KVA	294.7	294.7	351.4	
	% PF	88.5 LAGGING	88.5 LAGGING	88.8 LAGGING	

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Project W-320 / Tank 241-C-106 Sluicing
AY-Farm Electrical Distribution
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LOAD DEMAND TABLE

LOAD DESCRIPTION	LOAD TYPE	FIRST DEMAND KVA	FIRST DEMAND %	SECOND DEMAND KVA	SECOND DEMAND %	THIRD DEMAND KVA	THIRD DEMAND %	DESIGN FACT
GENERAL LOADS	Z	100.	100.	ALL	50.	ALL	50.	1.00
LIGHTING	K	ALL	100.	ALL	100.	ALL	100.	1.25
RECEPTACLES	Z	10.	100.	ALL	50.	ALL	50.	1.00
Load Not Defined	K	ALL	0.	ALL	0.	ALL	0.	1.00
HEATING	Z	ALL	100.	ALL	100.	ALL	100.	1.25
OFFICE EQUIPMENT	Z	ALL	100.	ALL	100.	ALL	100.	1.00
WATER PUMPS	K	ALL	100.	ALL	100.	ALL	100.	1.00
VAR SPEED DRIVE	K	ALL	5.	ALL	5.	ALL	5.	1.00
SPARE	K	ALL	100.	ALL	100.	ALL	100.	1.00
SPARE	K	ALL	100.	ALL	100.	ALL	100.	1.00
HVAC MTR LOAD	K	ALL	100.	ALL	100.	ALL	100.	1.00
HVAC LGST MTR	K	ALL	100.	ALL	100.	ALL	100.	1.25
ACC MTR LOAD	K	ALL	100.	ALL	100.	ALL	100.	1.00
ACC LGST MTR	K	ALL	100.	ALL	100.	ALL	100.	1.25
SPARE	K	ALL	100.	ALL	100.	ALL	100.	1.00
SPARE	K	ALL	100.	ALL	100.	ALL	100.	1.00
SPARE	K	ALL	100.	ALL	100.	ALL	100.	1.00
SPARE	K	ALL	100.	ALL	100.	ALL	100.	1.00
SPARE	K	ALL	100.	ALL	100.	ALL	100.	1.00
SPARE	K	ALL	100.	ALL	100.	ALL	100.	1.00

NOTES: LARGEST MOTOR CIRCUIT IDENTIFIED,
AND USED TO CALCULATE DEMAND LOAD BASED ON NEC ART 430
DEMAND AND DESIGN FACTORS APPLIED AT EACH LOAD BUS
AND ALL LOAD TOTALS ARE POWER FACTOR CORRECTED
DESIGN LOAD VALUES BASED ON MOTOR RUNING OR STARTING CONDITION

Attachment C

Project W-320 / Tank 241-C-106 Sluicing
AY-Farm Electrical Distribution
Calc. No. W320-31-016 (Reference Drawing H-2-818693, SH 1, Rev. 1)

DATE: 7:24:1998
TIME: 8:34:59.76

ALL INFORMATION PRESENTED IS FOR REVIEW, APPROVAL, INTERPRETATION
AND APPLICATION BY A REGISTERED ENGINEER ONLY

SKM POWER*TOOLS FOR WINDOWS
FEEDER AND TRANSFORMER SIZING REPORT
COPYRIGHT SKM SYSTEMS ANALYSIS, INC. 1995-1996

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Project W-320 / Tank 241-C-106 Sluicing
AY-Farm Electrical Distribution
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FEEDER AND TRANSFORMER STUDY CRITERIA

==========

SIZE AND REPORT, DO NOT CHANGE THE DATA BASE

BRANCH VOLTAGE DROP CRITERIA 3.00 %

VOLTAGE DROP CALCULATIONS ARE PRELIMINARY
EXECUTE VOLTAGE DROP AND LOAD FLOW STUDY FOR MORE ACCURATE RESULTS

PRIMARY/SECONDARY TRANSFORMER FDRS SIZED AT 125. % OF TX FULL LOAD RATING

```
***  NOTICE   ***  FEEDER SIZED TO  125. PERCENT OF TRANSFORMER SIZE
                   BRANCH FROM  XFMR Pri        TO  XFMR Sec
                   TX KVA:    294.7  TR FLA:      12.3
                   MINIMUM FEEDER AMPACITY:       15.4

***  NOTICE   ***  FEEDER SIZED TO  125. PERCENT OF TRANSFORMER SIZE
                   BRANCH FROM  XFMR Pri        TO  XFMR Sec
                   TX KVA:    294.7  TR FLA:     354.5
                   MINIMUM FEEDER AMPACITY:      443.1
```

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Project W-320 / Tank 241-C-106 Sluicing
AY-Farm Electrical Distribution
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FEEDER SIZE REPORT

****

F E E D E R S C H E D U L E

FEEDER NO	ROUTING NAME	FEEDER VOLTAGE	NO /PH	WIRE QTY	SIZE FDR	TYPE MAT	INSUL TYPE	GROUND WIRE	RACEWAY SIZE	RACEWAY TYPE
FROM	Pole El	13800.								
**********										
TO	XFMR Pri	EX	(1)	3	1	CU	BARE			N
FROM	XFMR Sec	480.								
**********										
TO	AY-PDP-1 800A	EX	(2)	4	350	CU	THWN		3" C	M
FROM	AY-PDP-1 800A	480.								
**********										
TO	AY102-PP1 Bus	EX	(1)	4	4	CU	THWN	8	1" C	M
TO	Tap Bus Asmbly	EX	(2)	4	350	CU	THWN	1/0	2 1/2" C	M
FROM	Group Cntlr	480.								
**********										
TO	Pit Chillr Bus	EX	(1)	4	10	CU	THWN	10	1/2" C	M
FROM	Tap Bus Asmbly	480.								
**********										
TO	Group Cntlr	EX	(1)	4	2/0	CU	THWN	6	1 1/2" C	M
FROM	Group Cntlr	480.								
**********										
TO	Imrs SS	EX	(1)	4	1/0	CU	THHN	6	1 1/2" C	M
TO	Winch Bus	EX	(1)	4	12	CU	THHN	12	1/2" C	M
FROM	Boostr VSD	480.								
**********										
TO	P-0622 Bus	EX	(1)	4	500	CU	THWN	3	3" C	M
FROM	Imrs SS	480.								
**********										
TO	P-0621 Bus	EX	(1)	4	1/0	CU	THWN	6	1 1/2" C	M
FROM	Tap Bus Asmbly	480.								
**********										
TO	Boostr VSD	EX	(1)	4	500	CU	THWN	3	3" C	M

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Project W-320 / Tank 241-C-106 Sluicing
AY-Farm Electrical Distribution
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FEEDER EVALUATION

****

F E E D E R D E S I G N L O A D A N A L Y S I S

FEEDER NO	ROUTING NAME	EXTG	% VD	QTY /PH	SIZE FDR	FEEDER MAT	DESCRIPTION INSUL	AMBIENT	DESIGN LOAD	DERATED CAPACITY
FROM	Pole El	13800.								
TO	XFMR Pri	EX	0.00	1		CU	BARE	30.	15. A	UNKNOWN
***	WARNING ***	ENGINEERING REVIEW OF FEEDER CAPACITY SUGGESTED								
FROM	XFMR Sec		480.							
TO	AY-PDP-1 800A	EX	0.22	2		CU	THWN	30.	423. A	620. A
FROM	AY-PDP-1 800A		480.							
TO	AY102-PP1 Bus	EX	0.09	1		CU	THWN	30.	18. A	70. A
TO	Tap Bus Asmbly	EX	0.21	2		CU	THWN	30.	405. A	620. A
FROM	Group Cntlr		480.							
TO	Pit Chillr Bus	EX	0.42	1		CU	THWN	30.	10. A	30. A
FROM	Tap Bus Asmbly		480.							
TO	Group Cntlr	EX	0.01	1		CU	THWN	30.	77. A	175. A
FROM	Group Cntlr		480.							
TO	Imrs SS	EX	0.00	1		CU	THHN	30.	65. A	150. A
TO	Winch Bus	EX	0.22	1		CU	THHN	70.	3. A	12. A
FROM	Boostr VSD		480.							
TO	P-0622 Bus	EX	0.69	1		CU	THWN	30.	341. A	380. A
FROM	Imrs SS		480.							
TO	P-0621 Bus	EX	0.61	1		CU	THWN	30.	65. A	150. A
FROM	Tap Bus Asmbly		480.							
TO	Boostr VSD	EX	0.06	1		CU	THWN	30.	341. A	380. A

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Project W-320 / Tank 241-C-106 Sluicing
AY-Farm Electrical Distribution
Calc. No. W320-31-016 (Reference Drawing H-2-818693, SH 1, Rev. 1)

TRANSFORMER SIZE REPORT

****

T R A N S F O R M E R S C H E D U L E

LOCATION DESCRIPTION BUS NO.	NAME	VOLTAGE LEVELS	CONN CODE	PCT. TAP	TRANSFORMER DESCRIPTION		
FROM	XFMR Pri	13800.	D	-5.0	TYPE: OA	SIZE:	0.0 KVA
TOr	XFMR Sec	480.	YG		DESCRIPTION: XFMR C6351-3		
DEMAND LOAD:	294.7 KVA		EX		4.51 %Z NOMINAL RATING		0.0 KVA

Attachment D

Project W-320 / Tank 241-C-106 Sluicing
AY-Farm Electrical Distribution
Calc. No. W320-31-016 (Reference Drawing H-2-818693, SH 1, Rev. 1)

DATE: 7:24:1998
TIME: 8:35:19.70

ALL INFORMATION PRESENTED IS FOR REVIEW, APPROVAL
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SKM POWER*TOOLS FOR WINDOWS
LOAD FLOW AND VOLTAGE DROP ANALYSIS REPORT
COPYRIGHT SKM SYSTEMS ANALYSIS, INC. 1995-1996

Project W-320 / Tank 241-C-106 Sluicing
AY-Farm Electrical Distribution
Calc. No. W320-31-016 (Reference Drawing H-2-818693, SH 1, Rev. 1)

*** SOLUTION COMMENTS ***
==========

SOLUTION PARAMETERS

BRANCH VOLTAGE CRITERIA	:	3.00 %
BUS VOLTAGE CRITERIA	:	5.00 %
ACCELERATION FACTOR FOR 'PV' GENERATORS	:	1.00
ACCELERATION FACTOR FOR CONSTANT KVA LOADS	:	1.00
EXACT(ITERATIVE) SOLUTION	:	YES
UTILITY IMPEDANCE	:	YES
TRANSFORMER PHASE SHIFT	:	NO

ALL PU VALUES ARE EXPRESSED ON A 100 MVA BASE

LOAD FLOW IS BASED ON CALCULATED DEMAND LOAD RESULTS
FROM THE DEMAND LOAD ANALYSIS STUDY.
LOAD ANALYSIS INCLUDES ALL LOADS.

