SHORT CIRCUIT, PROTECTIVE DEVICE COORDINATION, ARC FLASH, HARMONIC, & LOAD FLOW STUDIES

SR 520 Pontoon Project
Aberdeen, WA

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Job #1001055-3
Date: 6/9/11
Revision C

SR 520 Pontoon Construction

No. Date

CHECK PRINT
Drawing checked against calculations and calculation check completed

By [signature] Date 6/10/11
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TAB 1

INTRODUCTION

In 2010, HNTB was awarded a contract to provide the electrical distribution equipment for the SR 520 Pontoon Project. The facility is located in Aberdeen, WA. The specifications for this project required a short circuit, protective device coordination, arc flash, harmonic, and load flow studies.

A short circuit study was performed to determine the short circuit current values at various points throughout the distribution system. The short circuit data was collected from the new equipment nameplates, drawings and submittals for the new equipment. These values were then compared to the equipment short circuit rating.

The study contains a reduced copy of the one-line drawing and computer printouts of the fault values. A list of the equipment short circuit ratings is also included.

PowerStudies.com, P.S. also performed a protective device coordination study. This study determined circuit breaker settings and verified the fuse sizes. The coordination study and time current curves can be found in Tab 7. The circuit breaker and relay setting sheets are located under Tab 8.

The protection engineer from PowerStudies.com also performed an Arc Flash Study for the distribution system shown on the one line drawing. The study calculated the Arc Flash Boundary, Incident Energy Level, and the required Personnel Protection Equipment (PPE). The study includes a spreadsheet-type listing of each piece of electrical equipment that would require servicing while energized, upstream protective devices, arc flash boundaries, incident energy, and required PPE; these are the Arc Flash Evaluation Bus and Protective device line side Reports. They are located in Tab 11. Paper copies of the Arc Flash labels located in Tab 12. (Note: Only 1 set of adhesive labels is included for this project.) These labels should be attached to each piece of equipment.

Also PowerStudies.com performed a harmonic analysis. The harmonic analysis can be found under Tab 14. PowerStudies.com also performed a load flow study. The purpose of the load flow study was to determine the power factor, voltage drops, kW, kVAR and current flows. The load flow study can be found in Tab 15.

TAB 2

EXECUTIVE SUMMARY AND RECOMMENDATIONS

The purpose of the short circuit study was to determine the available fault current at the switchgear, switchboards, panelboards, and other equipment throughout the facility. The engineer performed the short circuit study on the new equipment being supplied. The engineer compared the fault values to the equipment short circuit rating.

The engineer calculated the fault current using the SKM computer program. This program ignores the current limiting effect of the fuses. If the equipment is underrated on a fully rated basis, then the engineer applies a series rating method. If a series rating method can not be applied and the equipment is pre-1982 design, then the Bussmann Up-and-Over and Up-Over-and Down Method is used. Flow chart #2 shows this procedure and is included at the end of Tab 3.

The summary sheet in Tab 6 lists all equipment and short circuit ratings on a fully rated or series rated basis. Gray Harbor PUD supplied the available fault current and transformer information. A copy of this information can be seen at the end of this tab. According to PUD, only (1) 2500 kVA transformer with 5.7 impedance is currently servicing the facility and the other utility transformer is on order. As a result, the engineer has assumed the future utility transformer to be the same as the existing one. The available fault current used in the study is listed below.

			Available Fault Current	
Node ID#	**Node Name**	**Volts**	**3-Phase**	**Line to Grd**
XFMR-UTS	UTIL XFMR SEC	480	52,755 A	52,755 A

The study was performed on the new equipment being installed. The calculations show that all the new equipment is properly rated for the available fault current.

PowerStudies.com, P.S. performed the coordination study to determine proper settings for the protective devices. PowerStudies.com, P.S. also provided recommendations for obtaining better equipment protection.

Selecting a proper setting is part art and part science. The engineer determined settings to increase protection and reduce the number of circuits that will de-energize due to a fault. The settings of these devices depend not only on engineering judgment, but also on personal experience and local operating conditions. Any appreciable change in system capacity, load, operating procedure, or short circuit characteristics requires a reexamination of breaker settings.

Due to the inherent nature of molded case circuit breakers and fuses, there was some inevitable overlapping between fuse and breaker instantaneous operation regions. These devices are sometimes impossible to coordinate, unless there is a large amount of

impedance between upstream and downstream devices (i.e. transformers or long feeder lengths). This problem does not require any action. The industry considers this to be a tolerable situation except for elevator circuits and controllers.

The National Electric Code has some special requirements for people transporting equipment such as elevators and escalators. Section 620-62 states: Where more than one driving machine disconnecting means is supplied by a single feeder, the overcurrent protective devices in each disconnecting means shall be selectively coordinated with any other supply side overcurrent-protective devices. Properly sized upstream and downstream fuses can be selectively coordinated for all levels of fault current. A 2:1 size margin must be maintained between the upstream and downstream fuses. Usually, it is impossible to have total and complete selective coordination between devices that have instantaneous characteristics (i.e. circuit breakers and relays). The circuit breakers usually will coordinate in the long and short time regions but will overlap in the instantaneous region.

PowerStudies.com performed arc flash calculations for the distribution system shown on the one line drawing. The arc flash calculations show that PPE clothing can be worn to increase personnel protection for the majority of the locations. The study was performed using the NFPA-70E (2004), IEEE – 1584 (2002), and NEC standards and codes. Using these standards along with the Power*Tools for Windows – Arc Flash Module, the engineer determined the incident energy level at various points throughout the distribution system.

The engineer performed the arc flash calculations for the equipment shown on the electrical one line drawing contained in the report. The engineer started at the utility main service and continued downstream but stopping at the secondary side of any 208 Volt transformers rated less than 125 kVA. This is based upon IEEE 1584 (2002) Standard page 15 that states, "Equipment below 240 V need not be considered unless it involves at least one 125 kVA or larger low impedance transformer in its immediate power supply". Page 34 of the Standard also states, "The arc-flash hazard need only be considered for large 208 V systems: systems fed by transformers smaller than 125 kVA should not be a concern." For these downstream areas, generic labels were created for these locations.

To aid the technicians in determining what PPE must be worn, Arc flash warning labels are provided for these various locations. The examples of these warning labels are shown below.

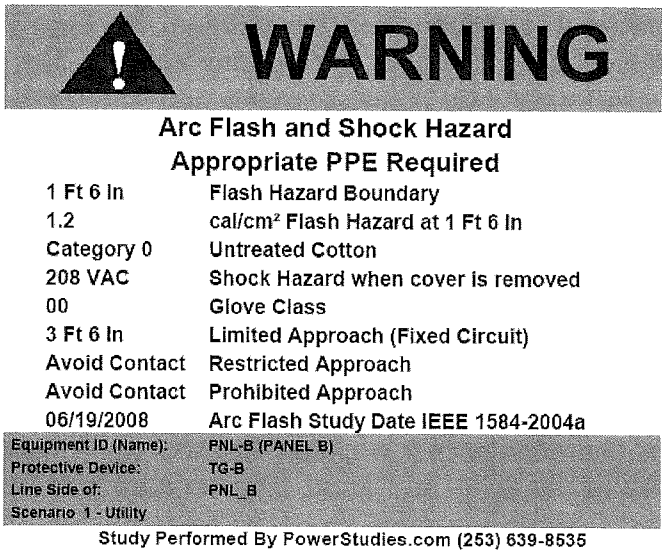


Figure 1 – Example Arc Flash Label

The PPE clothing class is determined based upon the incident energy and voltage class. The PPE matrix table (130.7(C)(10)) from NFPA 70E (2009) can be found in Tab 9.

The engineer assumed the maximum arcing time current would be two seconds as referenced in IEEE-1584-2002. This is a reasonable assumption because after this period, the individual would either move voluntarily or be blown clear of the arcing fault.

The arc flash calculations show that PPE clothing can be worn to increase personnel protection for most of the locations. Arc flash warning labels provided for these locations indicate the PPE required to be worn. The engineer recommends that the arc flash warning labels be installed on the electrical equipment to warn personnel of the potential hazard.

The following is a list of locations where the available incident energy exceeds 40 Cal/cm^2. At these locations, the Required Protective FR Clothing Class is displayed as: "**** Dangerous!!! No FR Class Found. Before working on this equipment, the protection engineer strongly recommends that this equipment be de-energized.

Maximum Arc Flash Energy (US) – Danger Only

Scenario Descriptions

Scenario 1: Utility - Motors ON
Scenario 2: Utility - Motors OFF
Scenario 3: Generator

Calculation Details

IEEE 1584 - 2002/2004a Edition Bus + Line Side Report (Include Line Side + Load Side Contributions), 80% Cleared Fault Threshold, include Ind. Motors for 5.0 Cycles), mis-coordination checked

Hazard Categories

Category 0: Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
Category 1: FR Clothing Minimum Arc Rating of 4 (See NFPA 70E 130.7(C)(10) for additional PPE)
Category 2: FR Clothing Minimum Arc Rating of 8 (See NFPA 70E 130.7(C)(10) for additional PPE)
Category 3: FR Clothing Minimum Arc Rating of 25 (See NFPA 70E 130.7(C)(10) for additional PPE)
Category 4: FR Clothing Minimum Arc Rating of 40 (See NFPA 70E 130.7(C)(10) for additional PPE)
DANGEROUS!: No PPE Exists - Do Not Work on Equipment while Energized!

Arc Flash Notes

(*N1) Out of IEEE 1584 or NFPA 70E Ranges. LEE equation is used in this case and applicable for Open Air only.
(*N2) < 80% Cleared Fault Threshold
(*N3) Arcing Fault Current Low Tolerances Used.
(*N4) Equipment Specific Incident Energy and Flash Boundary Equations Used.
(*N5) Mis-coordinated, Upstream Device Tripped.
(*N6) Special Instantaneous Protection in Use. Refer to Bus Detail & Device Setting Sheets.
(*N7) Trip Time Unlinked with TCC.
(*N8) Fault Current Unlinked with Fault Study results.
(*N9) Max Arcing Duration Reached
(*N10) Fuse Cable Protector Modeled.
(*N11) Out of IEEE 1584 Range, Lee Equation Used. Applicable for Open Air only. Existing Equipment type is not Open Air!
(*N12) Out of IEEE 1584 Gap Range.
(*N13) PPE up one Category
(*N14) Zone Selective Interlock (ZSI) in Use.
(*N15) Report as category 0 if fed by one transformer size < 125 kVA
(*N16) Trip Time Recalculated
(*N20) Out of NESC Voltage Range
(*N21) Out of NESC Fault Current Range
(*N22) Out of NESC Max Clearing Range
(*N23) Out of NESC Voltage Range
(*N24) Out of NESC Altitude Range
(*N25) Out of NESC Max Over Voltage Factor Range
(*N26) NESC SLG Fault is Zero

Maximum Arc Flash Energy (US) – Danger Only

Bus Name	Scenario	Protective Device Name	Bus Volt (v)	Bus Bolted Fault (kA)	Prot Dev Bolted Fault (kA)	Prot Dev Arcing Fault (kA)	Trip/ Delay Time (sec)	Breaker Opening Time (sec)	Ground	Equip Type	Gap (mm)	Arc Flash Bndry (in)	Work Dist (in)	Incident Energy (cal/cm2)	Required Protective Clothing Class
PNL-TRAIL1 (PANEL TRAILER 1)	1	FDR TO XFMR TRAIL	208	22.16	22.16	7.61	2.00	0.000	Y	PNL	25	172	18	49.00	Dangerous! (*N9)
PNL-TRAIL2 (PANEL TRAILER 2)	1	FDR TO XFMR TRAIL	208	22.16	22.16	7.61	2.00	0.000	Y	PNL	25	172	18	49.00	Dangerous! (*N9)
SWBD-A (SWBD A) (3-SWBD-A MAIN LineSide)	1	1-PRIME FUSE A	480	57.33	50.64	21.88	0.50	0.000	Y	PNL	25	153	18	40.00	Dangerous! (*N3)
SWBD-B (SWBD B) (SWBD-B MAIN LineSide)	1	PRIME FUSE B	480	55.36	49.39	21.45	0.52	0.000	Y	PNL	25	155	18	41.00	Dangerous! (*N3)
XFMR-2BS (XFMR 2B SEC)	1	FDR TO XFMR TRAIL	208	22.99	22.99	7.81	2.00	0.000	Y	PNL	25	175	18	50.00	Dangerous! (*N9)
XFMR-UTILAP (XFMR UTILA PRI)	1	MaxTripTime @2.0s	12,470	1,000.23	1,000.00	1,000.00	2.00	0.000	Y	SWG	153	4068	36	15,260.00	Dangerous! (*N11) (*N2) (*N9)
XFMR-UTILBP (XFMR UTILB PRI)	1	MaxTripTime @2.0s	12,470	1,000.20	1,000.00	1,000.00	2.00	0.000	Y	SWG	153	4068	36	15,260.00	Dangerous! (*N11) (*N2) (*N9)

At the time of the study, the following information was not available and therefore assumed:

1) According to PUD, only (1) 2500 kVA transformer with 5.7 impedance is currently servicing the facility and the other utility transformer is on order. As a result, the engineer has assumed the future utility transformer to be the same as the existing one.
2) The generator breaker was assumed to be a GE SELA 100A breaker.

The following general recommendations will maintain the distribution system reliability.

1. Revise, update, and redraw the Distribution System One-line drawing for the facility when new equipment is added. This will decrease trouble-shooting time, reduce errors in decision-making, and decrease engineering costs for future projects.

2. Verify that the device settings are set to the values shown in Tab 8.

3. Test and inspect all electrical equipment periodically as outlined in:

    a) NFPA 70B: Electrical Equipment Maintenance
    b) NETA 2009: Standard for Acceptance Testing Specifications
    c) NETA 2007: Standard for Maintenance Testing Specification

Grays Harbor PUD
P.O. Box 480
2720 Sumner Avenue
Aberdeen, WA 98520
(360) 532-4220
or (800) 562-7726
Fax - Engineering: (360) 538-6370

FAX TRANSMITTAL SHEET

TO:	ANN HOLLIDAY
	POWER STUDIES
FAX NO:	253 - 639 - 8685
FROM:	PHIL BRCKMAN
	GRAYS HARBOR PUD
RE:	SR 520 PONTOON
DATE:	7-29-2010

Message consists of 5 page(s), including this cover sheet.

PowerStudies.com PS
Phone 253-639-8535 ■ Fax 253-639-8685 ■ 16122 SE 266th St, Covington, WA 98042

Date 7/29/2010

TO:

COMPANY:	GHPUD
NAME:	Wesley Gray
REG. PHONE #	360-538-6353
FAX PHONE #	
Email Address	wgray@ghpud.org

FROM:

NAME:	Ann Holliday
REG. PHONE #	253-639-8535 Ext: 102
FAX PHONE #	253-639-8685
Email Address	holliday@powerstudies.com

SUBJECT: Utility Information Data Sheet:

Site Address
Project / Facility Name: SR 520 Pontoon
Address: _____

Please help us reduce your costs!

Providing your utility data will allow us to

1) Coordinate your customer's protective devices with your utility.
2) Reduce the need for you to replace your customer's fuses, reset relays, or reset reclosers.
3) Provide better protection for your transformer.
4) Increase the safety at your customer's facility.

Be a key player in keeping your customer's project on schedule!

Your customer has asked us to perform this power system study. Without your data, this study cannot be done. Providing us with your data will allow this project to stay on schedule.

Your quick response will be rewarded!

Please complete this form and fax it back to our office. We appreciate your timely response. In fact, if we receive your fax within 5 business days, we'll send you a Starbucks gift certificate to show our appreciation!