<<PERCENT VOLTAGE DROPS ARE BASED ON NOMINAL DESIGN VOLTAGES>>

SWING GENERATORS

SOURCE NAME	VOLTAGE	ANGLE
C8-L6 13.8Kv	1.030	0.00

LARGEST LOAD:	226.96 KVA	
CONVERGENCE CRITERIA:	0.011 KVA	
LARGEST BUS MISMATCH	P-0622 Bus	0.681 KVA
LARGEST BUS MISMATCH	P-0622 Bus	0.057 KVA
LARGEST BUS MISMATCH	P-0622 Bus	0.005 KVA

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Project W-320 / Tank 241-C-106 Sluicing
AY-Farm Electrical Distribution
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BALANCED VOLTAGE DROP AND LOAD FLOW ANALYSIS (SWING GENERATORS)
****

SOURCE	VOLTAGE	ANGLE	KW	KVAR	VD%	(UTILITY IMPEDANCE)
C8-L6 13.8Kv	1.030	0.00	274.67	164.41	0.35	0.64485+J 1.12848

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 Project W-320 / Tank 241-C-106 Sluicing
 AY-Farm Electrical Distribution
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                 BALANCED VOLTAGE DROP AND LOAD FLOW ANALYSIS
*******************************************************************************
 VOLTAGE EFFECT ON LOADS MODELED
 VOLTAGE DROP CRITERIA: BRANCH =  3.00 %   BUS =  5.00


 ==== BUS:  Pole E1        DESIGN VOLTS:   13800 BUS VOLTS:   14165 %VD: -2.65
 ======================== PU BUS VOLTAGE:  1.026       ANGLE:  -0.1 DEGREES
                 *** SWING  GENERATOR: C8-L6 13.8Kv      274.7 KW   164.4 KVAR

 LOAD   TO:  XFMR Pri        FEEDER AMPS:  13.0 VOLTAGE DROP:     0. %VD:  0.00
 PROJECTED POWER FLOW:   274.0 KW    163.3 KVAR    319.0 KVA  PF:  0.86 LAGGING
 LOSSES THRU FEEDER:       0.0 KW      0.0 KVAR      0.0 KVA


 ==== BUS:  XFMR Pri       DESIGN VOLTS:   13800 BUS VOLTS:   14165 %VD: -2.65
 ======================== PU BUS VOLTAGE:  1.026       ANGLE:  -0.1 DEGREES

 LOAD FROM:  Pole E1         FEEDER AMPS:  13.0 VOLTAGE DROP:     0. %VD:  0.00
 PROJECTED POWER FLOW:   274.0 KW    163.3 KVAR    319.0 KVA  PF:  0.86 LAGGING
 LOSSES THRU FEEDER:       0.0 KW      0.0 KVAR      0.0 KVA

 LOAD   TO:  XFMR Sec        TRANSF AMPS:  13.0 VOLTAGE DROP:   256. %VD:  1.86
 PROJECTED POWER FLOW:   274.0 KW    163.3 KVAR    319.0 KVA  PF:  0.86 LAGGING
 LOSSES THRU TRANSF:      11.3 KW     23.7 KVAR     26.2 KVA


 ==== BUS:  XFMR Sec       DESIGN VOLTS:     480 BUS VOLTS:     484 %VD: -0.79
 ======================== PU BUS VOLTAGE:  1.008       ANGLE:  -2.9 DEGREES

 LOAD FROM:  XFMR Pri        TRANSF AMPS:  12.1 VOLTAGE DROP:     9. %VD:  1.86
 PROJECTED POWER FLOW:   274.0 KW    163.3 KVAR    319.0 KVA  PF:  0.86 LAGGING
 LOSSES THRU TRANSF:      11.3 KW     23.7 KVAR     26.2 KVA

 LOAD   TO:  AY-PDP-1 800A   FEEDER AMPS: 355.1 VOLTAGE DROP:     1. %VD:  0.19
 PROJECTED POWER FLOW:   262.8 KW    139.7 KVAR    297.6 KVA  PF:  0.88 LAGGING
 LOSSES THRU FEEDER:       0.4 KW      0.5 KVAR      0.6 KVA


 ==== BUS:  AY-PDP-1 800A  DESIGN VOLTS:     480 BUS VOLTS:     483 %VD: -0.60
 ======================== PU BUS VOLTAGE:  1.006       ANGLE:  -3.0 DEGREES

 LOAD FROM:  XFMR Sec        FEEDER AMPS: 355.1 VOLTAGE DROP:     1. %VD:  0.19
 PROJECTED POWER FLOW:   262.4 KW    139.2 KVAR    297.0 KVA  PF:  0.88 LAGGING
 LOSSES THRU FEEDER:       0.4 KW      0.5 KVAR      0.6 KVA

 LOAD   TO:  Tap Bus Asmbly  FEEDER AMPS: 337.2 VOLTAGE DROP:     1. %VD:  0.18
 PROJECTED POWER FLOW:   250.3 KW    130.1 KVAR    282.1 KVA  PF:  0.89 LAGGING
 LOSSES THRU FEEDER:       0.3 KW      0.4 KVAR      0.5 KVA
```

DATE: 7:24:1998 TIME: 8:35:19.70
Project W-320 / Tank 241-C-106 Sluicing
AY-Farm Electrical Distribution
Calc. No. W320-31-016 (Reference Drawing H-2-818693, SH 1, Rev. 1)

BALANCED VOLTAGE DROP AND LOAD FLOW ANALYSIS

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*******************************************************************************
VOLTAGE EFFECT ON LOADS MODELED
VOLTAGE DROP CRITERIA: BRANCH =  3.00 %   BUS =  5.00


LOAD   TO:  AY102-PP1 Bus   FEEDER AMPS:  18.1 VOLTAGE DROP:     0. %VD:  0.09
PROJECTED POWER FLOW:     12.1 KW      9.1 KVAR     15.2 KVA  PF:  0.80 LAGGING
LOSSES THRU FEEDER:        0.0 KW      0.0 KVAR      0.0 KVA


==== BUS:  Tap Bus Asmbly DESIGN VOLTS:     480 BUS VOLTS:     482 %VD: -0.43
======================== PU BUS VOLTAGE:  1.004        ANGLE:  -3.0 DEGREES

LOAD FROM:  AY-PDP-1 800A   FEEDER AMPS: 337.2 VOLTAGE DROP:     1. %VD:  0.18
PROJECTED POWER FLOW:    249.9 KW    129.7 KVAR    281.6 KVA  PF:  0.89 LAGGING
LOSSES THRU FEEDER:        0.3 KW      0.4 KVAR      0.5 KVA

LOAD   TO:  Group Cntlr     FEEDER AMPS:  64.4 VOLTAGE DROP:     0. %VD:  0.01
PROJECTED POWER FLOW:     44.1 KW     30.8 KVAR     53.8 KVA  PF:  0.82 LAGGING
LOSSES THRU FEEDER:        0.0 KW      0.0 KVAR      0.0 KVA

LOAD   TO:  Boostr VSD      FEEDER AMPS: 273.4 VOLTAGE DROP:     0. %VD:  0.05
PROJECTED POWER FLOW:    205.8 KW     98.9 KVAR    228.3 KVA  PF:  0.90 LAGGING
LOSSES THRU FEEDER:        0.1 KW      0.1 KVAR      0.1 KVA


==== BUS:  Pit Chillr Bus DESIGN VOLTS:     480 BUS VOLTS:     480 %VD: -0.01
======================== PU BUS VOLTAGE:  1.000        ANGLE:  -2.9 DEGREES
                 NET BRANCH DIVERSITY LOAD:     7.5 KW     3.6 KVAR

LOAD FROM:  Group Cntlr     FEEDER AMPS:  10.0 VOLTAGE DROP:     2. %VD:  0.42
PROJECTED POWER FLOW:      7.5 KW      3.6 KVAR      8.3 KVA  PF:  0.90 LAGGING
LOSSES THRU FEEDER:        0.0 KW      0.0 KVAR      0.0 KVA


==== BUS:  Group Cntlr    DESIGN VOLTS:     480 BUS VOLTS:     482 %VD: -0.42
======================== PU BUS VOLTAGE:  1.004        ANGLE:  -3.0 DEGREES

LOAD FROM:  Tap Bus Asmbly  FEEDER AMPS:  64.4 VOLTAGE DROP:     0. %VD:  0.01
PROJECTED POWER FLOW:     44.1 KW     30.8 KVAR     53.8 KVA  PF:  0.82 LAGGING
LOSSES THRU FEEDER:        0.0 KW      0.0 KVAR      0.0 KVA

LOAD   TO:  Pit Chillr Bus  FEEDER AMPS:  10.0 VOLTAGE DROP:     2. %VD:  0.42
PROJECTED POWER FLOW:      7.5 KW      3.6 KVAR      8.3 KVA  PF:  0.90 LAGGING
LOSSES THRU FEEDER:        0.0 KW      0.0 KVAR      0.0 KVA
```

```
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 Project W-320 / Tank 241-C-106 Sluicing
 AY-Farm Electrical Distribution
 Calc. No. W320-31-016  (Reference Drawing H-2-818693, SH 1, Rev. 1)

                    BALANCED VOLTAGE DROP AND LOAD FLOW ANALYSIS
*******************************************************************************
 VOLTAGE EFFECT ON LOADS MODELED
 VOLTAGE DROP CRITERIA: BRANCH =  3.00 %   BUS =  5.00


 LOAD   TO:  Imrs SS          FEEDER AMPS:  52.0 VOLTAGE DROP:     0. %VD:  0.00
 PROJECTED POWER FLOW:    34.9 KW     25.8 KVAR     43.4 KVA  PF:  0.80 LAGGING
 LOSSES THRU FEEDER:      0.0 KW     0.0 KVAR     0.0 KVA

 LOAD   TO:  Winch Bus        FEEDER AMPS:   2.5 VOLTAGE DROP:     1. %VD:  0.17
 PROJECTED POWER FLOW:     1.7 KW      1.3 KVAR      2.2 KVA  PF:  0.80 LAGGING
 LOSSES THRU FEEDER:      0.0 KW     0.0 KVAR     0.0 KVA


 ==== BUS:  Imrs SS        DESIGN VOLTS:     480 BUS VOLTS:     482 %VD: -0.42
 ========================= PU BUS VOLTAGE:  1.004       ANGLE:  -3.0 DEGREES

 LOAD FROM:  Group Cntlr      FEEDER AMPS:  52.0 VOLTAGE DROP:     0. %VD:  0.00
 PROJECTED POWER FLOW:    34.9 KW     25.8 KVAR     43.4 KVA  PF:  0.80 LAGGING
 LOSSES THRU FEEDER:      0.0 KW     0.0 KVAR     0.0 KVA

 LOAD   TO:  P-0621 Bus       FEEDER AMPS:  52.0 VOLTAGE DROP:     2. %VD:  0.48
 PROJECTED POWER FLOW:    34.9 KW     25.8 KVAR     43.4 KVA  PF:  0.80 LAGGING
 LOSSES THRU FEEDER:      0.2 KW     0.1 KVAR     0.2 KVA


 ==== BUS:  Winch Bus      DESIGN VOLTS:     480 BUS VOLTS:     481 %VD: -0.25
 ========================= PU BUS VOLTAGE:  1.002       ANGLE:  -2.9 DEGREES
                NET BRANCH DIVERSITY LOAD:     1.7 KW     1.3 KVAR

 LOAD FROM:  Group Cntlr      FEEDER AMPS:   2.5 VOLTAGE DROP:     1. %VD:  0.17
 PROJECTED POWER FLOW:     1.7 KW      1.3 KVAR      2.2 KVA  PF:  0.80 LAGGING
 LOSSES THRU FEEDER:      0.0 KW     0.0 KVAR     0.0 KVA


 ==== BUS:  AY102-PP1 Bus  DESIGN VOLTS:     480 BUS VOLTS:     482 %VD: -0.51
 ========================= PU BUS VOLTAGE:  1.005       ANGLE:  -2.9 DEGREES
                NET BRANCH DIVERSITY LOAD:    12.1 KW     9.1 KVAR

 LOAD FROM:  AY-PDP-1 800A   FEEDER AMPS:  18.1 VOLTAGE DROP:     0. %VD:  0.09
 PROJECTED POWER FLOW:    12.1 KW      9.1 KVAR     15.2 KVA  PF:  0.80 LAGGING
 LOSSES THRU FEEDER:      0.0 KW     0.0 KVAR     0.0 KVA
```

```
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 Project W-320 / Tank 241-C-106 Sluicing
 AY-Farm Electrical Distribution
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                    BALANCED VOLTAGE DROP AND LOAD FLOW ANALYSIS
 ******************************************************************************
 VOLTAGE EFFECT ON LOADS MODELED
 VOLTAGE DROP CRITERIA: BRANCH =  3.00 %   BUS =  5.00


 ==== BUS:  Boostr VSD     DESIGN VOLTS:     480 BUS VOLTS:     482 %VD: -0.38
 ========================= PU BUS VOLTAGE:  1.004       ANGLE:  -3.0 DEGREES

 LOAD FROM:  Tap Bus Asmbly  FEEDER AMPS: 273.4 VOLTAGE DROP:     0. %VD:  0.05
 PROJECTED POWER FLOW:   205.7 KW     98.8 KVAR    228.2 KVA  PF:  0.90 LAGGING
 LOSSES THRU FEEDER:       0.1 KW     0.1 KVAR     0.1 KVA

 LOAD   TO:  P-0622 Bus      FEEDER AMPS: 273.4 VOLTAGE DROP:     3. %VD:  0.55
 PROJECTED POWER FLOW:   205.7 KW     98.8 KVAR    228.2 KVA  PF:  0.90 LAGGING
 LOSSES THRU FEEDER:       0.8 KW     1.3 KVAR     1.5 KVA


 ==== BUS:  P-0622 Bus     DESIGN VOLTS:     480 BUS VOLTS:     479 %VD:  0.17
 ========================= PU BUS VOLTAGE:  0.998       ANGLE:  -3.2 DEGREES
                 NET BRANCH DIVERSITY LOAD:   204.9 KW    97.5 KVAR

 LOAD FROM:  Boostr VSD      FEEDER AMPS: 273.4 VOLTAGE DROP:     3. %VD:  0.55
 PROJECTED POWER FLOW:   204.9 KW     97.5 KVAR    227.0 KVA  PF:  0.90 LAGGING
 LOSSES THRU FEEDER:       0.8 KW     1.3 KVAR     1.5 KVA


 ==== BUS:  P-0621 Bus     DESIGN VOLTS:     480 BUS VOLTS:     480 %VD:  0.06
 ======================== PU BUS VOLTAGE:  0.999       ANGLE:  -2.9 DEGREES
                 NET BRANCH DIVERSITY LOAD:    34.7 KW    25.8 KVAR

 LOAD FROM:  Imrs SS         FEEDER AMPS:  52.0 VOLTAGE DROP:     2. %VD:  0.48
 PROJECTED POWER FLOW:    34.7 KW     25.8 KVAR     43.2 KVA  PF:  0.80 LAGGING
 LOSSES THRU FEEDER:       0.2 KW     0.1 KVAR     0.2 KVA


 ==== BUS:  C8-L6 13.8Kv   DESIGN VOLTS:       1 BUS VOLTS:       1 %VD: -3.00
 ========================= PU BUS VOLTAGE:  1.030       ANGLE:   0.0 DEGREES
                *** SWING  GENERATOR: C8-L6 13.8Kv      274.7 KW   164.4 KVAR

 LOAD   TO:  Pole E1         FEEDER AMPS:174210 VOLTAGE DROP:     0. %VD:  0.35
 PROJECTED POWER FLOW:   274.7 KW    164.4 KVAR    320.1 KVA  PF:  0.86 LAGGING
 LOSSES THRU FEEDER:       0.6 KW     1.1 KVAR     1.3 KVA
```