Thank you!
Ann

NUMBER OF PAGES TO BE FAXED: COVER SHEET + 4 PAGES
THE ORGINALS __WILL √WILL NOT BE SENT.

PowerStudies.com PS
Phone 253-639-8535 ■ Fax 253-639-8685 ■ 16122 SE 266th St, Covington, WA 98042

Job # 1001055 **Project / Facility Name: SR 520 Pontoon**

Instructions: Please fill out as much of the information as you can and fax back.

Fault Current Data (See attached NEMA Statement)

Fault Current Location (Check one) ☒XFMR ☐Pole ☐Other_____

MAXIMUM FAULT CURRENT

Type of Fault	Volts	Amps	X/R Ratio
3-Phase	480	52755	
Line to Ground	277	"	

MINIMUM FAULT CURRENT

Type of Fault	Volts	Amps	X/R Ratio
3-Phase	480	9100	
Line to Ground	277	"	

Closest Utility Protective Device

Device Location (Check one) ☒XFMR ☐Pole ☐Other_____

Fuse

Manufacturer COOPER Type BAY-O-NET

Voltage 12470Y/7200 Amps 140

Catalog # 4000353C17 Mfg TCC # R240-91-50

OR

Relay

Manuf._____ Type_____ Cat. #_____

	CT Ratio	Tap	Time Delay	Instantaneous
Phase				
Ground				

Conductor Data – *If installed by utility*

	Volts	Number / Phase	Size	Copper/Alum	Length
Secondary	480Y/277	7	750 MCM	COPPER	30 FT.

PowerStudies.com PS
Phone 253-639-8535 ■ Fax 253-639-8685 ■ 16122 SE 266th St, Covington, WA 98042

Transformer *Data (For Maximum Fault Contribution)*

Type (Check One) [X] Oil [ ] Dry [ ] Silicone

KVA 2500 Impedance 5.7

	Volts	Winding Connection (Check one)		
		Delta	Wye Ungrnd	Wye Grnd
Primary	12470Y/7200			X
Secondary	480Y/277			X

Transformer *Data (For Minimum Fault Contribution)*

Type (Check One) [X] Oil [ ] Dry [ ] Silicone

KVA 2500 Impedance 5.7

	Volts	Winding Connection (Check one)		
		Delta	Wye Ungrnd	Wye Grnd
Primary	12470Y/7200			X
Secondary	480Y/277			X

Comments:

THE ONLY TRANSFORMER WE HAVE RIGHT NOW FOR THIS PROJECT IS SERIAL NUMBER #08J996023.

I LEFT THE X/R RATIO BLANK BUT ATTACHED CERTIFIED TEST REPORTS FOR THE UNIT WE HAVE. THE OTHER TRANSFORMER IS ON ORDER.

THANKS!

PHIL BECKMAN
360-538-6377

RECEIVED
MAY 22 2008

Certified Test Report

ABB Inc.
Jefferson City, Missouri - USA
Distribution Transformers

Customer Name : WESCO DISTRIBUTION INC

No Load Losses are reported at 100 Percent of rated voltage
No Load losses reported at 85 degree. C and load losses at 85 degree C.

CUST PO	STOCK CODE	ABB ORDER	ABB ITEM
7883-953500		WD67190	001

STYLE	PHASE	HERTZ	KVA	LOW VOLTAGE	HIGH VOLTAGE	SERVICE STYLE
F73E266234	3PH	60	2500	480Y/277	12470GRDY/ 7200	PAD

	SERIAL NUMBER	NO LOAD LOSS (WATTS)	LOAD LOSS (WATTS)	TOTAL LOSS (WATTS)	IMPEDANCE %	RESISTANCE %	EXCITING CURRENT %	TEST DATE	SHIP DATE	INVOICE NUMBER
→	08J996023	2,821	14,753	17,574	5.70	0.59	0.25	04/04/2008	04/07/2008	7601236
	08J017152	2,701	14,095	16,795	5.69	0.56	0.22	05/06/2008	05/14/2008	7603288
	08J963174	2,763	14,192	16,956	5.64	0.57	0.26	02/20/2008	02/22/2008	7598673
Average		2,761	14,347	17,108	5.68	0.57	0.24			
Quoted Losses		2,737	14,184	16,921						
Total Units	3									

STYLE			REGULATION		RESISTANCE		EFFICIENCY			
F73E266234										
	SERIAL NUMBER	REACTANCE	100%	80%	HIGH VOLT (OHMS)	LOW VOLT (OHMS)	25%	50%	75%	100%
→	08J996023	5.67	0.75	3.96	0.50	0.0007	99.41	99.48	99.41	99.30
	08J017152	5.66	0.72	3.93	0.47	0.0006	99.44	99.50	99.44	99.33
	08J963174	5.61	0.72	3.90	0.49	0.0007	99.42	99.50	99.43	99.33

INSULATION TEST -APPLIED POTENTIAL TESTS			
STYLE			
F73E266234			
	RATED VOLTS	TEST VOLTS	DURATION IN SECONDS
HLIC	12470	18000	60
LHIC	480	10000	60

Rise of windings by resistance at 65 deg. C, guaranteed.

Filled to the proper level with non-PCB MINERAL OIL that contained less than 1-PPM PCB at time of manufacture.

Routine leak tests and polarity tests were performed and passed on these units. Turns ratio for these units are within 0.5 percent of the nameplate voltages.

Unit Successfully Passed QC Impulse Test.

We Certify that the above information is a true report based on factory tests made in accordance with the latest transformer test code of ANSI/IEEE C57.12.90, and that the above transformers withstood these tests.

Iqbal M Hussain, P.Eng
Engineering Manager
Distribution Transformers Division

StdReportTemplate_GRAYS

TAB 3

SHORT CIRCUIT STUDY

Short Circuit Discussions

A short circuit study was performed to determine the available short circuit current at various locations throughout the distribution system. The following assumptions were made for the short circuit study.

1. The summary sheet in Tab 6 lists all equipment and short circuit ratings on a fully rated or series rated basis. Gray Harbor PUD supplied the available fault current and transformer information. A copy of this information can be seen at the end of this tab. According to PUD, only (1) 2500 kVA transformer with 5.7 impedance is currently servicing the facility and the other utility transformer is on order. As a result, the engineer has assumed the future utility transformer to be the same as the existing one. The available fault current used in the study is listed below.

			Available Fault Current	
Node ID#	**Node Name**	**Volts**	**3-Phase**	**Line to Grd**
XFMR-UTS	UTIL XFMR SEC	480	52,755 A	52,755 A

2. The short circuit values calculated by the computer ignore the effect of the current limiting fuses.

3. All the motors were assumed to be operating. This assumption will produce the maximum available fault current for the distribution system.

The short circuit study was performed to verify that the existing equipment has the proper interrupting and withstand ratings. The circuit protector's (breaker, fused switch, etc.) proper application requires that the protector's short circuit current rating equal or exceed the system fault current available at the proposed protector location. However, protector short circuit ratings are based on ANSI and NEMA standards. These standards specify the test procedures used to determine the ratings. The procedures and ratings are based on time of fault initiation, asymmetrical peak, asymmetrical rms, or symmetrical rms current values.

Medium voltage circuit breakers have a momentary, also referred as close and latch, rating and interrupting rating.

1. The momentary rating is expressed as total rms current or asymmetrical rms current based on 1.6 I"d symmetrical rms at time of fault initiation.

2. The interrupting rating is expressed as symmetrical rms current for symmetrical rated breakers or total rms current for total current rated breakers either at a time of few cycles after fault (1.5-4 cycles). It is dependent on rated interrupting time which is a function of

contact parting time including relay operating plus breaker opening time and further modified by considering the power source whether remote or local.

Medium voltage power fused and distribution cutout fuses have an interrupting or momentary rating, which are identical, expressed in symmetrical rms current or asymmetrical rms current based on 1.55I"d symmetrical rms at time of fault initiation.

The Flow Chart #1 summarizes the method required to rate the adequacy of protective devices. There are four different categories of low voltage protectors. Each category has a different test X/R ratio or power factor. The following is a summary of the categories:

Category #1 - Low Voltage Power Circuit Breakers (without fuses) (LVPCB)
Test X/R = 6.6; P.F. = 15%

Category #2 - Fused Low Voltage Power Circuit Breakers, Fuses, Molded Case (MCCB) and Insulated Case (ICCB) Circuit Breakers with IAC > 20 kA.
Test X/R = 4.9; P.F. = 20%

Category #3 - Molded Case (MCCB) Circuit Breakers with 10 kA < IAC < 20 kA.
Test X/R = 3.2; P.F. = 30%

Category #4 - Molded Case (MCCB) Circuit Breakers with IAC < 10 kA.
Test X/R = 1.7; P.F. = 50%

Low voltage circuit breakers have an interrupting or momentary rating, which are identical, expressed in symmetrical rms current based on 1.0I"d symmetrical rms at time of fault initiation. However, the breakers are tested to interrupt the asymmetrical peak current at a given X/R ratio or equivalent power factor.

If the fault point where the breaker is being applied has a lower power factor or higher X/R ratio than the test values, then the system calculated rms symmetrical current must be modified by an X/R dependent multiplying factor (MF).

Low voltage power fuses have an interrupting or momentary rating, which are identical, expressed in symmetrical rms amperes based on 1.0I"d symmetrical rms at time of fault initiation. However, the fuses are tested to interrupt the asymmetrical peak current at a given X/R ratio 4.899 or equivalent power factor 20 percent.

If the low voltage equipment is underrated on a fully rated basis, then the engineer applies a series rating method. If a series rating method can not be applied and the breaker is pre-1982 design, then the Bussmann Up-and-Over and Up-Over-and Down Method is used. Flow chart #2 shows this procedure and is included at the end of Tab 3.

The summary sheet in Tab 6 lists all the equipment and the short circuit ratings on a fully rated or series rated basis. There is one list for all of the devices (nodes) that are rated > 600 volts. The second list is the low voltage equipment rated < 600 volts.

The study was performed on the new equipment being installed. The calculations show that all the new equipment is properly rated for the available fault current.

SKM PowerTools Power System Analysis Software

The short circuit study was performed using two computer programs. The main program is the SKM PowerTools program. PowerTools is a collection of programs that are used for design and analysis of power systems. The software was written and is distributed by SKM Systems Analysis Inc. of Manhattan Beach, CA.

The short circuit study required equipment nameplate data, conductor sizes, and lengths. The data were entered into PowerStudies.com's PSDB ACCESS database. This additional program stores the entire transformer, conductor, power company, and motor data.

Once the data has been entered into PSDB, the system data is imported into the SKM program. From here, short circuit, protective device, and arc flash studies can be run. The short circuit study results are exported back to PSDB where the calculated fault values are compared to the equipment short circuit ratings. A report is generated that lists the calculated short circuit current and the equipment short circuit ratings. An example of this is shown below.

Input Data

The distribution system input data is listed at the beginning of the computer printout. The feeder, transformer, generator, utility, and motor data are listed. Following this input data is the Dapper Unbalanced Fault Report. This report lists the Bus Name, Voltage, 3 Phase fault and X/R values, Single line to ground fault and X/R ratios, Momentary Amps (Asymmetrical) and Asymmetrical amperes for various time periods.

For low-voltage conductors, the resistance and reactance values used in the study are based on Table 9 of the NEC. The resistance values are those at 75°C (167°F). Using this temperature in fault calculations is consistent with the example fault calculation carried out in ANSI/IEEE Standard 141-1986.

Calculation of Fault Currents

The short circuit fault values were calculated using the SKM short circuit routine. The routine uses Thevennin's theorem and a bus impedance matrix to calculate the fault values. The basic calculated values fall into two forms: three phase bolted fault and line-to-ground fault values. As stated previously, the calculated short circuit current is exported from the SKM program and imported into PSDB. The PSDB program prints out a list that shows the maximum available calculated fault currents compared to the equipment short circuit rating. There is a report for Low Voltage Equipment and one for Medium Voltage. Examples of these lists are shown below.

Low Voltage Equipment Short Circuit Summary List

Node ID	Node Name	Volts	Type of Device	Cat	Equip Rating With	Equip Rating Int	X/R Ratio	1/2 Cycle Sym (KA) (ACComp)	1/2 Cycle Asym (KA)	MF	1/2 Cycle Sym (KA) X MF	S#	Type Of Fault	Equipment Underrated? With	Equipment Underrated? Int
ATS-E		480				42.0	6.23	0.6	0.7			2	3 Phase		
		Comment:													
ATS-N		480				42.0	6.89	18.5	24.9			1	3 Phase		
		Comment:													

Table 1 - Low Voltage Short Circuit Summary List

The column descriptions are listed below:

Field Name	Field Description
Node ID	Name of the Node, Bus, MCC, Switchgear, or Generator
Node Name	Longer and more description of Node ID
Volts	Equipment Voltage Rating
Type of Device	Type of Low Voltage Device ATS (Automatic Transfer Switch) FLVPCB (Fused Low Voltage Power Circuit Breaker) FUSE ICCB (Insulated Case Circuit Breaker) LVPCB (Low Voltage Power Circuit Breaker) MCCB (Molded Case Circuit Breaker) MISC (Miscellaneous) N/A (Not Applicable – No Short Circuit Rating)
Cat	Type of Circuit Breaker Category (See Short Circuit Device Rating Procedure Flow Chart)
With	Withstand Rating
Int	Short Circuit Current Interrupting Rating (IAC)
X/R Ratio	Calculated X/R Ratio of maximum fault Current
½ Cycle Sym (kA) (AC Comp)	This is the calculated maximum ½ Cycle Symmetrical Short Circuit value
½ Cycle ASym (kA	This is the calculated maximum ½ Cycle Asymmetrical Short Circuit value
MF	Multiplying Factor to increase fault current if calculated X/R is greater than device test X/R ratio. (See Short Circuit Device Rating Procedure Flow Chart)
½ Cycle Sym (kA) X MF	½ Cycle Sym (kA) current multiplied by MF (De-rates device interrupting rating) **Use this column and compare to the equipment interrupting rating.**
S#	Scenario Number of the maximum fault current calculated (If multiple cases are run, then there may be different case or scenarios where the fault current is higher. For example Scenario 1 – Normal Power, Scenario 2 – Emergency Power
Type of Fault	This lists the type of fault that produced the maximum fault current.
Equipment Underrated? With	If the field is blank, then the equipment withstand is rated

Field Name	Field Description
	properly for the available fault current. If the field is equal to "Yes", then the device is underrated and has too low of a withstand rating.
Equipment Underrated? Int	If the field is blank, then the equipment interrupting is rated properly for the available fault current. If the field is equal to "Yes", then the device is underrated and has too low of a interrupting rating.