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AY-Farm Electrical Distribution
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BALANCED VOLTAGE DROP AND LOAD FLOW BUS DATA SUMMARY
****

BUS NAME	BASE VOLT	PU VOLT	BUS NAME	BASE VOLT	PU VOLT
Pole E1	13800.00	1.0265	XFMR Pri	13800.00	1.0265
XFMR Sec	480.00	1.0079	AY-PDP-1 800A	480.00	1.0060
Tap Bus Asmbly	480.00	1.0043	Pit Chillr Bus	480.00	1.0001
Group Cntlr	480.00	1.0042	Imrs SS	480.00	1.0042
Winch Bus	480.00	1.0025	AY102-PP1 Bus	480.00	1.0051
Boostr VSD	480.00	1.0038	P-0622 Bus	480.00	0.9983
P-0621 Bus	480.00	0.9994			

BALANCED VOLTAGE DROP AND LOAD FLOW BRANCH DATA SUMMARY
****

FROM NAME	TO NAME	TYPE	VD%	AMPS	KVA	RATING%
Pole E1	XFMR Pri	FDR	0.00	13.00	319.02	UNKNOWN
XFMR Pri	XFMR Sec	TX2	1.86	13.00	319.02	184.94
XFMR Sec	AY-PDP-1 800A	FDR	0.19	355.13	297.58	57.28
AY-PDP-1 800A	Tap Bus Asmbly	FDR	0.18	337.23	282.06	54.39
AY-PDP-1 800A	AY102-PP1 Bus	FDR	0.09	18.13	15.17	25.91
Tap Bus Asmbly	Group Cntlr	FDR	0.01	64.44	53.80	36.82
Tap Bus Asmbly	Boostr VSD	FDR	0.05	273.46	228.33	71.96
Group Cntlr	Pit Chillr Bus	FDR	0.42	10.00	8.35	33.34
Group Cntlr	Imrs SS	FDR	0.00	52.01	43.42	34.67
Group Cntlr	Winch Bus	FDR	0.17	2.58	2.16	22.26
Imrs SS	P-0621 Bus	FDR	0.48	52.01	43.42	34.67
Boostr VSD	P-0622 Bus	FDR	0.55	273.46	228.22	71.96

NOTE: FDR RATING% = % AMPS RATING BASED ON LIBRARY FLA OR BRANCH INPUT FLA
TX2 RATING% = % KVA RATING BASED ON TRANSFORMER FL KVA

13 BUSES

*** T O T A L S Y S T E M L O S S E S ***
13. KW 27. KVAR

Attachment E

Project W-320 / Tank 241-C-106 Sluicing
AY-Farm Electrical Distribution
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ALL INFORMATION PRESENTED IS FOR REVIEW, APPROVAL
INTERPRETATION AND APPLICATION BY A REGISTERED ENGINEER ONLY

SKM POWER*TOOLS FOR WINDOWS
SHORT CIRCUIT ANALYSIS REPORT
COPYRIGHT SKM SYSTEMS ANALYSIS, INC. 1995-1996

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Project W-320 / Tank 241-C-106 Sluicing
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ALL PU VALUES ARE EXPRESSED ON A 100 MVA BASE

SWING GENERATORS

SOURCE NAME	VOLTAGE	ANGLE
C8-L6 13.8Kv	1.03	0.00

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********** P R E - F A U L T V O L T A G E P R O F I L E **********

BUS# NAME	BASE VOLTS	PU VOLTS	ANGLE (D)
Pole E1	13800.00	1.0300	0.
XFMR Pri	13800.00	1.0300	0.
XFMR Sec	480.00	1.0842	-30.
AY-PDP-1 800A	480.00	1.0842	-30.
Tap Bus Asmbly	480.00	1.0842	-30.
Pit Chillr Bus	480.00	1.0842	-30.
Group Cntlr	480.00	1.0842	-30.
Imrs SS	480.00	1.0842	-30.
Winch Bus	480.00	1.0842	-30.
AY102-PP1 Bus	480.00	1.0842	-30.
Boostr VSD	480.00	1.0842	-30.
P-0622 Bus	480.00	1.0842	-30.
P-0621 Bus	480.00	1.0842	-30.

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********** F A U L T A N A L Y S I S R E P O R T **********

FAULT TYPE: 3PH
MODEL INDUCTION MOTOR CONTRIBUTION: YES
MODEL TRANSFORMER TAPS: YES
MODEL TRANSFORMER PHASE SHIFT: YES

==========

Pole E1

VOLTAGE BASE LL: 13800.0 (VOLTS)
INI. SYM. RMS FAULT CURRENT: 3363.7 / -61. (AMPS/DEG)
THEVENIN EQUIVALENT IMPEDANCE: 0.631 +j 1.115 (PU)
THEVENIN IMPEDANCE X/R RATIO: 1.768

ASYM RMS INTERRUPTING AMPS			
1/2 CYCLES	3 CYCLES	5 CYCLES	8 CYCLES
3458.5	3363.7	3363.7	3363.7

ASYM RMS FAULTED CURRENT (AMPS)
AT TIME = 0.5 CYCLES

---PHASE A---	---PHASE B---	---PHASE C---
3458.5	3458.5	3458.5

Project W-320 / Tank 241-C-106 Sluicing
AY-Farm Electrical Distribution
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```
XFMR Pri        VOLTAGE BASE LL:                  13800.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:      3363.0 /  -60. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:      0.631 +j   1.115 (PU)
                THEVENIN IMPEDANCE X/R RATIO:       1.767

                 ASYM    RMS   INTERRUPTING AMPS
                 1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                     3457.7       3363.0       3363.0       3363.0

                ASYM    RMS   FAULTED CURRENT ( AMPS )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---        ---PHASE B---        ---PHASE C---
                    3457.7               3457.7               3457.7
-----------------------------------------------------------------------------

XFMR Sec        VOLTAGE BASE LL:                    480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:      6047.5 / -100. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:      7.304 +j  20.290 (PU)
                THEVENIN IMPEDANCE X/R RATIO:       2.778

                 ASYM    RMS   INTERRUPTING AMPS
                 1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                     6647.5       6047.5       6047.5       6047.5

                ASYM    RMS   FAULTED CURRENT ( AMPS )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---        ---PHASE B---        ---PHASE C---
                    6647.5               6647.5               6647.5
-----------------------------------------------------------------------------
```

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Project W-320 / Tank 241-C-106 Sluicing
AY-Farm Electrical Distribution
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```
AY-PDP-1 800A  VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   5974.6 / -100. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    7.377 +j  20.543 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     2.785

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    6570.6       5974.6       5974.6       5974.6

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   6570.6               6570.6               6570.6
```

```
Tap Bus Asmbly VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   5905.3 / -100. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    7.441 +j  20.792 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     2.794

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    6498.7       5905.3       5905.3       5905.3

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   6498.7               6498.7               6498.7
```

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```
Pit Chillr Bus VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   1964.8 /  -51. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:   61.944 +j  23.844 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     0.385

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    1964.8       1964.8       1964.8       1964.8

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   1964.8               1964.8               1964.8
```

```
Group Cntlr    VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   5887.4 / -100. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    7.517 +j  20.836 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     2.772

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    6468.9       5887.5       5887.4       5887.4

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   6468.9               6468.9               6468.9
```

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Project W-320 / Tank 241-C-106 Sluicing
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Imrs SS

VOLTAGE BASE LL: 480.0 (VOLTS)
INI. SYM. RMS FAULT CURRENT: 5877.7 / -100. (AMPS/DEG)
THEVENIN EQUIVALENT IMPEDANCE: 7.563 +j 20.859 (PU)
THEVENIN IMPEDANCE X/R RATIO: 2.758

ASYM RMS INTERRUPTING AMPS			
1/2 CYCLES	3 CYCLES	5 CYCLES	8 CYCLES
6451.9	5877.7	5877.7	5877.7

ASYM RMS FAULTED CURRENT (AMPS)
AT TIME = 0.5 CYCLES

---PHASE A---	---PHASE B---	---PHASE C---
6451.9	6451.9	6451.9

Winch Bus

VOLTAGE BASE LL: 480.0 (VOLTS)
INI. SYM. RMS FAULT CURRENT: 1198.9 / -44. (AMPS/DEG)
THEVENIN EQUIVALENT IMPEDANCE: 105.692 +j 25.724 (PU)
THEVENIN IMPEDANCE X/R RATIO: 0.243

ASYM RMS INTERRUPTING AMPS			
1/2 CYCLES	3 CYCLES	5 CYCLES	8 CYCLES
1198.9	1198.9	1198.9	1198.9

ASYM RMS FAULTED CURRENT (AMPS)
AT TIME = 0.5 CYCLES

---PHASE A---	---PHASE B---	---PHASE C---
1198.9	1198.9	1198.9

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Project W-320 / Tank 241-C-106 Sluicing
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```
AY102-PP1 Bus  VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   5037.9 /  -88. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:   13.888 +j  21.845 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     1.573

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    5129.8       5037.9       5037.9       5037.9

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   5129.8               5129.8               5129.8
```

```
Boostr VSD     VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   5875.3 / -100. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    7.471 +j  20.901 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     2.798

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    6467.3       5875.3       5875.3       5875.3

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   6467.3               6467.3               6467.3
```