Medium Voltage Equipment Short Circuit Summary List

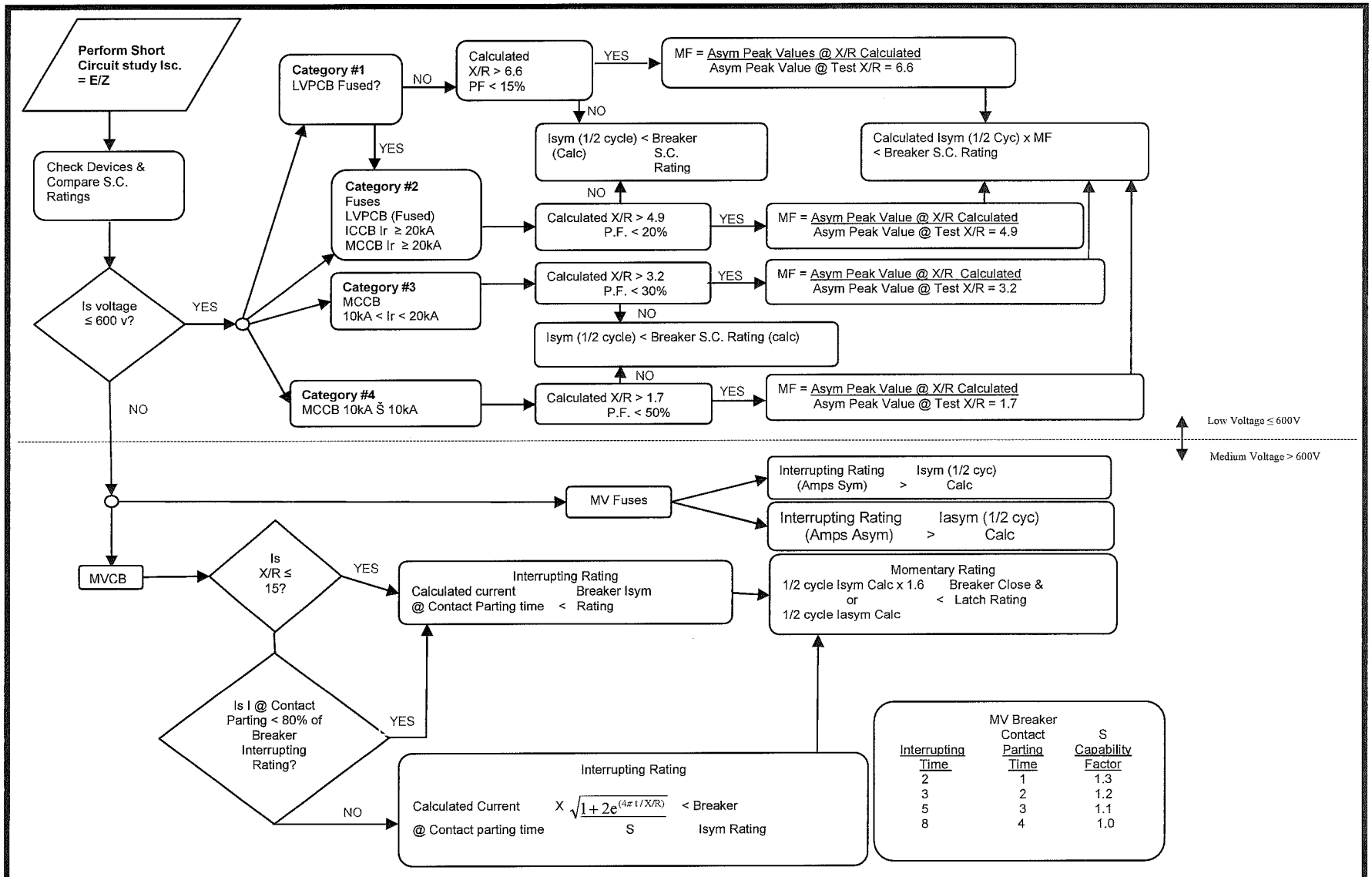
Node ID	Node Name	Volts	Type of Device	Equip Rating (KA) Int Sym	Int/ C+L Asym	With Asym	ST 10 CY	Int Time	Cont Part Time	X/R Ratio	1/2 Cycle Sym (KA) (AC Comp)	1/2 Cycle Asym (KA)	I @ Cont Parting Time	Calc Int Value	S#	Type Of Fault	Equipment Underrated? Int Sym	Int/ C+L Asym	With Asym	ST 10 CY
PSE		115000	N/A																	
		Comment:																		
R-10		4160	N/A							4.49	18.7	22.9			1	3 P				
		Comment:																		
SWGR BUS 1		4160	PCB	36.0	58.0			5	3	14.81	19.9	30.2	21.4	21.9	1	3 P				
		Comment:																		

Table 2 - Medium Voltage Short Circuit Summary List

The column descriptions are listed below:

Field Name	Field Description
Node ID	Name of the Node, Bus, MCC, Switchgear, or Generator
Node Name	Longer and more description of Node ID
Volts	Equipment Voltage Rating
Type of Device	Type of Low Voltage Device FUSE PCB (Medium Voltage Power Circuit Breaker) MISC (Miscellaneous) N/A (Not Applicable – No Short Circuit Rating)
Int Sym	Interrupting Short Circuit Current Rating in symmetrical Amperes
Int/C+L Asym	Interrupting Short Circuit Current Rating in Asymmetrical Amperes or Close and Latch Rating
With Asym	Withstand Rating in Asymmetrical Amperes
ST 10 CY	10 Cycle Short Time Short Circuit Rating
Int Time	Nameplate Interrupting Time (Cycles)
Cont Part Time	Contact Parting Time
X/R Ratio	Calculated X/R Ratio of maximum fault Current
½ Cycle Sym (kA) (AC Comp)	This is the calculated maximum ½ Cycle Symmetrical Short Circuit value
½ Cycle ASym (kA	This is the calculated maximum ½ Cycle Asymmetrical Short Circuit value
I @ Cont Parting Time	Current at contact parting time

Field Name	Field Description
Calc Int Value	Calculated Interrupting Value
S#	Scenario Number of the maximum fault current calculated (If multiple cases are run, then there may be different case or scenarios where the fault current is higher. For example Scenario 1 – Normal Power, Scenario 2 – Emergency Power
Type of Fault	This lists the type of fault that produced the maximum fault current.
Equipment Underrated? Int Sym	If the field is blank, then the equipment interrupting is rated properly for the available fault current. If the field is equal to "Yes", then the device is underrated and has too low of a interrupting rating.
Equipment Underrated? Int/ C+L Asym	If the field is blank, then the equipment interrupting is rated properly for the available fault current. If the field is equal to "Yes", then the device is underrated and has too low of an asymmetrical interrupting or Close & Latch rating.
Equipment Underrated? With Asym	If the field is blank, then the equipment withstand is rated properly for the available fault current. If the field is equal to "Yes", then the device is underrated and has too low of a withstand rating.
Equipment Underrated? ST 10 CY	If the field is blank, then the equipment withstand is rated properly for the available fault current. If the field is equal to "Yes", then the device is underrated and has too low of a 10 Cycle Short Time rating.

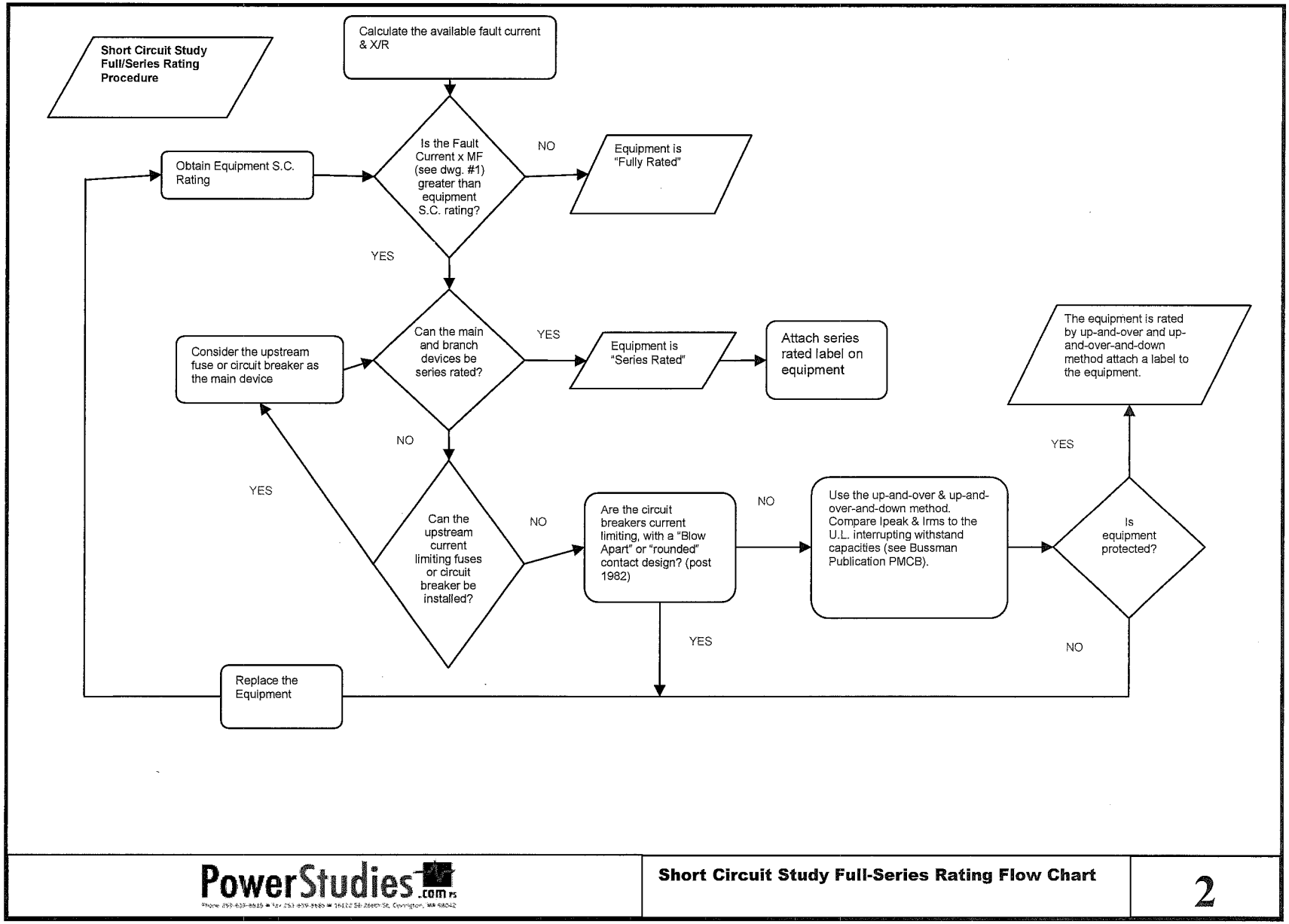


PowerStudies.com PS

Short Circuit Rating Flow Chart

1

SR 520 Pontoon Project
Job Number #1001055-3
Revision #C - Date: 6/1/11



PowerStudies.com

Short Circuit Study Full-Series Rating Flow Chart

2

Grays Harbor PUD
P.O. Box 480
2720 Sumner Avenue
Aberdeen, WA 98520
(360) 532-4220
or (800) 562-7726
Fax - Engineering: (360) 538-6370

FAX TRANSMITTAL SHEET

TO:	ANN HOLLIDAY
	POWER STUDIES
FAX NO:	253 - 639 - 8685
FROM:	PHIL BRCKMAN
	GRAYS HARBOR PUD
RE:	SR 520 PONTOON
DATE:	7-29-2010

Message consists of 5 page(s), including this cover sheet.

PowerStudies.com PS
Phone 253-639-8535 ■ Fax 253-639-8685 ■ 16122 SE 266th St, Covington, WA 98042

Date 7/29/2010

TO:

COMPANY:	GHPUD
NAME:	Wesley Gray
REG. PHONE #	360-538-6353
FAX PHONE #	
Email Address	wgray@ghpud.org

FROM:

NAME:	Ann Holliday
REG. PHONE #	253-639-8535 Ext: 102
FAX PHONE #	253-639-8685
Email Address	holliday@powerstudies.com

SUBJECT: Utility Information Data Sheet:

Site Address
Project / Facility Name: SR 520 Pontoon
Address: _____

Please help us reduce your costs!

Providing your utility data will allow us to

1) Coordinate your customer's protective devices with your utility.
2) Reduce the need for you to replace your customer's fuses, reset relays, or reset reclosers.
3) Provide better protection for your transformer.
4) Increase the safety at your customer's facility.

Be a key player in keeping your customer's project on schedule!

Your customer has asked us to perform this power system study. Without your data, this study cannot be done. Providing us with your data will allow this project to stay on schedule.

Your quick response will be rewarded!

Please complete this form and fax it back to our office. We appreciate your timely response. In fact, if we receive your fax within 5 business days, we'll send you a Starbucks gift certificate to show our appreciation!

Thank you!
Ann

NUMBER OF PAGES TO BE FAXED: COVER SHEET + 4 PAGES
THE ORGINALS __WILL √WILL NOT BE SENT.

PowerStudies.com PS
Phone 253-639-8535 ■ Fax 253-639-8685 ■ 16122 SE 266th St, Covington, WA 98042

Job # 1001055 Project / Facility Name: SR 520 Pontoon

Instructions: Please fill out as much of the information as you can and fax back.

Fault Current Data (See attached NEMA Statement)

Fault Current Location (Check one) ☒XFMR ☐Pole ☐Other_____

MAXIMUM FAULT CURRENT

Type of Fault	Volts	Amps	X/R Ratio
3-Phase	480	52755	
Line to Ground	277	"	

MINIMUM FAULT CURRENT

Type of Fault	Volts	Amps	X/R Ratio
3-Phase	480	9100	
Line to Ground	277	"	

Closest Utility Protective Device

Device Location (Check one) ☒XFMR ☐Pole ☐Other_____

Fuse

Manufacturer COOPER Type BAY-O-NET

Voltage 12470Y/7200 Amps 140

Catalog # 4000353C17 Mfg TCC # R240-91-50

OR

Relay

Manuf._____ Type_____ Cat. #_____

	CT Ratio	Tap	Time Delay	Instantaneous
Phase				
Ground				

Conductor Data – *If installed by utility*

	Volts	Number / Phase	Size	Copper/Alum	Length
Secondary	480Y/277	7	750 MCM	COPPER	30 FT.

PowerStudies.com PS
Phone 253-639-8535 ■ Fax 253-639-8685 ■ 16122 SE 266th St, Covington, WA 98042

Transformer *Data (For Maximum Fault Contribution)*

Type (Check One) [X] Oil [ ] Dry [ ] Silicone

KVA 2500 Impedance 5.7

	Volts	Winding Connection (Check one)		
		Delta	Wye Ungrnd	Wye Grnd
Primary	12470Y/7200			X
Secondary	480Y/277			X

Transformer *Data (For Minimum Fault Contribution)*

Type (Check One) [X] Oil [ ] Dry [ ] Silicone

KVA 2500 Impedance 5.7

	Volts	Winding Connection (Check one)		
		Delta	Wye Ungrnd	Wye Grnd
Primary	12470Y/7200			X
Secondary	480Y/277			X

Comments:

THE ONLY TRANSFORMER WE HAVE RIGHT NOW FOR THIS PROJECT IS SERIAL NUMBER # 08J996023.

I LEFT THE X/R RATIO BLANK BUT ATTACHED CERTIFIED TEST REPORTS FOR THE UNIT WE HAVE. THE OTHER TRANSFORMER IS ON ORDER.

THANKS!

PHIL BECKMAN
360-538-6377

RECEIVED
MAY 22 2008

ABB

Certified Test Report

ABB Inc.
Jefferson City, Missouri - USA
Distribution Transformers

Customer Name : WESCO DISTRIBUTION INC

No Load Losses are reported at 100 Percent of rated voltage

No Load losses reported at 85 degree. C and load losses at 85 degree C.