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Project W-320 / Tank 241-C-106 Sluicing
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```
P-0622 Bus     VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   5554.8 / -101. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:    7.760 +j  22.157 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     2.855

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    6139.2       5554.8       5554.8       5554.8

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   6139.2               6139.2               6139.2
```

```
P-0621 Bus     VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   4290.3 /  -87. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:   16.480 +j  25.542 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     1.550

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    4364.1       4290.3       4290.3       4290.3

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   4364.1               4364.1               4364.1
```

****

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********** F A U L T A N A L Y S I S R E P O R T **********

FAULT TYPE: SLG
MODEL INDUCTION MOTOR CONTRIBUTION: YES
MODEL TRANSFORMER TAPS: YES
MODEL TRANSFORMER PHASE SHIFT: YES

==========

Pole E1

VOLTAGE BASE LL: 13800.0 (VOLTS)
INI. SYM. RMS FAULT CURRENT: 1302.9 / -45. (AMPS/DEG)
THEVENIN EQUIVALENT IMPEDANCE: 7.016 +j 7.017 (PU)
THEVENIN IMPEDANCE X/R RATIO: 1.000
SEQUENCE EQUIVALENT IMPEDANCE Z1: 0.631 +j 1.115 (PU)
Z2: 0.631 +j 1.115 (PU)
Z0: 5.754 +j 4.787 (PU)

ASYM RMS 1/2 CYCLES	INTERRUPTING AMPS 3 CYCLES	5 CYCLES	8 CYCLES
1305.3	1302.9	1302.9	1302.9

ASYM RMS FAULTED CURRENT (AMPS)
AT TIME = 0.5 CYCLES

---PHASE A---	---PHASE B---	---PHASE C---
1305.3	0.0	0.0

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Project W-320 / Tank 241-C-106 Sluicing
AY-Farm Electrical Distribution
Calc. No. W320-31-016 (Reference Drawing H-2-818693, SH 1, Rev. 1)

```
XFMR Pri        VOLTAGE BASE LL:                    13800.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   1302.7 /  -45. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:    7.016 +j   7.018 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     1.000
                SEQUENCE EQUIVALENT IMPEDANCE Z1:   0.631 +j   1.115 (PU)
                                              Z2:   0.631 +j   1.115 (PU)
                                              Z0:   5.754 +j   4.787 (PU)

                 ASYM    RMS   INTERRUPTING AMPS
                 1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                     1305.2       1302.7       1302.7       1302.7

                ASYM    RMS   FAULTED CURRENT ( AMPS )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---        ---PHASE B---        ---PHASE C---
                    1305.2                 0.0                  0.0
```

```
XFMR Sec        VOLTAGE BASE LL:                      480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   5352.0 /  -98. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:   27.546 +j  67.712 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     2.458
                SEQUENCE EQUIVALENT IMPEDANCE Z1:   7.304 +j  20.290 (PU)
                                              Z2:   7.304 +j  20.290 (PU)
                                              Z0:  12.937 +j  27.133 (PU)

                 ASYM    RMS   INTERRUPTING AMPS
                 1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                     5752.3       5352.0       5352.0       5352.0

                ASYM    RMS   FAULTED CURRENT ( AMPS )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---        ---PHASE B---        ---PHASE C---
                    5752.3                 0.0                  0.0
```

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Project W-320 / Tank 241-C-106 Sluicing
AY-Farm Electrical Distribution
Calc. No. W320-31-016 (Reference Drawing H-2-818693, SH 1, Rev. 1)

```
AY-PDP-1 800A  VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   5190.9 /  -97. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:   29.026 +j  69.555 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     2.396
               SEQUENCE EQUIVALENT IMPEDANCE Z1:   7.377 +j  20.543 (PU)
                                             Z2:   7.377 +j  20.543 (PU)
                                             Z0:  14.271 +j  28.469 (PU)

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    5555.3       5190.9       5190.9       5190.9

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                      AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   5555.3                 0.0                  0.0
```

```
Tap Bus Asmbly VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   5039.9 /  -97. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:   30.488 +j  71.389 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     2.342
               SEQUENCE EQUIVALENT IMPEDANCE Z1:   7.441 +j  20.792 (PU)
                                             Z2:   7.441 +j  20.792 (PU)
                                             Z0:  15.605 +j  29.805 (PU)

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    5373.3       5039.9       5039.9       5039.9

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                      AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   5373.3                 0.0                  0.0
```

```
Pit Chillr Bus VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   1212.4 /  -45. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:  311.297 +j  85.015 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     0.273
               SEQUENCE EQUIVALENT IMPEDANCE Z1:  61.944 +j  23.844 (PU)
                                             Z2:  61.944 +j  23.844 (PU)
                                             Z0: 187.409 +j  37.328 (PU)

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    1212.4       1212.4       1212.4       1212.4

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   1212.4                 0.0                  0.0
```

```
Group Cntlr    VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   5017.0 /  -97. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:   30.913 +j  71.592 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     2.316
               SEQUENCE EQUIVALENT IMPEDANCE Z1:   7.517 +j  20.836 (PU)
                                             Z2:   7.517 +j  20.836 (PU)
                                             Z0:  15.879 +j  29.920 (PU)

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    5339.4       5017.0       5017.0       5017.0

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   5339.4                 0.0                  0.0
```

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Project W-320 / Tank 241-C-106 Sluicing
AY-Farm Electrical Distribution
Calc. No. W320-31-016 (Reference Drawing H-2-818693, SH 1, Rev. 1)

```
Imrs SS        VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   5004.3 /  -97. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:   31.169 +j  71.696 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     2.300
               SEQUENCE EQUIVALENT IMPEDANCE Z1:   7.563 +j  20.859 (PU)
                                             Z2:   7.563 +j  20.859 (PU)
                                             Z0:  16.043 +j  29.979 (PU)

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    5320.2       5004.3       5004.3       5004.3

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   5320.2                0.0                  0.0
```

```
Winch Bus      VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:    715.9 /  -39. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:  539.053 +j  89.960 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     0.167
               SEQUENCE EQUIVALENT IMPEDANCE Z1: 105.692 +j  25.724 (PU)
                                             Z2: 105.692 +j  25.724 (PU)
                                             Z0: 327.669 +j  38.512 (PU)

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                     715.9        715.9        715.9        715.9

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                    715.9                0.0                  0.0
```

```
AY102-PP1 Bus  VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   3994.2 /  -80. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:   62.564 +j  75.366 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     1.205
               SEQUENCE EQUIVALENT IMPEDANCE Z1:  13.888 +j  21.845 (PU)
                                             Z2:  13.888 +j  21.845 (PU)
                                             Z0:  34.789 +j  31.676 (PU)

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    4015.8       3994.2       3994.2       3994.2

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   4015.8                 0.0                  0.0
```

```
Boostr VSD     VOLTAGE BASE LL:                    480.0 (VOLTS)
               INI. SYM. RMS FAULT CURRENT:   4985.2 /  -97. ( AMPS/DEG )
               THEVENIN EQUIVALENT IMPEDANCE:   30.944 +j  72.121 (PU)
               THEVENIN IMPEDANCE X/R RATIO:     2.331
               SEQUENCE EQUIVALENT IMPEDANCE Z1:   7.471 +j  20.901 (PU)
                                             Z2:   7.471 +j  20.901 (PU)
                                             Z0:  16.002 +j  30.318 (PU)

                ASYM    RMS   INTERRUPTING AMPS
                1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                    5311.0       4985.2       4985.2       4985.2

               ASYM    RMS   FAULTED CURRENT ( AMPS )
                       AT TIME =     0.5 CYCLES
               ---PHASE A---        ---PHASE B---        ---PHASE C---
                   5311.0                 0.0                  0.0
```

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Project W-320 / Tank 241-C-106 Sluicing
AY-Farm Electrical Distribution
Calc. No. W320-31-016 (Reference Drawing H-2-818693, SH 1, Rev. 1)

```
P-0622 Bus      VOLTAGE BASE LL:                    480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   4417.6 /  -96. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:   36.283 +j  80.789 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     2.227
                SEQUENCE EQUIVALENT IMPEDANCE Z1:   7.760 +j  22.157 (PU)
                                              Z2:   7.760 +j  22.157 (PU)
                                              Z0:  20.763 +j  36.474 (PU)

                 ASYM    RMS   INTERRUPTING AMPS
                 1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                     4673.0       4417.6       4417.6       4417.6

                ASYM    RMS   FAULTED CURRENT ( AMPS )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---        ---PHASE B---        ---PHASE C---
                    4673.0                 0.0                  0.0
```

```
P-0621 Bus      VOLTAGE BASE LL:                    480.0 (VOLTS)
                INI. SYM. RMS FAULT CURRENT:   3161.7 /  -79. ( AMPS/DEG )
                THEVENIN EQUIVALENT IMPEDANCE:   81.833 +j  92.816 (PU)
                THEVENIN IMPEDANCE X/R RATIO:     1.134
                SEQUENCE EQUIVALENT IMPEDANCE Z1:  16.480 +j  25.542 (PU)
                                              Z2:  16.480 +j  25.542 (PU)
                                              Z0:  48.874 +j  41.732 (PU)

                 ASYM    RMS   INTERRUPTING AMPS
                 1/2 CYCLES     3 CYCLES     5 CYCLES     8 CYCLES
                     3174.1       3161.7       3161.7       3161.7

                ASYM    RMS   FAULTED CURRENT ( AMPS )
                        AT TIME =     0.5 CYCLES
                ---PHASE A---        ---PHASE B---        ---PHASE C---
                    3174.1                 0.0                  0.0
```

****

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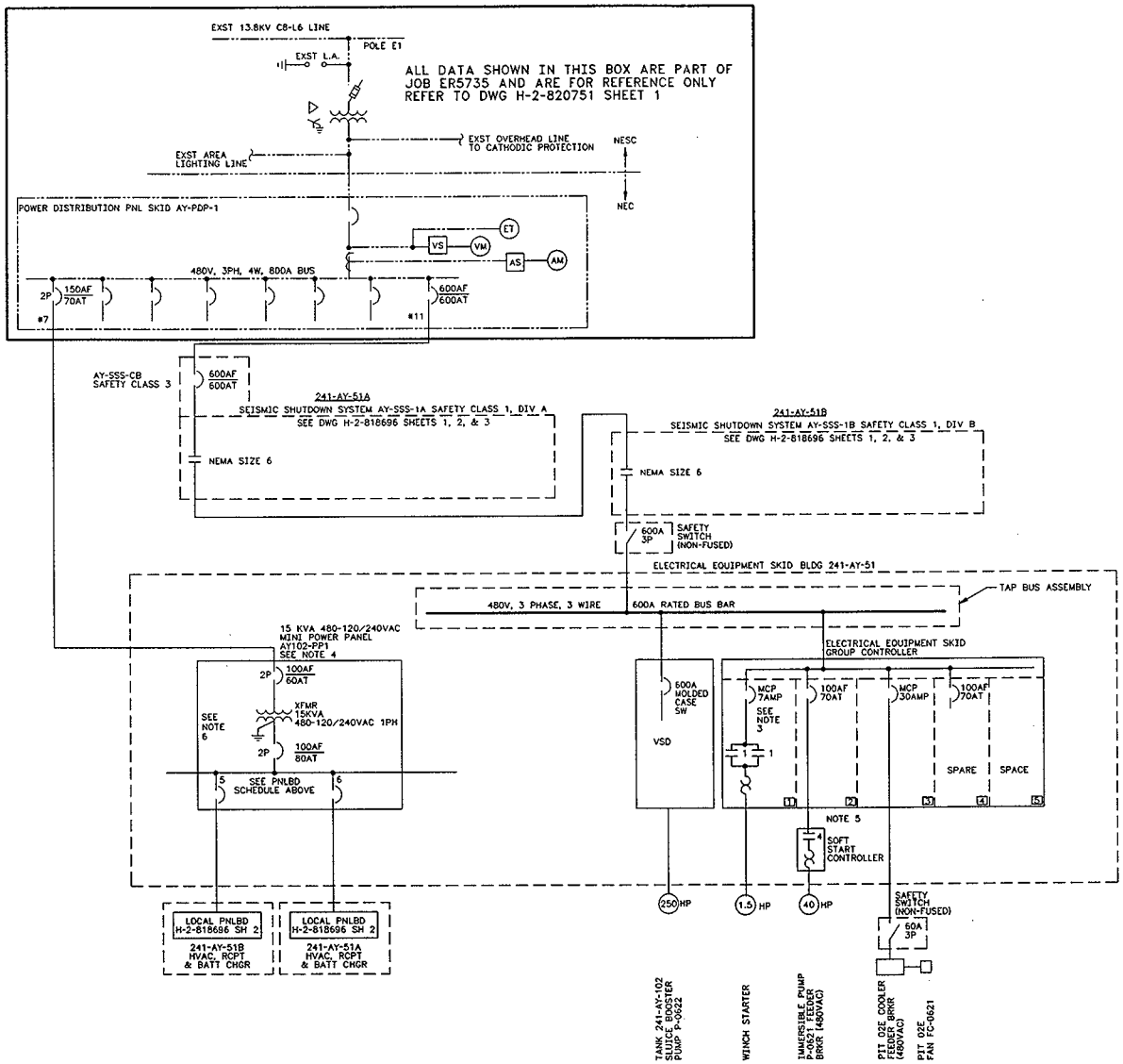
Project W-320 / Tank 241-C-106 Sluicing
AY-Farm Electrical Distribution
Calc. No. W320-31-016 (Reference Drawing H-2-818693, SH 1, Rev. 1)

********** F A U L T A N A L Y S I S S U M M A R Y **********

BUS NAME	VOLTAGE L-L	AVAILABLE FAULT CURRENT 3 PHASE	X/R	LINE/GRND	X/R
Pole E1	13800.	3363.7	1.8	1302.9	1.0
XFMR Pri	13800.	3363.0	1.8	1302.7	1.0
XFMR Sec	480.	6047.5	2.8	5352.0	2.5
AY-PDP-1 800A	480.	5974.6	2.8	5190.9	2.4
AY102-PP1 Bus	480.	5037.9	1.6	3994.2	1.2
Tap Bus Asmbly	480.	5905.3	2.8	5039.9	2.3
Group Cntlr	480.	5887.4	2.8	5017.0	2.3
Pit Chillr Bus	480.	1964.8	0.4	1212.4	0.3
Imrs SS	480.	5877.7	2.8	5004.3	2.3
Winch Bus	480.	1198.9	0.2	715.9	0.2
Boostr VSD	480.	5875.3	2.8	4985.2	2.3
P-0622 Bus	480.	5554.8	2.9	4417.6	2.2
P-0621 Bus	480.	4290.3	1.5	3161.7	1.1

********** FAULT ANALYSIS REPORT COMPLETED **********

Calculation No.
W-32031-016
Revision 1
Attachment F



NOTES:

1. SYMBOLS PER ANSI Y14.15 AND/OR Y32.2.
2. 2 POLE CIRCUIT BREAKER WHERE SHOWN.
3. CONTINUOUS CURRENT RATINGS ARE SHOWN ADJACENT TO MCPS (MOTOR CIRCUIT PROTECTOR).
4. MINI-POWER PANEL, SQUARE-D #MPZB15S40F CONSISTING OF 15KVA TRANSFORMER, PRIMARY AND SECONDARY CIRCUIT BREAKERS AND BRANCH CIRCUIT BREAKERS AS SHOWN.
5. MOTOR MCP'S AND CB FOR MOTOR STARTERS & VSD CONTROLLER SHALL BE CAPABLE OF BEING LOCKED IN OPEN POSITION.
6. AT MINI POWER PANEL, BOND JUMPER NEUTRAL, AND GROUND CONDUCTORS.
7. REFER TO H-2-818423 NOTE 1 FOR SPECIFIC INFORMATION CONCERNING SAFETY CLASSIFICATION OF COMPONENTS.

ONE-LINE DIAGRAM

ESSENTIAL DRAWING

H-2-99389	ONE LINE DIAGRAMS	H-2-818423	DRAWING LIST
H-2-64300	DRAWING INDEX		

REV	DESCRIPTION	DATE
3	INC ECN 648294 AND 647628	9/14/98

DW CROFT — SC — 606537
GRAEBER
SA NAJJAR
AW CLARKSON
DL FORT
CE NORTON
TJ KASNICK
THOMAS H MAY

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

ELECTRICAL
AY-FARM
ONE-LINE DIAGRAM

W-320 TANK 241-C-106 SLUICING

F — 241-AY — 7201 — H-2-818693 — 3

SCALE: SHOWN — ER4319 — SHEET 1 OF 1

PLOT SCALE: 1=1 — KEHCAD

W320-31-017

Tank AY-102 Load Determination,
Feeder/Protection Sizing, Voltage Drop,
Lighting and Conduit Sizing Calculations

Fluor Daniel Northwest	CALCULATION IDENTIFICATION AND INDEX	Page i of 24 Date 7/24/98

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

Discipline Electrical WO/Job No. Task Order N09 Calculation No. W320-31-017

Project No. & Name W320 Tank 241-C-106 Sluicing

Calculation Item Tank AY-102 Load Determination, Feeder/Protection Sizing, Voltage Drop, Lighting, and Conduit Sizing Calculations

These calculations apply to:

Dwg. No. See Continuation Sheet Rev. No.

Dwg. No. Rev. No.

Other (Study, CDR) Rev. No.

The status of these calculations is:

[] Preliminary Calculations

[X] Final Calculations

[] Check Calculations (On Calculation Dated)

[] Void Calculation (Reason Voided)

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

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

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	RH Graeber 9/13/95	[illegible] 7/24/98	
Checked by	SA Najjar 9/13/95	[illegible] 7/24/98	
Approved by	TJ Kasnick 9/15/95	[illegible] 7/24/98	
Checked Against Approved Vendor Data	N/A	[illegible] 7/24/98	

INDEX

Design Analysis Page No.	Description
i-ii	Calculation Identification and Index, Continuation Sheet
iii	Calculation Cross Index
1	Objective; Design Inputs
2	Given Data; Assumptions; Method of Analysis
3	References
3-23	Calculations
23	Conclusions
A-1 to A-7	Attachment A: Additional Reference Materials
B-1 to B-29	Attachment B: Vendor Information Cut Sheets
C-1	Attachment C: One-Line Diagram Drawing H-2-818693

KEH 0378.00 (06/92) KEF072

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	RH Graeber 9/13/95	7/24/98	
Checked by	SA Najjar 9/13/95		

These calculations apply to:

H-2-818686 Sheet 1, Rev. 0
H-2-818693 Sheet 1, Rev. 0
H-2-818694 Sheet 1, Rev. 0

H-2-818695 Sheet 1, Rev. 1
H-2-818695 Sheet 2, Rev. 1
H-2-818695 Sheet 3, Rev. 1

H-2-818695 Sheet 4, Rev. 1
H-2-818695 Sheet 5, Rev. 1
H-2-818696 Sheet 3, Rev. 0

H-2-818698 Sheet 1, Rev. 0
H-2-818698 Sheet 2, Rev. 0
H-2-818699 Sheet 1, Rev. 0

H-2-818699 Sheet 2, Rev. 0
H-2-818700 Sheet 1, Rev. 0
H-2-818700 Sheet 2, Rev. 0
H-2-818700 Sheet 3, Rev. 0

CALCULATION CROSS INDEX (Typical)

Subject Calculation No.: W320-31-017

Subject Calculation Revision No.	Superceded by Calculation No.	These interfacing calculation/documents provide input to the subject calculation, and if revised may require revision of the subject calculation.		Results and conclusions of the subject calculation are used in these interfacing calculations and/or documents		Does the output interface calculation/ documents require revision?		Has the output interfacecalculation/ documents been revised?		Discipline manager's signature and date indicating evaluation complete.
		Calculation/Document No.	Revision No.	Calculation/Document No.	Revision No.	Yes	No	Yes		
0	N/A	H-2-818693	0	H-2-818686	0		X		X	
				H-2-818693	0		X		X	
				H-2-818695, sh 1	1		X		X	
				H-2-818695, sh 2	1		X		X	
				H-2-818695, sh 3	1		X		X	
				H-2-818695, sh 4	1		X		X	
				H-2-818695, sh 5	1		X		X	
				H-2-818696, sh 3	0		X		X	
				H-2-818698, sh 1	0		X		X	
				H-2-818698, sh 2	0		X		X	
				H-2-818699, sh 1	0		X		X	
				H-2-818699, sh 2	0		X		X	
				H-2-818700, sh 1	0		X		X	
				H-2-818700, sh 2	0		X		X	
				H-2-818700, sh 3	0		X		X	

KEH 1975.00 (12/88)

DESIGN ANALYSIS

Client Numatec Hanford Corporation
Subject TANK AY-102 LOAD DETERMINATION, FEEDER/PROTECTION SIZING, VOLTAGE DROP AND LIGHTING CALCULATIONS
Location 200E, AY Farm

WO/Job No. Task Order N09
Date 9/13/95 By RH Graeber
Checked 9/13/95 By SA Najjar
Revised 7/24/98 By Cris Carlson

1. OBJECTIVE

1.1 To determine the total connected load and estimate the maximum demand for the Tank AY-102 portion of Project W-320, Tank 241-C-106 Sluicing.

1.2 To size the power feeder/branch circuit conductors, circuit protection and conduits.

1.3 To calculate the voltages at motor terminals during normal running and starting conditions in order to ensure proper operation of pump motors.

1.4 To determine number of light fixtures required to provide adequate illumination levels.

1.5 To determine instrument and control conduit sizes.

1.6 Special situation equipment sizing and voltage drop checks.

2. DESIGN INPUTS

2.1 Functional Design Criteria, HNF-SD-W320-FDC-001, Rev. 5.

2.2 One-Line Diagram, Drawing (DWG) H-2-818693.

2.3 NFPA-70, National Electrical Code (NEC), 1993 edition.

a. Branch circuit conductors shall be sized to carry at least 125% of the largest load plus the sum of other loads, for multiple load circuits.

b. Single conductor copper wires, with 90°C XHHW, 600 VAC insulation in buried raceway and conductor ampacity per Reference 6.1, Table 310-16 for 86°F (30°C) ambient temperature, shall be used.

c. Minimum conduit size shall be based on Reference 6.1, NEC Chapter 9 Table 3B.

d. Motor rated full load currents shall be based on Reference 6.1, 1993 NEC Table 430-150, Reliance Electric motor catalog and motor data sheets in vendor file #22668. Vendor data for Booster pump motor (250 HP motor) shows full load amps is 273 amperes. See Reliance data sheet E06854-A-A009.

e. Motor Circuit Protector (MCP) for motor protection and motor starters shall be sized per Reference 6.4.

2.4 The lockable "Service Entrance Rated" safety switch shall provide the main service disconnecting means to the AY-Farm loads supplied via the Electrical Equipment Skid (EES), building 241-AY-51.

2.5 Effective impedance (Z_{eff}) at 85% Power Factor (PF), shown in Reference 6.1, NEC Chapter 9 Table 9, shall be used for voltage calculations.

3. GIVEN DATA

3.1 The 150 KVA transformer bank installed by the Equipment Removal Phase of Project W-320 will be the source of power for these sluicing loads. Hanford Electrical Utilities Department estimates demand of the existing services is 22 KW @ 0.8 PF = 27.5 KVA ≈ 28 KVA.

3.2 Distribution transformer %Z = 2.6%.

3.3 Minimum allowable voltage at the motor terminals is 414 volts based on NEMA motor rating of 460 V ± 10%.

3.4 Pit-02E, the EES housing 241-AY-51 and Seismic Shutdown System missile shield enclosures 241-AY-51A and 51B are air conditioned.

3.5 Motors shown on the One-Line Diagram, Drawing H-2-818693 are induction motors rated 460 VAC, 3ø, 60 Hz. Motor FLA are from the NEC, except for the 250 HP motor which is based on vendor information in CVI file #22668.

3.6 The Variable Speed Drive (VSD) controller for the 250 HP In-Line Booster pump motor has been furnished by pump vendor (Procurement Specification W-320-P17). VSD controller maximum input current is 325 A. (150% Torque Limit for 60 sec. maximum).