CUST PO	STOCK CODE	ABB ORDER	ABB ITEM
7883-953500		WD67190	001

STYLE	PHASE	HERTZ	KVA	LOW VOLTAGE	HIGH VOLTAGE	SERVICE STYLE
F73E266234	3PH	60	2500	480Y/277	12470GRDY/ 7200	PAD

	SERIAL NUMBER	NO LOAD LOSS (WATTS)	LOAD LOSS (WATTS)	TOTAL LOSS (WATTS)	IMPEDANCE %	RESISTANCE %	EXCITING CURRENT %	TEST DATE	SHIP DATE	INVOICE NUMBER
→	08J996023	2,621	14,753	17,574	5.70	0.59	0.25	04/04/2008	04/07/2008	7601236
	08J017152	2,701	14,095	16,795	5.69	0.56	0.22	05/06/2008	05/14/2008	7603288
	08J963174	2,763	14,192	16,956	5.64	0.57	0.26	02/20/2008	02/22/2008	7598673
Average		2,761	14,347	17,108	5.68	0.57	0.24			
Quoted Losses		2,737	14,184	16,921						
Total Units	3									

STYLE			REGULATION		RESISTANCE		EFFICIENCY			
F73E266234										
	SERIAL NUMBER	REACTANCE	100%	80%	HIGH VOLT (OHMS)	LOW VOLT (OHMS)	25%	50%	75%	100%
→	08J996023	5.67	0.75	3.96	0.50	0.0007	99.41	99.48	99.41	99.30
	08J017152	5.66	0.72	3.93	0.47	0.0006	99.44	99.50	99.44	99.33
	08J963174	5.61	0.72	3.90	0.49	0.0007	99.42	99.50	99.43	99.33

INSULATION TEST -APPLIED POTENTIAL TESTS

STYLE			
F73E266234			
	RATED VOLTS	TEST VOLTS	DURATION IN SECONDS
HLIC	12470	19000	60
LHIC	480	10000	60

Rise of windings by resistance at 65 deg. C, guaranteed.

Filled to the proper level with non-PCB MINERAL OIL that contained less than 1-PPM PCB at time of manufacture.

Routine leak tests and polarity tests were performed and passed on these units. Turns ratio for these units are within 0.5 percent of the nameplate voltages.

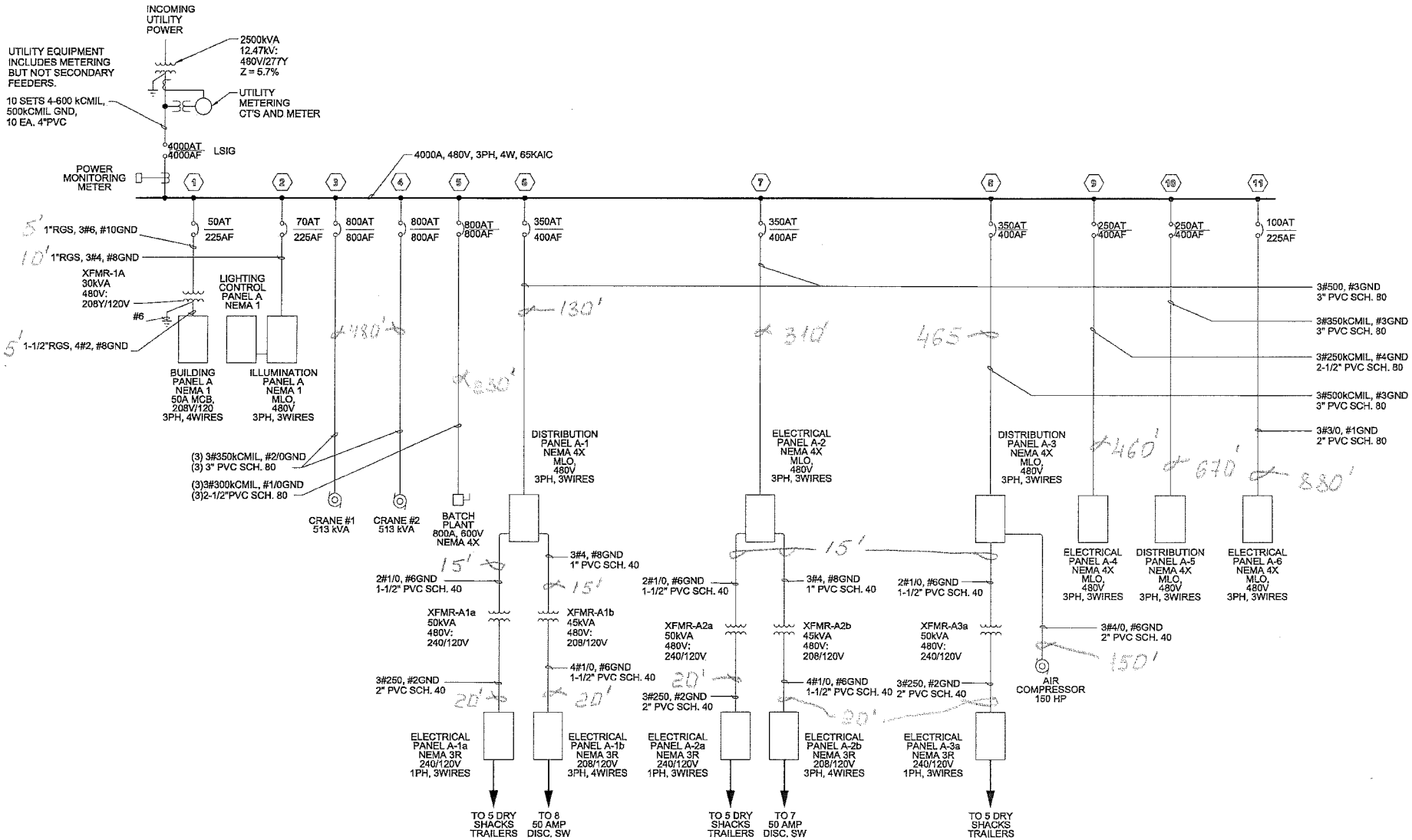
Unit Successfully Passed QC Impulse Test.

We Certify that the above information is a true report based on factory tests made in accordance with the latest transformer test code of ANSI/IEEE C57.12.90, and that the above transformers withstood these tests.

Iqbal M Hussain, P.Eng
Engineering Manager
Distribution Transformers Division

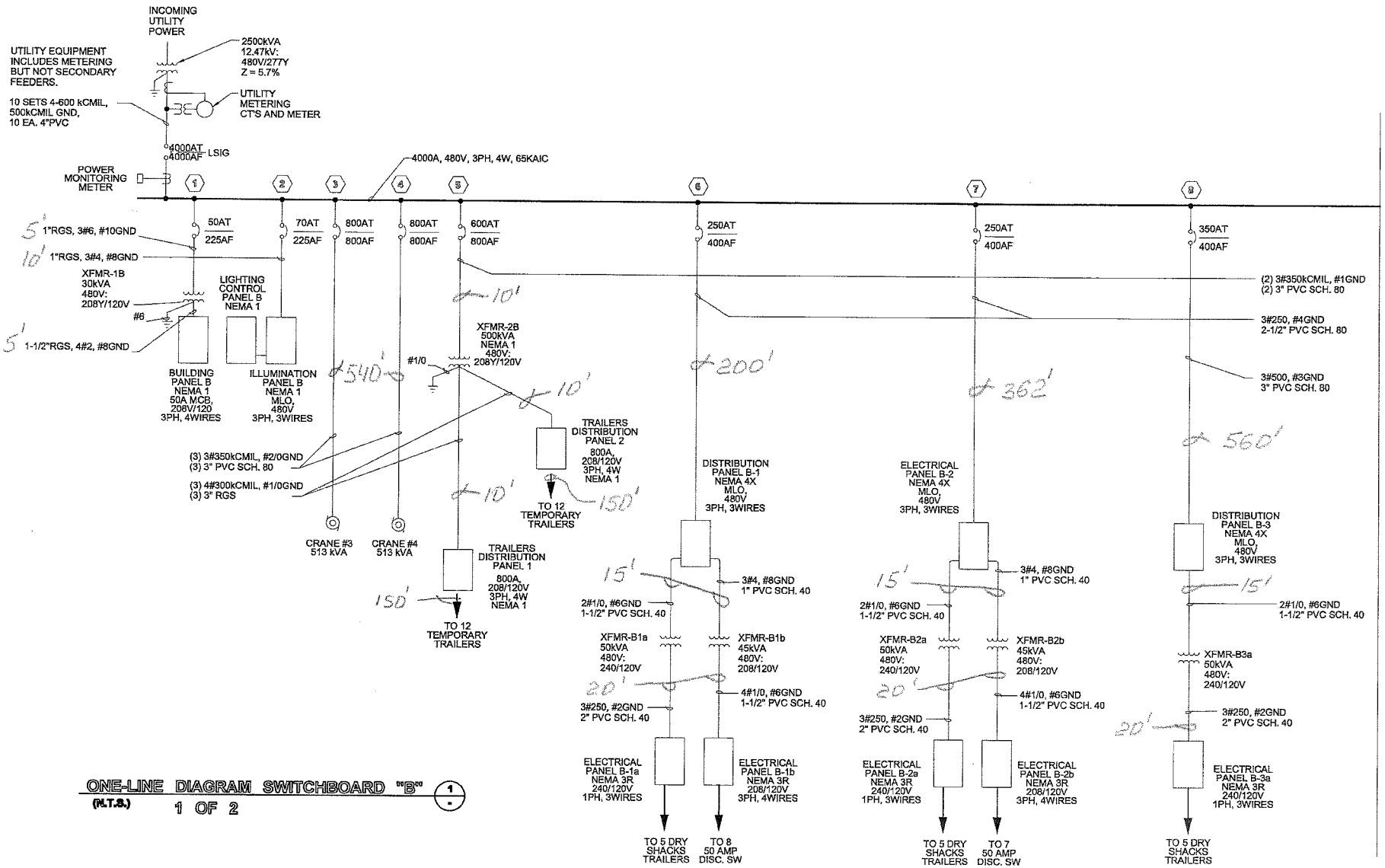
StdReportTemplate_GRAYS

TAB 4



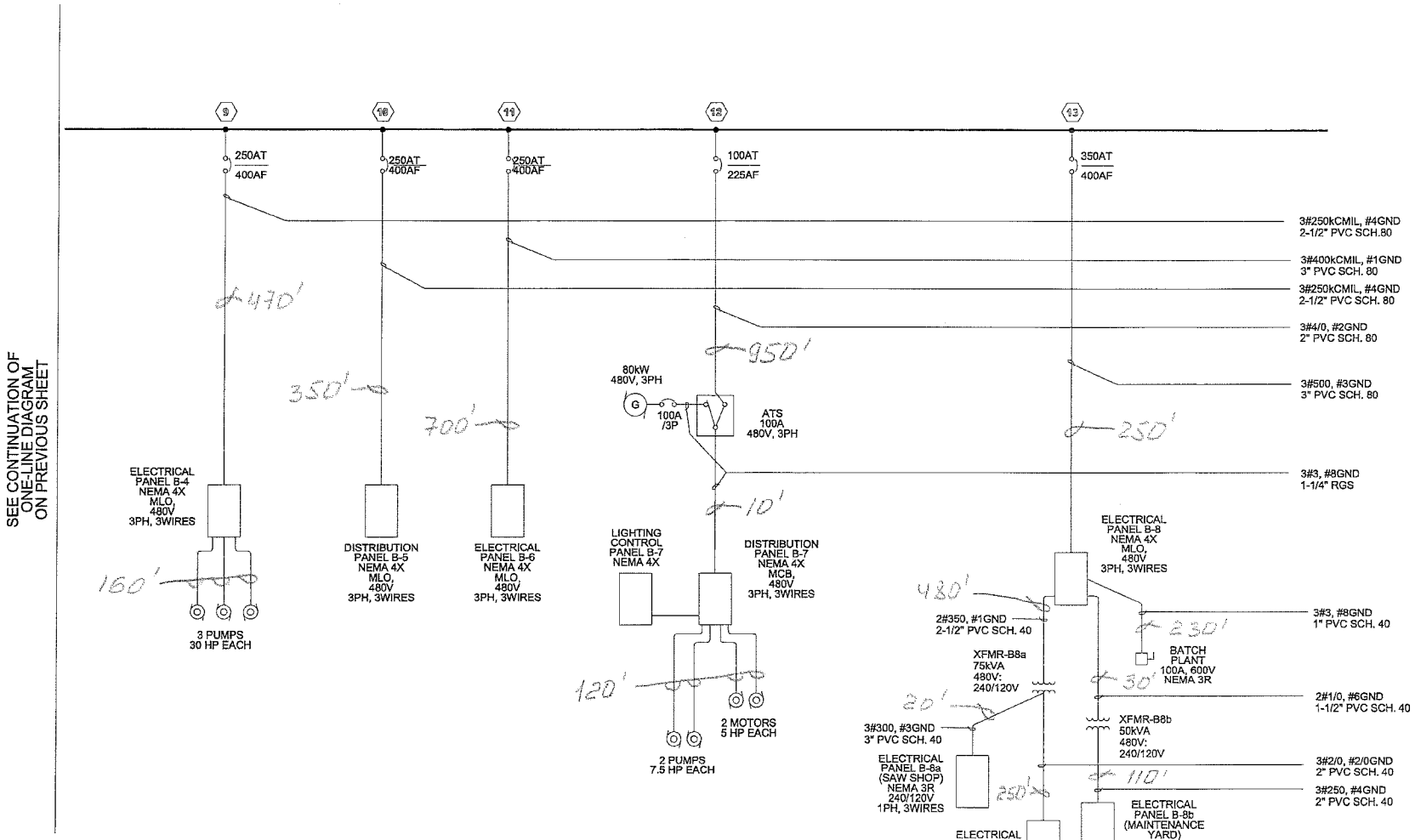
ONE-LINE DIAGRAM - SWITCHBOARD "A" (1)

(N.T.S.)



ONE-LINE DIAGRAM SWITCHBOARD "B" 1

(N.T.S.) 1 OF 2



ONE-LINE DIAGRAM SWITCHBOARD "B" (1/-)

(N.T.S.) 2 OF 2

TAB 5

Project: 1001055

DAPPER Fault Analysis Input Report (English)

Utilities

Contribution From Name	Bus Name	In/Out Service	Nominal Voltage	-------- Contribution Data -------- Duty	Units	X/R	PU (100 MVA Base	R PU	X PU
UTIL-PUDA	XFMR-UTILAP	In	12,470	3P: 1,000,000	Amps	5.00	Pos:	0.001	0.005
				SLG: 1,000,000	Amps	5.00	Zero:	0.001	0.005
UTIL-PUDB	XFMR-UTILBP	In	12,470	3P: 1,000,000	Amps	5.00	Pos:	0.001	0.005
				SLG: 1,000,000	Amps	5.00	Zero:	0.001	0.005

Generators

Contribution From Name	Bus Name	In/Out Service	Nominal Voltage	-------- Contribution Data -------- Base kVA	X"	X/R	PU (100 MVA Base) R PU	X PU
GENERATOR-1	GEN-1	In	480	100.00	0.10	3.02	33.16	100.00
					0.11	3.32	33.16	110.00
					0.08	2.41	33.16	80.00

Motors

Contribution From Name	# of Motors	Bus Name	In/Out Service	Nominal Voltage	--------- Contribution Data -------- Base kVA	Xd"	X/R	PU (100 MVA Base) R PU	X PU
MTR-AIRCOMP	1	AIR-COMP	In	480	143.72	0.2405	9.00	17.076	153.685
MTR-CRANE1	1	CRANE-1	In	480	503.02	0.2004	9.00	4.065	36.589
MTR-CRANE2	1	CRANE-2	In	480	503.02	0.2004	9.00	4.065	36.589
MTR-CRANE3	1	CRANE-3	In	480	503.02	0.2004	9.00	4.065	36.589
MTR-CRANE4	1	CRANE-4	In	480	503.02	0.2004	9.00	4.065	36.589
MTRS-PNL-B4	1	PNL-B-4	In	480	90.79	0.2405	9.00	27.031	243.279
MTRS-PNL-B7	1	PNL-B-7	In	480	25.22	0.3347	9.00	135.427	1,218.844