3.7 The 40 HP Immersible pump is started before the booster pump. The submersible pump is interlocked with the booster pump so that the booster pump can only be started after the submersible pump discharge pressure exceeds the pressure switch setpoint. A "Soft Start" unit is to be used to limit torque effect to submersible pump hoses to prevent excess twisting.

3.8 Pit chiller FLA is 8.1 A per Edwards Engineering Corp. Vendor data, see file #22668.

4. ASSUMPTIONS

4.1 Estimated duration for this project is two years.

4.2 Transformer primary taps are set at 100% and secondary terminal voltage at no-load conditions is 480 V.

4.3 Demand factor (DF) for the booster and submersible pump and pit cooler motors is 80%; other loads at 30%.

4.4 "Soft-Start" unit used for 40 HP submersible pump, P-0621, is considered to have the same efficiency as a conventional motor starter. The basis for this is the description given in the Cutler Hammer document, "User's Manual Easy-Start Advantage EA Series." See Vendor Information file #22668.

4.5 Unless otherwise stated, PF = .95 and EFF. = 0.95

5. METHOD OF ANALYSIS

5.1 Hand calculations.

6. REFERENCES

6.1 NFPA-70, National Electrical Code (1993).

6.2 Drawing H-2-818693, Sheet 1, Rev. 1, Electrical AY-Farm One-Line Diagram.

6.3 W320-31-016, AY-102 Demand Load Analysis, Size Feeders, Voltage Drop and Fault study.

6.4 Westinghouse Cat. 25-000, Quick Selector 1993.

6.5 Additional References to Support C-Farm Demand Load Analysis:

a. Industrial Power Systems Handbook, Beeman, First Edition, Chapter 17 (Load and Cost Estimating Data).

b. Standard Handbook for Electrical Engineers, Fink and Beaty, Eleventh Edition, Chapter 18 (Demand and Diversity Factors).

6.6 W-320 vendor data CVI file #22668.

7. CALCULATIONS

7.1 Connected Load Determination

a) 250HP Booster Pump Motor: 273 A
VSD with 250 HP Input @ 95% eff.
VSD maximum input: 325 A — 287.4 A

b) 40 HP Immersible Pump Motor: 52 A
"Soft Start" Unit energized only during motor start. — 52 A

c) 1.5 HP Winch — 2.6 A

d) Package Chiller — 8.1 A

Subtotal 480V, 3 PH Motor Connected Load ≈ — 350.1 A

e) Mini-Power Panel: 15 KVA, 1 PH (B-C) — 31.3 A

Total Connected Load Phases B&C ≈ — 381.4 A
Phase A ≈ — 350.1 A

Total Connected Load ≈ 381.4 A x .480 KV x √3 ≈ 317.1 KVA

7.2 Estimated Demand Determination

7.2.1 ICF KH "Utilities" Method:

a) Existing Loads (Ave. Demand) — 28 KVA

b) 250 HP, 273 A @ 460 V,
VSD efficiency 95%, 80% DF — 183.2 KVA

c) 40 HP, 52 A @ 460 V, 80% DF — 33.1 KVA

d) 1.5 HP, 2.6 A @ 460 V, 30% DF — 0.6 KVA

e) 15 KVA @ 95% eff, 30% DF — 4.7 KVA

f) Pit Cooler @ 8.1 A x .460 kV x 1.73 x 80% DF — 5.2 KVA

Subtotal = ... 254.8 KVA

Diversity Factor = ... 1.44

Total Estimated Demand = ... 176.9 KVA

7.2.2 "Normal" Anticipated Method:

a)	Existing Loads	28 KVA
b)	250 HP running at 90 HP, extrapolated from motor data sheet, 100% DF	97.2 KVA
c)	40 HP, 52 A @ 460 V, 100% DF	41.4 KVA
d)	1.5 HP @ zero DF	0
e)	15 KVA @ 95% eff & 30% DF	4.7 KVA
f)	Pit Cooler @ 8.1 A X 460 V X 1.73 X 0.8	5.2 KVA
	Total Anticipated Demand = ...	176.5 KVA

7.2.3 "Worst Case" Full Load Method:

a)	Existing Loads	28 KVA
b)	250 HP, 273 A @ 460 V, 95% VSD eff, 100% DF	229.0 KVA
c)	40 HP @ 52 A @ 460 V, 100% DF	41.4 KVA
d)	1.5 HP @ zero DF	0
e)	15 KVA @ 95% eff, 30% DF	4.7 KVA
f)	Pit Cooler	5.2 KVA
	Total "Worst Case" Demand = ...	308.3 KVA

Sluicing Project "Worst Case" demand ≈ 308.3 KVA - 28 KVA ≈ 280.3 KVA

Three 50 KVA, Pole Mounted, Oil Filled Transformers are installed as a part of the Equipment Removal Phase of the project.

7.2.4 Summary

a) 176.9 KVA ÷ 150 KVA ≈ 117.9% of nameplate.

b) 176.5 KVA ÷ 150 KVA ≈ 117.7% of nameplate.

c) 308.3 KVA ÷ 150 KVA ≈ 205.5% of nameplate.

d) Therefore, the 150 KVA transformer bank is adequate based on:

1) For "Normal" Operation, 130% of demand (or less) is acceptable per Electrical Utilities engineering and IEEE /ANSI C57.91 and 92.

2) Duration of "Worst Case" is less than 5 minutes. Project design life is only 2 years. Small losses of the transformer's 30 year design life expectancy are acceptable.

7.3 Breaker, Starter, Feeder and Conduit Sizing

7.3.1 Main feeder from AY-PDP-1 via the EES, Circuit Breaker, Seismic Contactors and Safety Switch, to the Tap Bus Assembly

The Lockable Non-Fused Safety Switch will be the main disconnect means for 241-AY-51 (EES).

Feeder Sizing Per NEC 220-10, 240-21, 430-2, 430-22, 430-24 and 430-28 using actual loads listed in 7.1.

a) Summation of motor loads Per VSD vendor & NEC 430-24:

1)	250 HP Booster Pump (VSD)	287.4 A
2)	40 HP Immersible Pump (Soft Start)	52 A
3)	1.5 HP Winch	2.6 A
4)	Pit Chiller	8.1 A
5)	Plus 25% of largest motor 1)	71.9 A
	Main Feeder Size Capacity = ...	422.0 A

600AF/600AT circuit breaker used at AY-PDP-1.

Down-stream feeder conductors shall be rated 600 A @ 75°C.

1) Need 2-350 kcmil per phase.

2) Requires 3-350 kcmil conductors and 1#1/0 copper ground, in each of two 3½" conduits.

3) Wire runs W102-01A, 01B, 02, 02A, 03, 03A, 04, 04A, 19 and 19A.

4) Conduits AY102-3P01, 01A, 04, 04A, 22, 22A and AY102 - 1P02, 02A, 03 and 03A.

Note: Up sized 3½" conduits to 4" conduits based on constructability comment.

7.3.2 The 250 HP Booster Pump and VSD Controller (P-0622) (VSD protective circuitry included with controller provided by booster pump vendor).

VSD Feeder:

VSD controller maximum input current = 325 A per vendor information. Per NEC 430-2, required feeder ampacity = 1.0 X 325 = 325 A. Per NEC Table 310-16, use 3-500 kcmil 90°C conductors with 1 #1/0 ground wire in 3½" conduit (Up sized to 4" conduit to aid in cable pulling).

Wire run W102-05; conduit AY102-3P05

Motor Feeder:

Booster Pump motor (vendor information) FLA = 273 A. Per NEC 430-22, required feeder ampacity = 1.25 x 273 = 341 A. Per NEC Table 310-16, use 3-500 kcmil 90°C conductors with 1 #1/0 ground wire in 3½" conduit (Up sized to 4" conduit to aid in cable pulling).

Wire run W102-08; conduit AY102-3P08.

See 7.3.9 For "In Pit" segment of motor feeder.

VSD feeder is tapped off buss at "Tap Bus Assembly". Feeder length is approximately 7 feet. Feeder meets "10 foot" Tap Rule criteria (NEC 240-21 and 430-28).

7.3.3 40 HP Submersible Pump (P-0621)

Motor Feeder:

FLA = 52A; required feeder ampacity = 1.25 x 52 A = 65 A

3-#4 conductors (ampacity = 70 A) is adequate based on ampacity. Used 3-#1/0 with 1-#4 ground wire in 2" conduit.

Install 1#1/0 AWG per phase from Group Controller Power Terminal Block to "Soft Start" unit. Use 70 A MCP (mounted within Group Controller).

Wire run W102-09; conduit AY102-3P09.

Install 1#1/0 AWG per phase from "soft start" to PTBX-0621.

Wire run W102-29; conduit AY102-3P26.

Use 150 A MCP and NEMA Size 4, Full Voltage Non-Reversing (FVNR) starter (mounted within Group Controller).

See 7.3.9 for "In Pit" Segment of Motor Feeder.

See 7.3.10 for "Group Controller" feeder and jumper sizing. Per Code Authority, power terminal block ties within Group Controller are not considered as taps. See Appendix page A-1.

7.3.4 The 1.5 HP Winch (W-0621)

Motor starter line and load side feeder conductors:

FLA = 2.6 A; required feeder ampacity = 1.25 x 2.6 A = 3.25 A

Use 7 A MCP and NEMA Size 1, Full Voltage Reversing (FVR) starter.

Use 3-#12 with 1-#12 ground wire in 3/4" conduit (Up sized to 1" conduit for conservatism).

Wire run W102-10 & 31; conduit AY102-3P10 & 3P27.

Install 1#12 AWG per phase from top of starter to Group Controller power terminal block.

Note: Out of PTBX on top of cover block, change to 3/C cable. Change/upsize to 3/C #8 with ground over to winch motor (manufacturer availability).

Wire run W102-28.

7.3.5 Packaged Pit Chiller (R-0621/FC-0621)

Feeder circuit breaker "line and load side" Conductors:

Use 30 A CB, as recommended by MFR. Install in Group Controller."

Use 3-#10 with 1-#10 ground wire in 3/4" conduit (Up sized to 1" conduit for conservatism).

Wire run W102-11; conduits AY102-3P11 & 3P17.

Install 1#10 AWG conductor per phase from circuit breaker within "Group Controller" to safety switch and to Group Controller power terminal blocks.

7.3.6 Mini-Power Panel (AY102-PP1)

Feed 15 KVA, 1ø, transformer, with 480 V primary, from circuit breaker in Power Distribution Panel.

$$I = \frac{15{,}000 \text{ VA}}{480 \text{ V}} = 31.25 \text{ A}$$

Unit supplied with 60 A, 2 pole primary circuit breaker by manufacturer.

Install 150AF/70AT, 2 Pole CB in AY-PDP-1, Ckt# 7. Provide 70A, 1 phase circuit to unit.

Use 2-#4 with 1-#8 ground wire in 3/4" conduit.

Wire run W102-07; conduit AY102-3P39.

7.3.7 Seismic Shutdown Missile Enclosure Air Conditioning and Receptacles

$$I = \frac{1320}{120} = 11A;\ 11A \times 1.25 = 14A \text{ capacity (from AY102-PP1)}$$

Calculation W102-31-022 requires #10 AWG due to voltage drops.

Use 2-#10 with 1-#10 ground wire in 3/4" conduit (underground conduits will be Up sized to 1" conduit for conservatism).

Wire runs W102-22 & 23; conduits AY102-3P15 & 3P16 will be 1".