Cables

Cable Name	From Bus To Bus	In/Out Service	Qty /Ph	Length Feet	------ Cable Description ------ Size	Cond. Type	Duct Type	Insul	Per Unit (100 MVA Base)	R pu	jX pu
TO AIR-COMP	PNL-A-3	In	1	150	4-0	Copper	Non-Magnetic		Pos:	4.3685	2.6693
	AIR-COMP								Zero:	8.1641	5.8984

Cable Name	From Bus To Bus	In/Out Service	Qty /Ph	Length Feet	Size	Cond. Type	Duct Type	Insul		R pu	jX pu
					------ Cable Description ------				Per Unit (100 MVA Base)		
TO ATS-B-7	SWBD-B	In	1	950	4-0	Copper	Non-Magnetic		Pos:	25.6055	16.9054
	ATS-B-7								Zero:	51.7057	37.3568
TO ATS-B-7E	GEN-1	In	1	10	3	Copper	Magnetic		Pos:	1.0872	0.2561
	ATS-B-7								Zero:	1.3416	0.6688
TO CRANE-1	SWBD-A	In	3	480	350	Copper	Non-Magnetic		Pos:	2.6389	2.7778
	CRANE-1								Zero:	7.0625	5.2917
TO CRANE-2	SWBD-A	In	3	480	350	Copper	Non-Magnetic		Pos:	2.6389	2.7778
	CRANE-2								Zero:	7.0625	5.2917
TO CRANE-3	SWBD-B	In	3	540	350	Copper	Non-Magnetic		Pos:	2.9688	3.1250
	CRANE-3								Zero:	7.9453	5.9531
TO CRANE-4	SWBD-B	In	3	540	350	Copper	Non-Magnetic		Pos:	2.9688	3.1250
	CRANE-4								Zero:	7.9453	5.9531
TO DISC-100ABP	PNL-B-8	In	1	230	3	Copper	Non-Magnetic		Pos:	25.0065	4.6918
	DISC-100ABP								Zero:	30.8563	12.8177
TO DISC-800ABP	SWBD-A	In	3	230	300	Copper	Non-Magnetic		Pos:	1.4674	1.3643
	DISC-800ABP								Zero:	3.5871	2.7286
TO PNL-A-1	SWBD-A	In	1	130	500	Copper	Non-Magnetic		Pos:	1.5291	2.2005
	PNL-A-1								Zero:	5.1289	3.5942
TO PNL-A-1A	XFMR-A1AS	In	1	20	250	Copper	Non-Magnetic		Pos:	1.8090	1.4236
	PNL-A-1A								Zero:	4.0382	2.9792
TO PNL-A-1B	XFMR-A1BS	In	1	20	1-0	Copper	Non-Magnetic		Pos:	5.5566	2.0340
	PNL-A-1B								Zero:	8.6122	4.9926
TO PNL-A-2	SWBD-A	In	1	310	500	Copper	Non-Magnetic		Pos:	3.6463	5.2474
	PNL-A-2								Zero:	12.2305	8.5707
TO PNL-A-2A	XFMR-A2AS	In	1	20	250	Copper	Non-Magnetic		Pos:	1.8090	1.4236
	PNL-A-2A								Zero:	4.0382	2.9792
TO PNL-A-2B	XFMR-A2BS	In	1	20	1-0	Copper	Non-Magnetic		Pos:	5.5566	2.0340
	PNL-A-2B								Zero:	8.6122	4.9926
TO PNL-A-3	SWBD-A	In	1	465	500	Copper	Non-Magnetic		Pos:	5.4694	7.8711
	PNL-A-3								Zero:	18.3457	12.8561
TO PNL-A-3A	XFMR-A3AS	In	1	20	250	Copper	Non-Magnetic		Pos:	1.8090	1.4236
	PNL-A-3A								Zero:	4.0382	2.9792
TO PNL-A-4	SWBD-A	In	1	460	250	Copper	Non-Magnetic		Pos:	10.4019	8.1858
	PNL-A-4								Zero:	23.2196	17.1302
TO PNL-A-5	SWBD-A	In	1	670	350	Copper	Non-Magnetic		Pos:	11.0503	11.6319
	PNL-A-5								Zero:	29.5742	22.1589
TO PNL-A-6	SWBD-A	In	1	880	3-0	Copper	Non-Magnetic		Pos:	29.4861	16.0417
	PNL-A-6								Zero:	53.9306	37.7361
TO PNL-A-BLD	XFMR-1AS	In	1	5	2	Copper	Magnetic		Pos:	2.3160	0.6587
	PNL-A-BLD								Zero:	2.9805	1.6827
TO PNL-A-ILL	SWBD-A	In	1	10	4	Copper	Magnetic		Pos:	1.3481	0.2604
	PNL-A-ILL								Zero:	1.6211	0.7491

Cable Name	From Bus To Bus	In/Out Service	Qty /Ph	Length Feet	------ Cable Description ------ Size	Cond. Type	Duct Type	Insul	Per Unit (100 MVA Base)	R pu	jX pu
TO PNL-B-1	SWBD-B	In	1	200	250	Copper	Non-Magnetic		Pos:	4.5226	3.5590
	PNL-B-1								Zero:	10.0955	7.4479
TO PNL-B-1A	XFMR-B1AS	In	1	20	250	Copper	Non-Magnetic		Pos:	1.8090	1.4236
	PNL-B-1A								Zero:	4.0382	2.9792
TO PNL-B-1B	XFMR-B1BS	In	1	20	1-0	Copper	Non-Magnetic		Pos:	5.5566	2.0340
	PNL-B-1B								Zero:	8.6122	4.9926
TO PNL-B-2	SWBD-B	In	1	362	250	Copper	Non-Magnetic		Pos:	8.1859	6.4418
	PNL-B-2								Zero:	18.2728	13.4807
TO PNL-B-2A	XFMR-B2AS	In	1	20	250	Copper	Non-Magnetic		Pos:	1.8090	1.4236
	PNL-B-2A								Zero:	4.0382	2.9792
TO PNL-B-2B	XFMR-B2BS	In	1	20	1-0	Copper	Non-Magnetic		Pos:	5.5566	2.0340
	PNL-B-2B								Zero:	8.6122	4.9926
TO PNL-B-3	SWBD-B	In	1	560	500	Copper	Non-Magnetic		Pos:	6.5868	9.4792
	PNL-B-3								Zero:	22.0938	15.4826
TO PNL-B-3A	XFMR-B3AS	In	1	20	250	Copper	Non-Magnetic		Pos:	1.8090	1.4236
	PNL-B-3A								Zero:	4.0382	2.9792
TO PNL-B-4	SWBD-B	In	1	470	250	Copper	Non-Magnetic		Pos:	10.6280	8.3637
	PNL-B-4								Zero:	23.7244	17.5026
TO PNL-B-5	SWBD-B	In	1	350	250	Copper	Non-Magnetic		Pos:	7.9145	6.2283
	PNL-B-5								Zero:	17.6671	13.0339
TO PNL-B-6	SWBD-B	In	1	700	400	Copper	Non-Magnetic		Pos:	10.0260	12.1528
	PNL-B-6								Zero:	29.5313	21.5712
TO PNL-B-7	ATS-B-7	In	1	10	3	Copper	Magnetic		Pos:	1.0872	0.2561
	PNL-B-7								Zero:	1.3416	0.6688
TO PNL-B-8	SWBD-B	In	1	250	500	Copper	Non-Magnetic		Pos:	2.9405	4.2318
	PNL-B-8								Zero:	9.8633	6.9119
TO PNL-B-8A	XFMR-B8AS	In	1	20	300	Copper	Non-Magnetic		Pos:	1.5313	1.4236
	PNL-B-8A								Zero:	3.7431	2.8472
TO PNL-B-8B	XFMR-B8BS	In	1	110	250	Copper	Non-Magnetic		Pos:	9.9497	7.8299
	PNL-B-8B								Zero:	22.2101	16.3854
TO PNL-B-8C	XFMR-B8AS	In	1	250	2-0	Copper	Non-Magnetic		Pos:	43.4896	18.6632
	PNL-B-8C								Zero:	70.0521	46.1806
TO PNL-B-BLD	XFMR-1BS	In	1	5	2	Copper	Magnetic		Pos:	2.3160	0.6587
	PNL-B-BLD								Zero:	2.9805	1.6827
TO PNL-B-ILL	SWBD-B	In	1	10	4	Copper	Magnetic		Pos:	1.3481	0.2604
	PNL-B-ILL								Zero:	1.6211	0.7491
TO PNL-TRAIL1	XFMR-2BS	In	3	10	300	Copper	Magnetic		Pos:	0.3475	0.3929
	PNL-TRAIL1								Zero:	0.8306	0.7581
TO PNL-TRAIL2	XFMR-2BS	In	3	10	300	Copper	Magnetic		Pos:	0.3475	0.3929
	PNL-TRAIL2								Zero:	0.8306	0.7581
TO SWBD-A	XFMR-UTILAS	In	10	50	600	Copper	Non-Magnetic		Pos:	0.0499	0.0846
	SWBD-A								Zero:	0.1882	0.1315

Cable Name	From Bus To Bus	In/Out Service	Qty /Ph	Length Feet	Size	Cond. Type	Duct Type	Insul		R pu	jX pu
					------ Cable Description ------				Per Unit (100 MVA Base)		
TO SWBD-B	XFMR-UTILBS	In	10	83	600	Copper	Non-Magnetic		Pos:	0.0829	0.1405
	SWBD-B								Zero:	0.3123	0.2183
TO XFMR-1AP	SWBD-A	In	1	5	6	Copper	Magnetic		Pos:	1.0653	0.1389
	XFMR-1AP								Zero:	1.2014	0.3908
TO XFMR-1BP	SWBD-B	In	1	5	6	Copper	Magnetic		Pos:	1.0653	0.1389
	XFMR-1BP								Zero:	1.2014	0.3908
TO XFMR-A1AP	PNL-A-1	In	1	15	1-0	Copper	Non-Magnetic		Pos:	0.7826	0.2865
	XFMR-A1AP								Zero:	1.2129	0.7031
TO XFMR-A1BP	PNL-A-1	In	1	15	4	Copper	Non-Magnetic		Pos:	2.0221	0.3125
	XFMR-A1BP								Zero:	2.4316	0.9362
TO XFMR-A2AP	PNL-A-2	In	1	15	1-0	Copper	Non-Magnetic		Pos:	0.7826	0.2865
	XFMR-A2AP								Zero:	1.2129	0.7031
TO XFMR-A2BP	PNL-A-2	In	1	15	4	Copper	Non-Magnetic		Pos:	2.0221	0.3125
	XFMR-A2BP								Zero:	2.4316	0.9362
TO XFMR-A3AP	PNL-A-3	In	1	15	1-0	Copper	Non-Magnetic		Pos:	0.7826	0.2865
	XFMR-A3AP								Zero:	1.2129	0.7031
TO XFMR-B1AP	PNL-B-1	In	1	15	1-0	Copper	Non-Magnetic		Pos:	0.7826	0.2865
	XFMR-B1AP								Zero:	1.2129	0.7031
TO XFMR-B1BP	PNL-B-1	In	1	15	4	Copper	Non-Magnetic		Pos:	2.0221	0.3125
	XFMR-B1BP								Zero:	2.4316	0.9362
TO XFMR-B2AP	PNL-B-2	In	1	15	1-0	Copper	Non-Magnetic		Pos:	0.7826	0.2865
	XFMR-B2AP								Zero:	1.2129	0.7031
TO XFMR-B2BP	PNL-B-2	In	1	15	4	Copper	Non-Magnetic		Pos:	2.0221	0.3125
	XFMR-B2BP								Zero:	2.4316	0.9362
TO XFMR-B3AP	PNL-B-3	In	1	15	1-0	Copper	Non-Magnetic		Pos:	0.7826	0.2865
	XFMR-B3AP								Zero:	1.2129	0.7031
TO XFMR-B8AP	PNL-B-8	In	1	480	350	Copper	Non-Magnetic		Pos:	7.9167	8.3333
	XFMR-B8AP								Zero:	21.1875	15.8750
TO XFMR-B8BP	PNL-B-8	In	1	30	1-0	Copper	Non-Magnetic		Pos:	1.5651	0.5729
	XFMR-B8BP								Zero:	2.4258	1.4063
TO XFMR-TRAILF	SWBD-B	In	2	10	350	Copper	Non-Magnetic		Pos:	0.0825	0.0868
	XFMR-2BP								Zero:	0.2207	0.1654

2-Winding Transformers

Xformer Name	In/Out Service	Bus	Conn.	Volts	FLA	Nominal kVA		R pu	jX pu
		----------Primary & Secondary----------					Z PU (100 MVA Base)		
XFMR-1A	In	XFMR-1AP	D	480	36	30.0	Pos:	149.9100	111.2233
		XFMR-1AS	WG	208	83		Zero:	149.9100	111.2233
XFMR-1B	In	XFMR-1BP	D	480	36	30.0	Pos:	149.9100	111.2233
		XFMR-1BS	WG	208	83		Zero:	149.9100	111.2233

Xformer Name	In/Out Service	----------Primary & Secondary---------- Bus	Conn.	Volts	FLA	Nominal kVA	Z PU (100 MVA Base)	R pu	jX pu
XFMR-2B	In	XFMR-2BP	D	480	601	500.0	Pos:	1.7634	9.6400
		XFMR-2BS	WG	208	1,388		Zero:	1.7634	9.6400
XFMR-A1A	In	XFMR-A1AP	D	480	60	50.0	Pos:	54.0000	50.0000
		XFMR-A1AS	WG	240	120		Zero:	54.0000	50.0000
XFMR-A1B	In	XFMR-A1BP	D	480	54	45.0	Pos:	60.0000	55.5556
		XFMR-A1BS	WG	208	125		Zero:	60.0000	55.5556
XFMR-A2A	In	XFMR-A2AP	D	480	60	50.0	Pos:	54.0000	50.0000
		XFMR-A2AS	WG	240	120		Zero:	54.0000	50.0000
XFMR-A2B	In	XFMR-A2BP	D	480	54	45.0	Pos:	60.0000	55.5556
		XFMR-A2BS	WG	208	125		Zero:	60.0000	55.5556
XFMR-A3A	In	XFMR-A3AP	D	480	60	50.0	Pos:	54.0000	50.0000
		XFMR-A3AS	WG	240	120		Zero:	54.0000	50.0000
XFMR-B1A	In	XFMR-B1AP	D	480	60	50.0	Pos:	54.0000	50.0000
		XFMR-B1AS	WG	240	120		Zero:	54.0000	50.0000
XFMR-B1B	In	XFMR-B1BP	D	480	54	45.0	Pos:	60.0000	55.5556
		XFMR-B1BS	WG	208	125		Zero:	60.0000	55.5556
XFMR-B2A	In	XFMR-B2AP	D	480	60	50.0	Pos:	54.0000	50.0000
		XFMR-B2AS	WG	240	120		Zero:	54.0000	50.0000
XFMR-B2B	In	XFMR-B2BP	D	480	54	45.0	Pos:	60.0000	55.5556
		XFMR-B2BS	WG	208	125		Zero:	60.0000	55.5556
XFMR-B3A	In	XFMR-B3AP	D	480	60	50.0	Pos:	54.0000	50.0000
		XFMR-B3AS	WG	240	120		Zero:	54.0000	50.0000
XFMR-B8A	In	XFMR-B8AP	D	480	90	75.0	Pos:	40.0000	44.0000
		XFMR-B8AS	WG	240	180		Zero:	40.0000	44.0000
XFMR-B8B	In	XFMR-B8BP	D	480	60	50.0	Pos:	54.0000	50.0000
		XFMR-B8BS	WG	240	120		Zero:	54.0000	50.0000
XFMR-UTILA	In	XFMR-UTILAP	WG	12,470	116	2,500.0	Pos:	0.2828	2.2624
		XFMR-UTILAS	WG	480	3,007		Zero:	0.2828	2.2624
XFMR-UTILB	In	XFMR-UTILBP	WG	12,470	116	2,500.0	Pos:	0.2828	2.2624
		XFMR-UTILBS	WG	480	3,007		Zero:	0.2828	2.2624

Project: 1001055
Utility - Motors ON

DAPPER Unbalanced Fault Report

Comprehensive Short Circuit Study Settings

Three Phase Fault	Yes	**Faulted Bus**	All Buses
Single Line to Ground	Yes	**Bus Voltages**	First Bus From Fault
Line to Line Fault	No	**Branch Currents**	First Branch From Fault
Line to Line to Ground	No	**Phase or Sequence**	Report phase quantities
Motor Contribution	Yes	**Fault Current Calculation**	Asymmetrical RMS (with DC offset and Decay)
Transformer Tap	Yes	**Asym Fault Current at Time**	4.00 **Cycles**
Xformer Phase Shift	Yes		

Fault Location Bus Name	Bus Voltage	3-Phase Amps	3-Phase MVA	3P X/R	SLG Amps	SLG MVA	SLG X/R	Mom Amps	---------3P Asym Amps-------- 3 Cycles	5 Cycles	8 Cycles
AIR-COMP	480	8,034	6.68	1.38	6,073	1.68	1.17	8,117	8,034	8,034	8,034
ATS-B-7	480	3,737	3.11	0.73	2,778	0.77	0.75	3,738	3,737	3,737	3,737
CRANE-1	480	23,820	19.80	1.92	19,372	5.37	1.62	24,710	23,820	23,820	23,820
CRANE-2	480	23,820	19.80	1.92	19,372	5.37	1.62	24,710	23,820	23,820	23,820
CRANE-3	480	21,991	18.28	1.88	17,798	4.93	1.61	22,761	21,991	21,991	21,991
CRANE-4	480	21,991	18.28	1.88	17,798	4.93	1.61	22,761	21,991	21,991	21,991
DISC-100ABP	480	3,961	3.29	0.39	3,363	0.93	0.45	3,961	3,961	3,961	3,961
DISC-800ABP	480	31,092	25.85	1.95	25,846	7.16	1.55	32,299	31,092	31,092	31,092
GEN-1	480	0	0.00	0.00	0	0.00	000.00	0	0	0	0
PNL-A-1	480	25,856	21.50	2.34	21,230	5.88	1.55	27,557	25,856	25,856	25,856

Fault Location Bus Name	Bus Voltage	3-Phase Amps	3-Phase MVA	3P X/R	SLG Amps	SLG MVA	SLG X/R	Mom Amps	---------3P Asym Amps-------- 3 Cycles	5 Cycles	8 Cycles
PNL-A-1A	240	2,973	1.24	0.96	3,002	0.42	0.94	2,977	2,973	2,973	2,973
PNL-A-1B	208	2,979	1.07	0.90	2,997	0.36	0.89	2,981	2,979	2,979	2,979
PNL-A-2	480	14,457	12.02	1.86	11,056	3.06	1.23	14,938	14,457	14,457	14,457
PNL-A-2A	240	2,845	1.18	0.98	2,914	0.40	0.95	2,849	2,845	2,845	2,845
PNL-A-2B	208	2,867	1.03	0.91	2,921	0.35	0.90	2,870	2,867	2,867	2,867
PNL-A-3	480	11,090	9.22	1.83	8,406	2.33	1.30	11,441	11,090	11,090	11,090
PNL-A-3A	240	2,765	1.15	0.99	2,858	0.40	0.97	2,770	2,765	2,765	2,765
PNL-A-4	480	8,112	6.74	0.96	6,003	1.66	0.88	8,123	8,112	8,112	8,112
PNL-A-5	480	6,758	5.62	1.21	4,887	1.35	0.98	6,795	6,758	6,758	6,758
PNL-A-6	480	3,450	2.87	0.61	2,634	0.73	0.67	3,450	3,450	3,450	3,450
PNL-A-BLD	208	1,451	0.52	0.74	1,454	0.17	0.74	1,451	1,451	1,451	1,451
PNL-A-ILL	480	42,055	34.96	1.42	38,984	10.80	1.41	42,551	42,055	42,055	42,055
PNL-B-1	480	16,054	13.35	1.18	12,314	3.41	1.04	16,130	16,054	16,054	16,054
PNL-B-1A	240	2,861	1.19	0.93	2,924	0.41	0.93	2,864	2,861	2,861	2,861
PNL-B-1B	208	2,879	1.04	0.88	2,929	0.35	0.88	2,882	2,879	2,879	2,879
PNL-B-2	480	9,943	8.27	1.01	7,417	2.06	0.92	9,963	9,943	9,943	9,943
PNL-B-2A	240	2,711	1.13	0.93	2,818	0.39	0.92	2,714	2,711	2,711	2,711
PNL-B-2B	208	2,747	0.99	0.87	2,836	0.34	0.88	2,749	2,747	2,747	2,747
PNL-B-3	480	8,890	7.39	1.68	6,579	1.82	1.12	9,099	8,890	8,890	8,890
PNL-B-3A	240	2,682	1.11	1.00	2,798	0.39	0.97	2,687	2,682	2,682	2,682
PNL-B-4	480	7,920	6.58	0.96	5,858	1.62	0.88	7,932	7,920	7,920	7,920
PNL-B-5	480	10,233	8.51	1.02	7,643	2.12	0.92	10,254	10,233	10,233	10,233
PNL-B-6	480	6,812	5.66	1.38	4,945	1.37	1.03	6,883	6,812	6,812	6,812
PNL-B-7	480	3,621	3.01	0.71	2,704	0.75	0.73	3,622	3,621	3,621	3,621
PNL-B-8	480	16,776	13.95	1.95	13,031	3.61	1.29	17,431	16,776	16,776	16,776
PNL-B-8A	240	3,008	1.25	1.14	3,222	0.45	1.12	3,020	3,008	3,008	3,008
PNL-B-8B	240	2,546	1.06	0.94	2,489	0.34	0.92	2,549	2,546	2,546	2,546

Fault Location Bus Name	Bus Voltage	3-Phase Amps	3-Phase MVA	3P X/R	SLG Amps	SLG MVA	SLG X/R	Mom Amps	---------3P Asym Amps--------		
									3 Cycles	5 Cycles	8 Cycles
PNL-B-8C	240	1,967	0.82	0.82	1,866	0.26	0.82	1,968	1,967	1,967	1,967
PNL-B-BLD	208	1,450	0.52	0.74	1,454	0.17	0.74	1,451	1,450	1,450	1,450
PNL-B-ILL	480	40,964	34.06	1.43	37,780	10.47	1.41	41,470	40,964	40,964	40,964
PNL-TRAIL1	208	22,163	7.98	4.86	23,287	2.80	4.57	27,578	22,172	22,163	22,163
PNL-TRAIL2	208	22,163	7.98	4.86	23,287	2.80	4.57	27,578	22,172	22,163	22,163
SWBD-A	480	57,332	47.66	6.89	56,685	15.71	6.06	77,002	57,573	57,338	57,332
SWBD-B	480	55,356	46.02	6.45	54,416	15.08	5.39	73,345	55,517	55,359	55,356
XFMR-1AP	480	46,214	38.42	1.62	43,960	12.18	1.59	47,162	46,214	46,214	46,214
XFMR-1AS	208	1,468	0.53	0.75	1,474	0.18	0.75	1,468	1,468	1,468	1,468
XFMR-1BP	480	44,886	37.32	1.64	42,438	11.76	1.58	45,839	44,886	44,886	44,886
XFMR-1BS	208	1,467	0.53	0.75	1,474	0.18	0.75	1,468	1,467	1,467	1,467
XFMR-2BP	480	52,934	44.01	5.38	51,242	14.20	4.30	67,420	52,982	52,934	52,934
XFMR-2BS	208	22,993	8.28	5.45	24,532	2.95	5.46	29,369	23,015	22,993	22,993
XFMR-A1AP	480	22,875	19.02	1.75	18,369	5.09	1.30	23,493	22,875	22,875	22,875
XFMR-A1AS	240	3,060	1.27	0.96	3,126	0.43	0.95	3,064	3,060	3,060	3,060
XFMR-A1BP	480	20,074	16.69	1.19	16,181	4.48	1.01	20,177	20,074	20,074	20,074
XFMR-A1BS	208	3,164	1.14	0.94	3,238	0.39	0.94	3,168	3,164	3,164	3,164
XFMR-A2AP	480	13,424	11.16	1.61	10,192	2.82	1.14	13,691	13,424	13,424	13,424
XFMR-A2AS	240	2,924	1.22	0.98	3,031	0.42	0.96	2,929	2,924	2,924	2,924
XFMR-A2BP	480	12,410	10.32	1.28	9,460	2.62	1.00	12,501	12,410	12,410	12,410
XFMR-A2BS	208	3,038	1.09	0.96	3,149	0.38	0.95	3,043	3,038	3,038	3,038
XFMR-A3AP	480	10,472	8.71	1.64	7,904	2.19	1.22	10,695	10,472	10,472	10,472
XFMR-A3AS	240	2,840	1.18	1.00	2,970	0.41	0.97	2,845	2,840	2,840	2,840
XFMR-B1AP	480	14,619	12.15	1.06	11,217	3.11	0.97	14,658	14,619	14,619	14,619
XFMR-B1AS	240	2,941	1.22	0.94	3,043	0.42	0.93	2,944	2,941	2,941	2,941
XFMR-B1BP	480	13,161	10.94	0.88	10,278	2.85	0.84	13,171	13,161	13,161	13,161

Fault Location Bus Name	Bus Voltage	3-Phase Amps	3-Phase MVA	3P X/R	SLG Amps	SLG MVA	SLG X/R	Mom Amps	---------3P Asym Amps--------		
									3 Cycles	5 Cycles	8 Cycles
XFMR-B1BS	208	3,053	1.10	0.92	3,159	0.38	0.92	3,057	3,053	3,053	3,053
XFMR-B2AP	480	9,356	7.78	0.95	6,997	1.94	0.88	9,369	9,356	9,356	9,356
XFMR-B2AS	240	2,783	1.16	0.93	2,928	0.41	0.93	2,786	2,783	2,783	2,783
XFMR-B2BP	480	8,718	7.25	0.84	6,612	1.83	0.81	8,723	8,718	8,718	8,718
XFMR-B2BS	208	2,905	1.05	0.91	3,052	0.37	0.92	2,908	2,905	2,905	2,905
XFMR-B3AP	480	8,479	7.05	1.55	6,258	1.73	1.08	8,624	8,479	8,479	8,479
XFMR-B3AS	240	2,752	1.14	1.00	2,906	0.40	0.98	2,757	2,752	2,752	2,752
XFMR-B8AP	480	6,507	5.41	1.31	4,707	1.30	1.01	6,562	6,507	6,507	6,507
XFMR-B8AS	240	3,088	1.28	1.15	3,353	0.46	1.13	3,101	3,088	3,088	3,088
XFMR-B8BP	480	14,201	11.81	1.44	10,858	3.01	1.09	14,379	14,201	14,201	14,201
XFMR-B8BS	240	2,938	1.22	0.97	3,041	0.42	0.95	2,942	2,938	2,938	2,938
XFMR-UTILAP	12,470	1,000,228	21,603.59	5.00	1,000,222	7,201.16	5.00	1,252,981	1,000,759	1,000,231	1,000,228
XFMR-UTILAS	480	59,300	49.30	7.67	59,105	16.38	7.49	81,352	59,735	59,316	59,300
XFMR-UTILBP	12,470	1,000,205	21,603.10	5.00	1,000,199	7,200.99	5.00	1,252,949	1,000,736	1,000,208	1,000,205
XFMR-UTILBS	480	58,560	48.69	7.65	58,358	16.17	7.47	80,295	58,984	58,576	58,560

Project: 1001055
Utility - Motors OFF

DAPPER Unbalanced Fault Report

Comprehensive Short Circuit Study Settings

Three Phase Fault	Yes	**Faulted Bus**	All Buses
Single Line to Ground	Yes	**Bus Voltages**	First Bus From Fault
Line to Line Fault	No	**Branch Currents**	First Branch From Fault
Line to Line to Ground	No	**Phase or Sequence**	Report phase quantities
Motor Contribution	Yes	**Fault Current Calculation**	Asymmetrical RMS (with DC offset and Decay)
Transformer Tap	Yes	**Asym Fault Current at Time**	4.00 **Cycles**
Xformer Phase Shift	Yes		

Fault Location Bus Name	Bus Voltage	3-Phase Amps	3-Phase MVA	3P X/R	SLG Amps	SLG MVA	SLG X/R	Mom Amps	---------3P Asym Amps-------- 3 Cycles	5 Cycles	8 Cycles
AIR-COMP	480	7,325	6.09	1.27	5,414	1.50	0.99	7,376	7,325	7,325	7,325
ATS-B-7	480	3,716	3.09	0.74	2,766	0.77	0.75	3,717	3,716	3,716	3,716
CRANE-1	480	20,289	16.87	1.73	16,076	4.45	1.33	20,814	20,289	20,289	20,289
CRANE-2	480	20,289	16.87	1.73	16,076	4.45	1.33	20,814	20,289	20,289	20,289
CRANE-3	480	18,619	15.48	1.66	14,589	4.04	1.28	19,036	18,619	18,619	18,619
CRANE-4	480	18,619	15.48	1.66	14,589	4.04	1.28	19,036	18,619	18,619	18,619
DISC-100ABP	480	3,944	3.28	0.40	3,349	0.93	0.46	3,944	3,944	3,944	3,944
DISC-800ABP	480	29,128	24.22	2.06	24,529	6.80	1.64	30,483	29,128	29,128	29,128
GEN-1	480	0	0.00	0.00	0	0.00	000.00	0	0	0	0
PNL-A-1	480	24,455	20.33	2.44	20,335	5.64	1.62	26,258	24,455	24,455	24,455