7.3.8 Typical 120 VAC branch circuit conductor loaded up to 1,500 VA

I = 1500VA/120V = 12.5A; 12.5A x 1.25 = 15.625 A capacity and a 20 A circuit breaker.

Use 2-#12 with 1-#12 ground wire in 3/4" conduit (underground conduits will be Up sized to 1" conduit for conservatism).

Wire runs W102-12, 13, 14, 15, 16, 17, 18, 20, 21, 25, 32 & 36; conduits AY102-3P13, 18, 19, 20, 21, 23, 25A, 28, 38 & 41 will be 3/4"; conduits AY102-12, 14, 24, 25, 30 & 34 will be 1".

7.3.9 "In Pit" Cord Sizing

NEC article 40 defines the requirements for the "In-Pit" cords. NEC article 430-22 states that branch circuit conductors supplying a single motor shall have an ampacity not less than 125 percent of the motor full-load current rating.

40 HP Immersible pump motor has FLA = 52 A. The 1993 NEC Table 430-150 does not include values for motors of 250 HP. Reliance Electric information shows that the 250 HP motor FLA is 273 amps.

The cables will be in free air within the pump pit. NEC Table 400-5(B) for Type G, portable power cord will be utilized. The cable is a thermoset cable that, if assumed equivalent to Type G, will need derating for high ambient conditions using the correction factors in Table 310-16.

Per Project W-320 Motor Cooling Evaluation dated 6/7/95, the ambient temperature at the AY-102 pump pit will be maintained below 120°F (50°C) by the use of a pit cooler. Per NEC Table 310-17, a

correction factor of 0.82 will apply. Since this is considered cord (not cable in conduit), the calculation of the desired derating factor is based on the cable manufacturer's recommendation.

Per the Rockbestos company, the following formula is used for determining an acceptable derating factor.

$$TCF=\sqrt{\frac{(Tc2-Ta2)}{(Tc1-Ta1)}\times\frac{(234.5+Tc1)}{(234.5+Tc2)}}$$

Tc1 = Maximum conductor temperature used to determine base ampacity.
Ta1 = Ambient temperature used to determine base ampacity (30°C per NEC Table 400-5(b).
Tc2 = Maximum conductor temperature used to determine adjusted ampacity (90°C for Rockbestos Firewall III for 40 year qualified life.)
Ta2 = Ambient temperature used to determine adjusted ampacity; 0.3°C additional is used as margin.

The cords for the pumps fall under the F category, i.e. no more than 3 current carrying conductors. The 90° column is used, because of rating of the terminations in the pump terminal boxes will be defined to be 90°C.

$$TCF=\sqrt{\frac{(90-(50+0.3))}{(90-30)}\times\frac{(234.5+90)}{(234.5+90)}}=0.8134$$

<u>For sizing the 40 HP Immersible Pump cord:</u>

(52 A X 1.25) / .8134 = 79.9 A; Per NEC Table 400-5(B), use a minimum #6 conductor with ground wire.

Vendor supplied Wire Run W102-27.

<u>For sizing the 250 HP Booster Pump cord:</u>

(273 A X 1.25) / .8134 = 419.5 A; per NEC Table 400-5(B), use 500 kcmil conductors with ground wire.

Wire Run W102-26.

Rockbestos Firewall III XHHW P62-3119 is a 3/C#1 AWG cable with an overall diameter of 1.16" (something similar will be vendor furnished by procurement specification W-320-P17).

Rockbestos Firewall III XHHW P62-0504 is a 500 kcmil cable with an overall diameter of 2.26".

7.3.10 Group Controller Feeder and "Jumper" (between all starters) Sizing

a) Group Controller Total Load

1) Winch (1.5 HP)	2.6 A
2) Immersible Pump (40 HP)	52 A
3) Chiller motor loads	8.1 A
4) Plus 25% of largest motor 2)	13 A
Total = ...	75.7 A

For 75°C rated conductors, use 3#2/0 and 1#4 ground wire in 2" conduit.

Wire run W102-06; conduit AY102-3P06.

Jumpers between power terminal blocks shall be #2/0.

NEC "10 Foot" Tap Rule applies and criteria is met.

7.4 Steady State Voltage Drop Evaluation (Worst Case Full Load Method)

7.4.1 On Transformer Bank

$$I_{PU} = \frac{308.3 \text{ KVA}}{150 \text{ KVA}} = 2.06 \qquad \text{[from 7.2]}$$

$$\% \text{ VD} = \%Z \times I_{PU} = 2.6 \times 2.06 = 5.3\%$$

7.4.2 On 100' of Parallel 350 kcmil copper feeders in steel conduits (AY-PDP-1 to Tap Bus Assembly).

$$\% \text{ VD} = \frac{\sqrt{3} \times I \times \text{Zeff}/1000' \times L}{4.8} \; ; \; 308.3\text{KVA} - 28\text{KVA} = 280.3\text{KVA}$$

$$\text{Where } I = \frac{280.3 \text{ KVA}}{\sqrt{3} \times .480 \text{ KV}} \approx 337.2 \text{ A}$$ [from 7.2]

Parallel 350 kcmil Feeders:

$Z_{eff} = 0.06 \div 2 = 0.03$, $L = 0.12$

$$\%\text{VD 350 kcmil feeder} = \frac{\sqrt{3} \times 337.2 \times 0.03 \times .12}{4.8} = \underline{0.44\%}$$

Total %VD from transformer bank to Tap Buss Assembly = 0.44 + 5.3 = 5.74%

7.4.3 %VD from VSD Controller to Motor (100' of 500 kcmil copper feeder in steel conduit)

Motor FLA = 273 A; Zeff = .05 ohms, L = .1

$$\text{Total \%VD} = \frac{\sqrt{3} \times 273 \times .05 \times .1}{4.8} = \underline{0.49\%}$$

Summary:

Total %VD at motor terminals = 5.74 + 0.49 = 6.23%

Motor terminal voltage = 480 (1 - 0.0623) ≈ 450.1 Volts

Minimum permissible voltage = 414 volts

7.4.4 %VD on Immersible Pump Feeder (#1/0 copper feeder in steel conduit - 80' to Pump Pit and 60' #4 down into Tank AY-102)

Motor FLA = 52 A; Z_{eff} for #4 AWG = .30; L = .06
Z_{eff} for #1/0 = .13; L = .08

$$\%VD = \frac{\sqrt{3} \times 52 \times ((.13 \times .08) + (.30 \times .06))}{4.8} = 0.53\%$$

Total %VD at motor terminals = 5.74 + 0.53 = 6.27%

Motor terminal voltage = 480 (1 - .0627) ≈ 449.9 Volts

Minimum permissible voltage = 414 V

7.5 % Voltage Dip During Immersible Pump Startup

Initial conditions:
a) Booster Pump is Off
b) Winch is Off
c) Chiller is On
d) Normal Panelboard loads are On.
   1) Chiller 8.1 A
   2) Mini-Power Panel (8 KVA) 17 A
   Total = ... 25.1 A

Existing Load: 28KVA ÷ 480 ÷ 1.73 ≈ 34A

7.5.1 %VD on Transformer Bank

I = 25.1 + 34 + (6 x FLA) = 25.1 + 34 + 6(52) = 25.1 + 34 + 312
= 371.1 A

$$\%VD = \frac{371.1}{181} \times 2.6 \approx 5.33\%$$ [from 4.4]

Where 181 = transformer rated full load secondary current.

7.5.2 %VD on Service Drop and Feeder up to "Tap Bus Assembly" with I = 25.1 + 6(52) = 337.1 A

Using direct proportionality:

$$\%VD = 1.24 \times \frac{337.1}{337.2} = 1.24\%$$ [from 7.4.2]

7.5.3 %VD on Submersible Pump Feeder

Z_{eff} for #1/0 = .13; Z_{eff} for #4 = .30; L = .08 for #1/0 and .06 for #4; I = 336 A (starting)

$$\%VD = \frac{\sqrt{3} \times 312 \times ((.13 \times .08) + (.30 \times .06))}{4.8} = 3.20\%$$

Total %VD up to Immersible Pump motor terminals = 5.33 + 1.24 + 3.20 = 9.77%

Motor terminal voltage = 480 (1 - .977) ≈ 433.1 V

Minimum permissible voltage = 414 V

A single #1/0 feeder is adequate. Initially, the "soft start" unit was utilized to limit the torque effect of the Immersible pump as it hangs down into the tank. Additionally, the "soft start" unit will be configured to limit starting current to aid in starting the Immersible pump..

7.6 % Voltage Dip With Booster Pump Starting (Immersible Pump already running)

7.6.1 %VD on Transformer Bank

With 150% current limit, [from 4.6]

I = (1.5 x 273) + 25.1 + 34 + 52 = 520.6 A [from 7.5]

$$\%VD = \frac{520.6}{181} \times 2.6 = 7.48\%$$

7.6.2 %VD on parallel 350 kcmil Feeder

%VD = .44% x 1.44 = 0.63% [from 7.4.2]

7.6.4 %VD on 500 Kcmil motor feeder

%VD = .49% x 1.44 = 0.63% [from 7.4.3]

Total %VD = 7.48% + 0.63% + 0.63% = 8.74%

Motor terminal voltage = 480 (1 - 0.874) = 438.1 V

Minimum permissible voltage = 414 V

7.7 Outdoor Lighting Calculations

Entrance lighting needs 3 footcandles. Total area that needs to be lit is approximately 6' x 3' = 18ft^2

The fixture selected for outdoor use is the Voigt SOX-35 Wall-Most. The manufacture's data may be used to determine whether this fixture is adequate for our needs. The Footcandle Isolux diagram shows the footcandles available from Voigt SOX-55 at a height of 15 ft. This must be adjusted to obtain values for the SOX-35 at 10 feet.

To adjust for the lower lamp output, the footcandles will be multiplied by 0.6. This is obtained from the ratio of the lumen output of the lamps. The Westinghouse Lighting Handbook provides guidance for adjusting for the height difference. The following is quoted from page 2-14 of the 1969 Westinghouse Lighting Handbook, "Footcandles for other mounting heights than the one shown are obtained by multiplying the values given on the curves by the ratio of the square of the present mounting height to the square of the new mounting height."

This adjustment factor will be (15^2 / 10^2) = 2.25

We will consider an area 3 ft out from the wall. The chart shows this as approximately 7 footcandles.

Using the adjustment factors: 7 footcandles x 2.25 x .6 = 9.5 footcandles

Outdoor fixture selected will give adequate light over doorway.

7.8 Indoor Lighting Calculations - AY Electrical Equipment Skid

Per IES, average of 50 (approximately) footcandles is adequate. The Zonal-Cavity Method will be used to determine the number of fixtures.

Room Cavity Ratio (RCR) = [5 x h x (L + W)] / (L x W)

Where h = height of light = 8'
L = room length = 13'
W = room width = 7'

RCR = [5 x 8 x (13 + 7)] / (13 x 7) = 8.8

Using the Crouse-Hinds photometric data (see Appendix B), with an assumed ceiling reflectance of 80% and an assumed wall reflectance of 50%, the coefficient of utilization is 0.25.