Fault Location Bus Name	Bus Voltage	3-Phase Amps	3-Phase MVA	3P X/R	SLG Amps	SLG MVA	SLG X/R	Mom Amps	---------3P Asym Amps-------- 3 Cycles	5 Cycles	8 Cycles
PNL-A-1A	240	2,965	1.23	0.96	2,997	0.42	0.95	2,969	2,965	2,965	2,965
PNL-A-1B	208	2,972	1.07	0.90	2,992	0.36	0.89	2,975	2,972	2,972	2,972
PNL-A-2	480	14,022	11.66	1.91	10,823	3.00	1.27	14,535	14,022	14,022	14,022
PNL-A-2A	240	2,838	1.18	0.98	2,909	0.40	0.96	2,842	2,838	2,838	2,838
PNL-A-2B	208	2,861	1.03	0.92	2,917	0.35	0.90	2,864	2,861	2,861	2,861
PNL-A-3	480	10,232	8.51	1.76	7,693	2.13	1.17	10,518	10,232	10,232	10,232
PNL-A-3A	240	2,736	1.14	0.99	2,837	0.39	0.97	2,741	2,736	2,736	2,736
PNL-A-4	480	7,996	6.65	0.98	5,942	1.65	0.90	8,009	7,996	7,996	7,996
PNL-A-5	480	6,671	5.55	1.23	4,844	1.34	0.99	6,711	6,671	6,671	6,671
PNL-A-6	480	3,433	2.85	0.62	2,623	0.73	0.67	3,433	3,433	3,433	3,433
PNL-A-BLD	208	1,449	0.52	0.74	1,453	0.17	0.74	1,450	1,449	1,449	1,449
PNL-A-ILL	480	38,719	32.19	1.55	36,111	10.01	1.53	39,390	38,719	38,719	38,719
PNL-B-1	480	15,593	12.96	1.22	12,047	3.34	1.07	15,683	15,593	15,593	15,593
PNL-B-1A	240	2,854	1.19	0.94	2,920	0.40	0.93	2,857	2,854	2,854	2,854
PNL-B-1B	208	2,874	1.04	0.88	2,925	0.35	0.88	2,876	2,874	2,874	2,874
PNL-B-2	480	9,774	8.13	1.03	7,324	2.03	0.94	9,796	9,774	9,774	9,774
PNL-B-2A	240	2,705	1.12	0.93	2,814	0.39	0.92	2,708	2,705	2,705	2,705
PNL-B-2B	208	2,741	0.99	0.88	2,832	0.34	0.88	2,744	2,741	2,741	2,741
PNL-B-3	480	8,734	7.26	1.71	6,500	1.80	1.14	8,953	8,734	8,734	8,734
PNL-B-3A	240	2,676	1.11	1.00	2,794	0.39	0.97	2,681	2,676	2,676	2,676
PNL-B-4	480	7,815	6.50	0.98	5,801	1.61	0.90	7,828	7,815	7,815	7,815
PNL-B-5	480	10,053	8.36	1.04	7,544	2.09	0.94	10,077	10,053	10,053	10,053
PNL-B-6	480	6,724	5.59	1.40	4,901	1.36	1.04	6,799	6,724	6,724	6,724
PNL-B-7	480	3,602	2.99	0.72	2,693	0.75	0.74	3,603	3,602	3,602	3,602
PNL-B-8	480	16,216	13.48	2.01	12,713	3.52	1.33	16,911	16,216	16,216	16,216
PNL-B-8A	240	3,000	1.25	1.14	3,215	0.45	1.12	3,012	3,000	3,000	3,000
PNL-B-8B	240	2,540	1.06	0.95	2,485	0.34	0.92	2,544	2,540	2,540	2,540

Fault Location Bus Name	Bus Voltage	3-Phase Amps	3-Phase MVA	3P X/R	SLG Amps	SLG MVA	SLG X/R	Mom Amps	---------3P Asym Amps--------		
									3 Cycles	5 Cycles	8 Cycles
PNL-B-8C	240	1,964	0.82	0.82	1,864	0.26	0.82	1,965	1,964	1,964	1,964
PNL-B-BLD	208	1,449	0.52	0.74	1,453	0.17	0.74	1,449	1,449	1,449	1,449
PNL-B-ILL	480	37,927	31.53	1.56	35,160	9.74	1.52	38,590	37,927	37,927	37,927
PNL-TRAIL1	208	21,709	7.82	4.89	22,951	2.76	4.60	27,061	21,719	21,709	21,709
PNL-TRAIL2	208	21,709	7.82	4.89	22,951	2.76	4.60	27,061	21,719	21,709	21,709
SWBD-A	480	50,642	42.10	7.05	50,170	13.90	6.23	68,323	50,882	50,649	50,642
SWBD-B	480	49,393	41.06	6.57	48,630	13.48	5.49	65,682	49,552	49,397	49,393
XFMR-1AP	480	42,108	35.01	1.78	40,251	11.15	1.74	43,325	42,108	42,108	42,108
XFMR-1AS	208	1,466	0.53	0.75	1,473	0.18	0.75	1,467	1,466	1,466	1,466
XFMR-1BP	480	41,174	34.23	1.78	39,087	10.83	1.71	42,359	41,174	41,174	41,174
XFMR-1BS	208	1,466	0.53	0.75	1,473	0.18	0.75	1,466	1,466	1,466	1,466
XFMR-2BP	480	47,461	39.46	5.55	46,090	12.77	4.45	60,878	47,514	47,461	47,461
XFMR-2BS	208	22,504	8.11	5.48	24,159	2.90	5.48	28,785	22,527	22,504	22,504
XFMR-A1AP	480	21,812	18.13	1.83	17,722	4.91	1.35	22,504	21,812	21,812	21,812
XFMR-A1AS	240	3,051	1.27	0.97	3,121	0.43	0.95	3,056	3,051	3,051	3,051
XFMR-A1BP	480	19,321	16.06	1.25	15,716	4.36	1.05	19,448	19,321	19,321	19,321
XFMR-A1BS	208	3,157	1.14	0.95	3,232	0.39	0.94	3,161	3,157	3,157	3,157
XFMR-A2AP	480	13,057	10.86	1.66	9,998	2.77	1.17	13,347	13,057	13,057	13,057
XFMR-A2AS	240	2,916	1.21	0.99	3,025	0.42	0.97	2,921	2,916	2,916	2,916
XFMR-A2BP	480	12,112	10.07	1.32	9,300	2.58	1.02	12,215	12,112	12,112	12,112
XFMR-A2BS	208	3,031	1.09	0.96	3,144	0.38	0.95	3,036	3,031	3,031	3,031
XFMR-A3AP	480	9,698	8.06	1.60	7,261	2.01	1.11	9,886	9,698	9,698	9,698
XFMR-A3AS	240	2,809	1.17	1.00	2,948	0.41	0.98	2,815	2,809	2,809	2,809
XFMR-B1AP	480	14,248	11.85	1.10	11,000	3.05	1.00	14,296	14,248	14,248	14,248
XFMR-B1AS	240	2,933	1.22	0.94	3,037	0.42	0.94	2,937	2,933	2,933	2,933
XFMR-B1BP	480	12,881	10.71	0.91	10,106	2.80	0.87	12,894	12,881	12,881	12,881

Fault Location Bus Name	Bus Voltage	3-Phase Amps	3-Phase MVA	3P X/R	SLG Amps	SLG MVA	SLG X/R	Mom Amps	---------3P Asym Amps-------- 3 Cycles	5 Cycles	8 Cycles
XFMR-B1BS	208	3,047	1.10	0.92	3,154	0.38	0.92	3,050	3,047	3,047	3,047
XFMR-B2AP	480	9,209	7.66	0.98	6,916	1.92	0.90	9,224	9,209	9,209	9,209
XFMR-B2AS	240	2,776	1.15	0.93	2,923	0.41	0.93	2,780	2,776	2,776	2,776
XFMR-B2BP	480	8,597	7.15	0.87	6,542	1.81	0.83	8,603	8,597	8,597	8,597
XFMR-B2BS	208	2,899	1.04	0.92	3,047	0.37	0.92	2,902	2,899	2,899	2,899
XFMR-B3AP	480	8,339	6.93	1.57	6,188	1.71	1.09	8,492	8,339	8,339	8,339
XFMR-B3AS	240	2,746	1.14	1.01	2,901	0.40	0.98	2,751	2,746	2,746	2,746
XFMR-B8AP	480	6,428	5.34	1.33	4,668	1.29	1.02	6,486	6,428	6,428	6,428
XFMR-B8AS	240	3,080	1.28	1.15	3,346	0.46	1.14	3,093	3,080	3,080	3,080
XFMR-B8BP	480	13,820	11.49	1.48	10,648	2.95	1.11	14,016	13,820	13,820	13,820
XFMR-B8BS	240	2,930	1.22	0.97	3,035	0.42	0.96	2,935	2,930	2,930	2,930
XFMR-UTILAP	12,470	1,000,000	21,598.67	5.00	1,000,000	7,199.56	5.00	1,252,685	1,000,531	1,000,004	1,000,000
XFMR-UTILAS	480	52,648	43.77	7.99	52,648	14.59	7.99	72,781	53,116	52,668	52,648
XFMR-UTILBP	12,470	1,000,000	21,598.67	5.00	1,000,000	7,199.56	5.00	1,252,685	1,000,531	1,000,004	1,000,000
XFMR-UTILBS	480	52,648	43.77	7.99	52,648	14.59	7.99	72,781	53,116	52,668	52,648

Project: 1001055
Generator

DAPPER Unbalanced Fault Report

Comprehensive Short Circuit Study Settings

Three Phase Fault	Yes	**Faulted Bus**	All Buses
Single Line to Ground	Yes	**Bus Voltages**	First Bus From Fault
Line to Line Fault	No	**Branch Currents**	First Branch From Fault
Line to Line to Ground	No	**Phase or Sequence**	Report phase quantities
Motor Contribution	Yes	**Fault Current Calculation**	Asymmetrical RMS (with DC offset and Decay)
Transformer Tap	Yes	**Asym Fault Current at Time**	4.00 **Cycles**
Xformer Phase Shift	Yes		

Fault Location Bus Name	Bus Voltage	3-Phase Amps	3-Phase MVA	3P X/R	SLG Amps	SLG MVA	SLG X/R	Mom Amps	---------3P Asym Amps-------- 3 Cycles	5 Cycles	8 Cycles
ATS-B-7	480	1,135	0.94	2.93	1,168	0.32	2.83	1,261	1,135	1,135	1,135
CRANE-1	480	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
CRANE-2	480	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
CRANE-3	480	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
CRANE-4	480	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
DISC-100ABP	480	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
DISC-800ABP	480	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
GEN-1	480	1,142	0.95	3.02	1,177	0.33	2.92	1,276	1,142	1,142	1,142
PNL-A-1	480	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
PNL-A-1A	240	0	0.00	0.00	0	0.00	)00.00	0	0	0	0

Fault Location Bus Name	Bus Voltage	3-Phase Amps	3-Phase MVA	3P X/R	SLG Amps	SLG MVA	SLG X/R	Mom Amps	---------3P Asym Amps-------- 3 Cycles	5 Cycles	8 Cycles
PNL-A-1B	208	0	0.00	0.00	0	0.00	000.00	0	0	0	0
PNL-A-2	480	0	0.00	0.00	0	0.00	000.00	0	0	0	0
PNL-A-2A	240	0	0.00	0.00	0	0.00	000.00	0	0	0	0
PNL-A-2B	208	0	0.00	0.00	0	0.00	000.00	0	0	0	0
PNL-A-3	480	0	0.00	0.00	0	0.00	000.00	0	0	0	0
PNL-A-3A	240	0	0.00	0.00	0	0.00	000.00	0	0	0	0
PNL-A-4	480	0	0.00	0.00	0	0.00	000.00	0	0	0	0
PNL-A-5	480	0	0.00	0.00	0	0.00	000.00	0	0	0	0
PNL-A-6	480	0	0.00	0.00	0	0.00	000.00	0	0	0	0
PNL-A-BLD	208	0	0.00	0.00	0	0.00	000.00	0	0	0	0
PNL-A-ILL	480	0	0.00	0.00	0	0.00	000.00	0	0	0	0
PNL-B-1	480	0	0.00	0.00	0	0.00	000.00	0	0	0	0
PNL-B-1A	240	0	0.00	0.00	0	0.00	000.00	0	0	0	0
PNL-B-1B	208	0	0.00	0.00	0	0.00	000.00	0	0	0	0
PNL-B-2	480	0	0.00	0.00	0	0.00	000.00	0	0	0	0
PNL-B-2A	240	0	0.00	0.00	0	0.00	000.00	0	0	0	0
PNL-B-2B	208	0	0.00	0.00	0	0.00	000.00	0	0	0	0
PNL-B-3	480	0	0.00	0.00	0	0.00	000.00	0	0	0	0
PNL-B-3A	240	0	0.00	0.00	0	0.00	000.00	0	0	0	0
PNL-B-4	480	0	0.00	0.00	0	0.00	000.00	0	0	0	0
PNL-B-5	480	0	0.00	0.00	0	0.00	000.00	0	0	0	0
PNL-B-6	480	0	0.00	0.00	0	0.00	000.00	0	0	0	0
PNL-B-7	480	1,129	0.94	2.84	1,160	0.32	2.75	1,247	1,129	1,129	1,129
PNL-B-8	480	0	0.00	0.00	0	0.00	000.00	0	0	0	0
PNL-B-8A	240	0	0.00	0.00	0	0.00	000.00	0	0	0	0
PNL-B-8B	240	0	0.00	0.00	0	0.00	000.00	0	0	0	0
PNL-B-8C	240	0	0.00	0.00	0	0.00	000.00	0	0	0	0

Fault Location Bus Name	Bus Voltage	3-Phase Amps	3-Phase MVA	3P X/R	SLG Amps	SLG MVA	SLG X/R	Mom Amps	---------3P Asym Amps-------- 3 Cycles	5 Cycles	8 Cycles
PNL-B-BLD	208	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
PNL-B-ILL	480	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
PNL-TRAIL1	208	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
PNL-TRAIL2	208	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
SWBD-A	480	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
SWBD-B	480	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-1AP	480	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-1AS	208	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-1BP	480	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-1BS	208	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-2BP	480	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-2BS	208	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-A1AP	480	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-A1AS	240	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-A1BP	480	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-A1BS	208	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-A2AP	480	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-A2AS	240	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-A2BP	480	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-A2BS	208	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-A3AP	480	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-A3AS	240	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-B1AP	480	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-B1AS	240	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-B1BP	480	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-B1BS	208	0	0.00	0.00	0	0.00	)00.00	0	0	0	0

Fault Location Bus Name	Bus Voltage	3-Phase Amps	3-Phase MVA	3P X/R	SLG Amps	SLG MVA	SLG X/R	Mom Amps	---------3P Asym Amps-------- 3 Cycles	5 Cycles	8 Cycles
XFMR-B2AP	480	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-B2AS	240	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-B2BP	480	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-B2BS	208	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-B3AP	480	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-B3AS	240	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-B8AP	480	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-B8AS	240	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-B8BP	480	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-B8BS	240	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-UTILAP	12,470	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-UTILAS	480	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-UTILBP	12,470	0	0.00	0.00	0	0.00	)00.00	0	0	0	0
XFMR-UTILBS	480	0	0.00	0.00	0	0.00	)00.00	0	0	0	0

TAB 6

SC Import Adjustment: 100%
Scenario 1: Utility - Motors ON
Scenario 2: Utility - Motors OFF
Scenario 3: Generator

Medium Voltage Equipment Short Circuit Summary List

Node ID	Node Name	Volts	Type of Device	Equip Rating (KA) Int Sym	Equip Rating (KA) Int/ C+L Asym	Equip Rating (KA) With Asym	Equip Rating (KA) ST 10 CY	Int Time	Cont Part Time	X/R Ratio	1/2 Cycle Sym(KA) (AC Comp)	1/2 Cycle Asym (KA)	I @ Cont Parting Time	Calc Int Value	S#	Type Of Fault	Equipment Underrated? Int Sym	Equipment Underrated? Int/ C+L Asym	Equipment Underrated? With Asym	Equipment Underrated? ST 10 CY
UTIL-PUDA	UTILITY PUDA	12470	N/A																	
		Comment:																		
UTIL-PUDB	UTILITY PUDB	12470	N/A																	
		Comment:																		
XFMR-UTILA	XFMR UTILA PRI	12470	FUSE	3.5	5.6					5.00	1,000.2	1,253.0			1	3 P	Yes	Yes		
		Comment: UTILITY'S RESPONSIBILITY																		
XFMR-UTILB	XFMR UTILB PRI	12470	FUSE	3.5	5.6					5.00	1,000.2	1,252.9			1	3 P	Yes	Yes		
		Comment: UTILITY'S RESPONSIBILITY																		

SC Import Adjustment: 100%
Scenario 1: Utility - Motors ON
Scenario 2: Utility - Motors OFF
Scenario 3: Generator