Number of fixtures = (FC x AREA) / (number of lamps x lumens/lamp x CU x MF)

Number of fixtures = (50 x 13 x 7) / (2 x 3200 x .25 x .9) = 3.16 fixtures

Use three fixtures.

7.9 Conduit Sizing for Control Wire Runs

Wire runs W102-42, 85, 86, 86A, 87, 88, 90, 91, 94, 95 & 104 are included.

Wire runs with largest cross sections are W102-86 with 8#14 and W102-87 with 4#12 and #104 with 20#14. Per NEC Table 3B, the first Wire Runs will "fit" into ¾" conduits and the last wire run will fit into a 1½" conduit which is 3C11.

AY102-3C01, 3C03, 3C04, 3C05, 3C08, 3C09 and 3C10 will be ¾" conduits.

The following underground conduit runs will be Up sized to 1" conduit for conservatism:

AY102-3C02 with wire run W102-86 and W102-86A
AY102-3C06 with wire run W102-87
AY102-3C07 with wire run W102-88

Conduit AY102-3C11 with wire run W102-104 will be 1½" conduit for to be conservative.

7.10 Conduit Sizing for Instrumentation (Signal) Wire Runs

Instrument wiring used for W-320 (AY-Farm) is of the following sizes and types:

Type 1 - 3#16 triad, diameter <= .34"
Type 2 - same as Type 1 (in pit)
Type 3 - 2 pair # 16, diameter <= .63"
Type 4 - same as Type 3 (in pit)
Type 5 - 1 pair #16, diameter <= .34"
Type 13 - Vendor furnished wire with PE-0621/0622
Type 16 - 8c/#14, diameter <= .48"

7.10.1 Conduit AY102-3S01

This conduit is a 1" installed spare.

7.10.2 Wire Runs W102-48A, 48B, 48C, 49A, 49B, 50, 51, 105, 106, 107 & 109 In Conduit AY102-3S02

Ten Type 1, one Type 13 and one Vendor Wire Run (Nominal diameter .6").

Type 1: $(10)(3.14 \times (0.34 \div 2)^2) =$ 0.91 in^2
Type 13: $(1)(3.14 \times (0.63 \div 2)^2) =$ 0.16 in^2
Type 17 (vendor): $(1)(3.14 \times (0.6 \div 2)^2) =$ 0.28 in^2

1.35 in^2

40% fill: $1.35 \div 0.4 = 3.38\ in^2$

2½" conduit cross-section area = 4.87 in^2

The minimum size needed for AY102-3S02 is 2½" conduit (Up sized to 3" conduit for conservatism and because there is no other 2½" conduit needed for the AY-102 installation).

7.10.3 Wire Runs W102-59, 61, 62, 63, & 82 In Conduit AY102-3S03

Five Type 1 and one Type 13.

Type 1: $(4)(3.14 \times (0.17^2) = 0.36$
Type 13: $(1)(3.14 \times (0.315^2) = 0.31$

0.67 in^2

40% fill: $0.67 \div .4 = 1.68$ in^2

1½" conduit area = 2.07 in^2 from NEC Chapter 9 Table 4

AY102-3S03 Up sized to 2" conduit for conservatism.

7.10.4 <u>Wire Runs W102-37A, 37B, 37C, 38A, 38B, 40, 41, 43, 115, 116, 117, 118 in Conduit AY102-3S19</u>

Five Type 1, six Type 5, one Type 16

Types 1 & 5: $(11)(3.14 \times .17^2) = 1.00$ in^2

Type 16: $(1)(3.14 \times .24^2) = .18$ in^2

$\overline{1.18}$ in^2

40 % fill: $1.18/0.4 = 2.95$ in^2

2" conduit cross sectional area = 3.41 in^2 from NEC Chapter 9 Table 4

Use a 2" conduit

7.10.5 <u>Wire Runs W102-68, 69, 70, 71, 72, 73 & 103 Routed Through Conduits AY102-3S08, 3S08A & 3S10</u>

All seven wire runs are Type 5.

$(7) \times (3.14 \times 0.17^2) = 0.64$ in^2

40% fill: $0.64 \div 0.4 = 1.60$ in^2

1½" conduit required (AY102-3S08, 3S08A, and 3S10 Up sized to 2" conduit for conservatism).

7.10.6 <u>Wire Run W102-80 In Conduit AY102-3S14</u>

Both are Type 3 => 0.63" diameter, radius = .315"

$(3.14) \times 0.315^2 = 0.31$ in^2

53% fill: $0.31 \div 0.53 = .59$ in^2

1" conduit needed (AY102-3S14 Up sized to 2" conduit for conservatism).

7.10.7 Wire Runs W102-64, & 67

Both are Type 5.

Conduits AY102-3S04, & 3S13 each contain only one of the above wire runs, i.e. one Type 5.

$(1) \times (3.14 \times 0.17^2) = 0.09 \text{ in}^2$

53% fill applies: $0.09 \div 0.53 = 0.17 \text{ in}^2$

Minimum size of conduit required is ¾". AY102-3S04 & -3S13 to be ¾" conduit for conservatism.

7.10.8 Four Type 7 Wire Runs Per Conduit

W102-100 & 101
AY102-3S16 & 3S17

Per NEC Table 3B, either wire run fits into a ½" conduit.

$(1) \times (3.14 \times 0.315^2) \div 0.53 = 0.5879 \text{ in}^2$

1" conduit area = $(3.14 \times (1.049 \div 2)^2 = 0.8638 \text{ in}^2$

AY102-3S16 & -3S17 to be 1" conduit for conservatism.

7.10.9 Wire Run W102-79, Type 14 2/C #16 Belden In Conduit AY102-3S09

Type 5 - diameter .34," Cross-sectional area = .091 sq"

1" conduit is acceptable.

7.10.10 Wire Run W102-74, Belden 9953 (0.264" Diameter) in Conduit AY102-3S15

$(3.14 \times (0.264 \div 2)^2) = 0.05 \text{ in}^2$

53% fill: $0.05 \div 53 = 0.10 \text{ in}^2$. Need minimum ¾" conduit for AY102-3S15 (Up sized to 1" conduit for conservatism).

7.10.11 Wire Run W102-39, SE-0621 In Conduit AY102-3S07

1" installed spare.

7.10.12 Wire Runs W102-65, 65A & 66 In Conduits AY102-3S11 & 3S12

3 or 4 #14 Type 7

Use ¾" conduit (Up sized to 1" conduit for conservatism).

7.10.13 Miscellaneous Wire Runs W102-32 & W102-33 ?? temperature ??

a) W102-32, Type 7, in conduit AY102-3P30, 3#12, vendor furnished:

Minimum conduit size for AY102-3P30 is ½", used 1".

b) W102-33, 3#8, Type 7, in conduit AY102-3P31:

Interfarm Cathodic Protection Rectifier to be fed from a 120 VAC, 20 A circuit. The 20 A circuit breaker will serve a 16 A circuit. Maximum rectifier input current is 4 Amps. Size circuit for 120VAC, 4 A minimum.

Circuit length is estimated at 225 LF x 2 = 450 ft.

1) 20 A circuit breaker dictates a #12 conductor size (minimum).

$R_{@55°C}$ = 1.72 x 1.115 = 1.92 ohm/1000LF

$\%VD_{max}$ = (4)(1.92 x 0.45) = 3.46 volt = 2.9%

3% voltage drop is maximum allowable for branch circuit; the 2.9% is considered to be too high.

2) Try #10 AWG: $R_{@55°C}$ = 1.1 x 1.115 = 1.23 ohms/100LF

$\%VD_{max}$ = 4(1.23 x 0.45) = 2.21 volt = 1.8%

This voltage drop is acceptable.

3) Since power is from an existing Panelboard, decided to upsize again to #8 AWG (2#8 with 1#8 ground wire).

$R_{@55°C}$ = 0.7 x 1.115 = 0.78 ohms/1000LF

%VD = (4A)(0.78 x 0.45) = 1.4 V = 1.2%

3#8 AWG requires a ½" conduit; Up sized AY102-3P31 to 1" conduit for conservatism because it is a long underground run.

7.11 Special Situations

7.11.1 P-0621 Motor Starter Control Power Transformer Sizing

The Control Power Transformers are an integral part of seller supplied equipment. They are sized by the providers of the motor control equipment. No evaluation is needed here.

7.11.2 Winch (W-0621) Limit Switch - 120VAC Circuit Conductor Sizing (Wire Run Nos #-86, #-86A, & #-95)

Circuit limited to maximum of 0.8 A by CPT fuses, therefore #14 AWG, Type 7, is acceptable.

Checking voltage drop during starting:
Size 1 starter inrush = 160 VA with minimum pickup voltage @ 85% (120 Vac x 0.85 = 102 V).

CPT %Z = 6.5% (cold); 7.8% (hot). (typical values)

#14 AWG R @ 55°C = 2.73 x 1.115
= 3.04 ohm/1000 LF

Circuit Length: 80' x 2 = 160 LF

a) VD #14 = (160VA/120V) x (3.04 x 0.16)
= 0.648 Volt = 0.5%

b) VD XFMR = (6.5) (160VA/120V) = 8.7% (cold)

= (7.8) (1.333) = 10.4% (hot)

Total VD = 0.5 + 8.7 = 9.2% (cold) and
.5 + 10.4 = 10.9% (hot)

Hot is worst case: (120V) (1 - 0.109) = 107 V

Minimal allowable voltage = 102 V

Will use #14 AWG, Type 7 Wire.

7.11.3 Seismic Safety System "Emergency Trip"/Remote Trip Circuit Conductor Sizing

Normally would use 14 AWG - Due to FU3 secondary CPT fuse size of 3 AMPS

Checking voltage drops during contactor pick up:

Size 6 Contactor In-Rush VA = 2900
Pickup Volts = 70% (120V x 0.7= 84V)
Coil Voltage = 120 VAC

750 VA CPT
CPT %Z = 4.44

Circuit Length 55' x 2 = 110LF

#14 AWG R @ 55°C = 2.73 x 1.115
= 3.04 ohm/1000LF

a) %VD #14 (inrush) = (2900VA/120V) (3.04ohm/1000LF x 110ft)
= 8.08 V = 6.73%

b) %VD CPT (inrush) = (I inrush / I base)(%Z)

I (inrush) = 2900VA/120V = 24.17 A

I base = 750VA/120V = 6.25 A

%VD CPT = 24.17/6.25 (4.44) = 17.17%

c) #14 AWG combination: VD #14 + VD CPT =
6.74 + 17.17 = 23.91%

120 V x (1 - 0.2391) = 91.3 V

Minimum allowable for pick-up = 84 V

d) VD #12 (inrush) where R @ 55°C =
1.72ohms/1000LF x 1.115 = 1.92ohm/1000ft

VD #12 (inrush) = (2900VA/120A) (1.92 x .011)=
51 V = .43%

e) #12 AWG combination:

VD #12 + VD CPT = .43 + 17.17 = 17.6%

(120 V) x (1 - 0.176) = 98.9 V

Minimum allowable for pick-up = 84 V

Elected to use #12 AWG, Type 7 Wire for W102-87 & 88.

8. CONCLUSIONS

8.1 Total connected load is 317.1 KVA. [from 7.1]

Maximum estimated demand for sluicing project = 176.9 KVA. [from 7.2]

Estimated total non-coincident demand on transformer bank = 308.3 KVA. [from 7.2.3]

8.2 The existing parallel 350 kcmil service entrance and feeder to AY-PDP-1 is adequate for the additional AY-102 Sluicing demand.

8.3 500 kcmil feeder for the 250 HP VSD motor is adequate to maintain proper terminal voltage level during motor starting.

8.4 To maintain adequate motor terminal voltage level for the 40 HP Immersible Pump motor (using the #1/0 feeder size indicated), the existing "soft start" will be adequate.

8.5 A single outdoor light fixture is adequate over the door. Three "two-tube" fixtures are required inside the Electrical Equipment skid.

8.6 Control and instrumentation conduit runs and misc. equipment are properly sized.

DISTRIBUTION SHEET

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