Low Voltage Equipment Short Circuit Summary List

Node ID	Node Name	Volts	Type of Device	Cat	Equip Rating With	Equip Rating Int	X/R Ratio	1/2 Cycle Sym (KA) (ACComp)	1/2 Cycle Asym (KA)	MF	1/2 Cycle Sym (KA) X MF	S#	Type Of Fault	Equipment Underrated? With	Equipment Underrated? Int
AIR-COMP	AIR COMPRESSOR	480	MCCB	3		14.0	1.38	8.0	8.1	1	8.0	1	3 Phase		
		Comment: CUT/HAM MOTOR CIRCUIT PROTECTOR; ASSUMED 14KAIC													
ATS-B-7	ATS B-7	480	ATS		5.0		0.73	3.7	3.7			1	3 Phase		
		Comment: Assummed minimum withstand rating													
CRANE-1	CRANE 1	480	N/A				1.92	23.8	24.7			1	3 Phase		
		Comment:													
CRANE-2	CRANE 2	480	N/A				1.92	23.8	24.7			1	3 Phase		
		Comment:													
CRANE-3	CRANE 3	480	N/A				1.88	22.0	22.8			1	3 Phase		
		Comment:													
CRANE-4	CRANE 4	480	N/A				1.88	22.0	22.8			1	3 Phase		
		Comment:													
DISC-100AB	DISC 100A BP	480	N/A				0.39	4.0	4.0			1	3 Phase		
		Comment: Non-fused Disconnect													
DISC-800AB	DISC 800A BP	480	N/A				1.95	31.1	32.3			1	3 Phase		
		Comment: Non-fused Disconnect													
GEN-1	GEN 1	480	MCCB	2		100.0	2.92	1.2	1.3	1	1.2	3	Line To Ground		
		Comment:													
GENERATO	GENERATOR 1	480	N/A												
		Comment:													

Low Voltage Equipment Short Circuit Summary List

Node ID	Node Name	Volts	Type of Device	Cat	Equip Rating With	Equip Rating Int	X/R Ratio	1/2 Cycle Sym (KA) (ACComp)	1/2 Cycle Asym (KA)	MF	1/2 Cycle Sym (KA) X MF	S#	Type Of Fault	Equipment Underrated? With	Equipment Underrated? Int
MTR-AIRCO	MOTOR AIR COMPR	480	N/A												
		Comment:													
MTR-CRANE	MOTOR CRANE1	480	N/A												
		Comment:													
MTR-CRANE	MOTOR CRANE2	480	N/A												
		Comment:													
MTR-CRANE	MOTOR CRANE3	480	N/A												
		Comment:													
MTR-CRANE	MOTOR CRANE4	480	N/A												
		Comment:													
MTRS-PNL-B	PANEL B4 MOTORS	480	N/A												
		Comment:													
MTRS-PNL-B	PANEL B7 MOTORS	480	N/A												
		Comment:													
PNL-A-1	PANEL A-1	480	MCCB	2		35.0	2.34	25.9	27.6	1	25.9	1	3 Phase		
		Comment:													
PNL-A-1A	PANEL A-1A	240	MCCB	4		10.0	0.94	3.0	3.0	1	3.0	1	Line To Ground		
		Comment:													
PNL-A-1B	PANEL A-1B	208	MCCB	2		35.0	0.89	3.0	3.0	1	3.0	1	Line To Ground		
		Comment:													
PNL-A-2	PANEL A-2	480	MCCB	2		35.0	1.86	14.5	14.9	1	14.5	1	3 Phase		
		Comment:													

Low Voltage Equipment Short Circuit Summary List

Node ID	Node Name	Volts	Type of Device	Cat	Equip Rating With	Equip Rating Int	X/R Ratio	1/2 Cycle Sym (KA) (ACComp)	1/2 Cycle Asym (KA)	MF	1/2 Cycle Sym (KA) X MF	S#	Type Of Fault	Equipment Underrated? With	Equipment Underrated? Int
PNL-A-2A	PANEL A-2A	240	MCCB	4		10.0	0.95	2.9	2.9	1	2.9	1	Line To Ground		
		Comment:													
PNL-A-2B	PANEL A-2B	208	MCCB	2		35.0	0.90	2.9	2.9	1	2.9	1	Line To Ground		
		Comment:													
PNL-A-3	PANEL A-3	480	MCCB	2		35.0	1.83	11.1	11.4	1	11.1	1	3 Phase		
		Comment:													
PNL-A-3A	PANEL A-3A	240	MCCB	4		10.0	0.97	2.9	2.9	1	2.9	1	Line To Ground		
		Comment:													
PNL-A-4	PANEL A-4	480	MCCB	2		35.0	0.96	8.1	8.1	1	8.1	1	3 Phase		
		Comment:													
PNL-A-5	PANEL A-5	480	MCCB	2		35.0	1.21	6.8	6.8	1	6.8	1	3 Phase		
		Comment:													
PNL-A-6	PANEL A-6	480	MCCB	2		35.0	0.61	3.4	3.5	1	3.4	1	3 Phase		
		Comment:													
PNL-A-BLD	PANEL A BUILDING	208	MCCB	4		10.0	0.74	1.5	1.5	1	1.5	1	Line To Ground		
		Comment:													
PNL-A-ILL	PANEL A ILLUMINA	480	MCCB	2		65.0	1.42	42.1	42.6	1	42.1	1	3 Phase		
		Comment:													
PNL-B-1	PANEL B-1	480	MCCB	2		35.0	1.18	16.1	16.1	1	16.1	1	3 Phase		
		Comment:													
PNL-B-1A	PANEL B-1A	240	MCCB	4		10.0	0.93	2.9	2.9	1	2.9	1	Line To Ground		
		Comment:													

Low Voltage Equipment Short Circuit Summary List

Node ID	Node Name	Volts	Type of Device	Cat	Equip Rating With	Equip Rating Int	X/R Ratio	1/2 Cycle Sym (KA) (ACComp)	1/2 Cycle Asym (KA)	MF	1/2 Cycle Sym (KA) X MF	S#	Type Of Fault	Equipment Underrated? With	Equipment Underrated? Int
PNL-B-1B	PANEL B-1B	208	MCCB	2		35.0	0.88	2.9	2.9	1	2.9	1	Line To Ground		
		Comment:													
PNL-B-2	PANEL B-2	480	MCCB	2		35.0	1.01	9.9	10.0	1	9.9	1	3 Phase		
		Comment:													
PNL-B-2A	PANEL B-2A	240	MCCB	4		10.0	0.92	2.8	2.8	1	2.8	1	Line To Ground		
		Comment:													
PNL-B-2B	PANEL B-2B	208	MCCB	2		35.0	0.88	2.8	2.8	1	2.8	1	Line To Ground		
		Comment:													
PNL-B-3	PANEL B-3	480	MCCB	2		35.0	1.68	8.9	9.1	1	8.9	1	3 Phase		
		Comment:													
PNL-B-3A	PANEL B-3A	240	MCCB	4		10.0	0.97	2.8	2.8	1	2.8	1	Line To Ground		
		Comment:													
PNL-B-4	PANEL B-4	480	MCCB	2		35.0	0.96	7.9	7.9	1	7.9	1	3 Phase		
		Comment:													
PNL-B-5	PANEL B-5	480	MCCB	2		35.0	1.02	10.2	10.3	1	10.2	1	3 Phase		
		Comment:													
PNL-B-6	PANEL B-6	480	MCCB	2		35.0	1.38	6.8	6.9	1	6.8	1	3 Phase		
		Comment:													
PNL-B-7	PANEL B-7	480	MCCB	2		35.0	0.71	3.6	3.6	1	3.6	1	3 Phase		
		Comment:													
PNL-B-8	PANEL B-8	480	MCCB	2		35.0	1.95	16.8	17.4	1	16.8	1	3 Phase		
		Comment:													

Low Voltage Equipment Short Circuit Summary List

Node ID	Node Name	Volts	Type of Device	Cat	Equip Rating With	Equip Rating Int	X/R Ratio	1/2 Cycle Sym (KA) (ACComp)	1/2 Cycle Asym (KA)	MF	1/2 Cycle Sym (KA) X MF	S#	Type Of Fault	Equipment Underrated? With	Equipment Underrated? Int
PNL-B-8A	PANEL B-8A	240	MCCB	4		10.0	1.12	3.2	3.2	1	3.2	1	Line To Ground		
		Comment:													
PNL-B-8B	PANEL B-8B	240	MCCB	4		10.0	0.94	2.5	2.5	1	2.5	1	3 Phase		
		Comment:													
PNL-B-8C	PANEL B-8C	240	MCCB	4		10.0	0.82	2.0	2.0	1	2.0	1	3 Phase		
		Comment:													
PNL-B-BLD	PANEL B BUILDING	208	MCCB	4		10.0	0.74	1.5	1.5	1	1.5	1	Line To Ground		
		Comment:													
PNL-B-ILL	PANEL B ILLUMINA	480	MCCB	2		100.0	1.43	41.0	41.5	1	41.0	1	3 Phase		
		Comment:													
PNL-TRAIL1	PANEL TRAILER 1	208	MCCB	2		65.0	4.57	23.3	28.6	1	23.3	1	Line To Ground		
		Comment:													
PNL-TRAIL2	PANEL TRAILER 2	208	MCCB	2		65.0	4.57	23.3	28.6	1	23.3	1	Line To Ground		
		Comment:													
SWBD-A	SWBD A	480	MCCB	2		65.0	6.89	57.3	77.0	1.07	61.3	1	3 Phase		
		Comment:													
SWBD-B	SWBD B	480	MCCB	2		65.0	6.45	55.4	73.3	1.058	58.6	1	3 Phase		
		Comment:													
XFMR-1AP	XFMR 1A PRI	480	N/A				1.62	46.2	47.2			1	3 Phase		
		Comment:													
XFMR-1AS	XFMR 1A SEC	208	N/A				0.75	1.5	1.5			1	Line To Ground		
		Comment:													

Low Voltage Equipment Short Circuit Summary List

Node ID	Node Name	Volts	Type of Device	Cat	Equip Rating With	Equip Rating Int	X/R Ratio	1/2 Cycle Sym (KA) (ACComp)	1/2 Cycle Asym (KA)	MF	1/2 Cycle Sym (KA) X MF	S#	Type Of Fault	Equipment Underrated? With	Equipment Underrated? Int
XFMR-1BP	XFMR 1B PRI	480	N/A				1.64	44.9	45.8			1	3 Phase		
		Comment:													
XFMR-1BS	XFMR 1B SEC	208	N/A				0.75	1.5	1.5			1	Line To Ground		
		Comment:													
XFMR-2BP	XFMR 2B PRI	480	N/A				5.38	52.9	67.4			1	3 Phase		
		Comment:													
XFMR-2BS	XFMR 2B SEC	208	N/A				5.46	24.5	31.3			1	Line To Ground		
		Comment:													
XFMR-A1AP	XFMR A1A PRI	480	N/A				1.75	22.9	23.5			1	3 Phase		
		Comment:													
XFMR-A1AS	XFMR A1A SEC	240	N/A				0.95	3.1	3.1			1	Line To Ground		
		Comment:													
XFMR-A1BP	XFMR A1B PRI	480	N/A				1.19	20.1	20.2			1	3 Phase		
		Comment:													
XFMR-A1BS	XFMR A1B SEC	208	N/A				0.94	3.2	3.2			1	Line To Ground		
		Comment:													
XFMR-A2AP	XFMR A2A PRI	480	N/A				1.61	13.4	13.7			1	3 Phase		
		Comment:													
XFMR-A2AS	XFMR A2A SEC	240	N/A				0.96	3.0	3.0			1	Line To Ground		
		Comment:													
XFMR-A2BP	XFMR A2B PRI	480	N/A				1.28	12.4	12.5			1	3 Phase		
		Comment:													

Low Voltage Equipment Short Circuit Summary List

Node ID	Node Name	Volts	Type of Device	Cat	Equip Rating With	Equip Rating Int	X/R Ratio	1/2 Cycle Sym (KA) (ACComp)	1/2 Cycle Asym (KA)	MF	1/2 Cycle Sym (KA) X MF	S#	Type Of Fault	Equipment Underrated? With	Equipment Underrated? Int
XFMR-A2BS	XFMR A2B SEC	208	N/A				0.95	3.1	3.2			1	Line To Ground		
		Comment:													
XFMR-A3AP	XFMR A3A PRI	480	N/A				1.64	10.5	10.7			1	3 Phase		
		Comment:													
XFMR-A3AS	XFMR A3A SEC	240	N/A				0.97	3.0	3.0			1	Line To Ground		
		Comment:													
XFMR-B1AP	XFMR B1A PRI	480	N/A				1.06	14.6	14.7			1	3 Phase		
		Comment:													
XFMR-B1AS	XFMR B1A SEC	240	N/A				0.93	3.0	3.0			1	Line To Ground		
		Comment:													
XFMR-B1BP	XFMR B1B PRI	480	N/A				0.88	13.2	13.2			1	3 Phase		
		Comment:													
XFMR-B1BS	XFMR B1B SEC	208	N/A				0.92	3.2	3.2			1	Line To Ground		
		Comment:													
XFMR-B2AP	XFMR B2A PRI	480	N/A				0.95	9.4	9.4			1	3 Phase		
		Comment:													
XFMR-B2AS	XFMR B2A SEC	240	N/A				0.93	2.9	2.9			1	Line To Ground		
		Comment:													
XFMR-B2BP	XFMR B2B PRI	480	N/A				0.84	8.7	8.7			1	3 Phase		
		Comment:													
XFMR-B2BS	XFMR B2B SEC	208	N/A				0.92	3.1	3.1			1	Line To Ground		
		Comment:													

Low Voltage Equipment Short Circuit Summary List

Node ID	Node Name	Volts	Type of Device	Cat	Equip Rating With	Equip Rating Int	X/R Ratio	1/2 Cycle Sym (KA) (ACComp)	1/2 Cycle Asym (KA)	MF	1/2 Cycle Sym (KA) X MF	S#	Type Of Fault	Equipment Underrated? With	Equipment Underrated? Int
XFMR-B3AP	XFMR B3A PRI	480	N/A				1.55	8.5	8.6			1	3 Phase		
		Comment:													
XFMR-B3AS	XFMR B3A SEC	240	N/A				0.98	2.9	2.9			1	Line To Ground		
		Comment:													
XFMR-B8AP	XFMR B8A PRI	480	N/A				1.31	6.5	6.6			1	3 Phase		
		Comment:													
XFMR-B8AS	XFMR B8A SEC	240	N/A				1.13	3.4	3.4			1	Line To Ground		
		Comment:													
XFMR-B8BP	XFMR B8B PRI	480	N/A				1.44	14.2	14.4			1	3 Phase		
		Comment:													
XFMR-B8BS	XFMR B8B SEC	240	N/A				0.95	3.0	3.0			1	Line To Ground		
		Comment:													
XFMR-UTILA	XFMR UTILA SEC	480	N/A				7.67	59.3	81.4			1	3 Phase		
		Comment:													
XFMR-UTILB	XFMR UTILB SEC	480	N/A				7.65	58.6	80.3			1	3 Phase		
		Comment:													

TAB 7

PROTECTIVE DEVICE COORDINATION STUDY

Time Current Curve Discussion

The determination of a particular setting is based upon a careful balancing of the competing goals of equipment protection and pure selectivity. There are many codes that specifically define the required limits of equipment protection. Examples of these are the National Electric Code (NEC) for cable, motor, and transformer protection. The American National Standards Institute (ANSI) also has requirements for protection of transformers due to short circuits and through faults. The engineer considered these standard codes and requirements. Their applications are graphically demonstrated on the time current curves. Time current curves are logarithmic graphs of time versus current. The graphs show the devices' operational characteristic curves. The curves graphically illustrate the coordination between the devices.

The engineer made every attempt to utilize the existing equipment and determine settings to meet present day requirements and practices. The engineer must maintain a coordination margin (dependent on device type) among device characteristic curves. This ensures that only the desired unit operates and prevents more of the system from being de-energized.

The coordination study required calculating the short circuit values at the equipment and plotting these values on time current curves. The engineer plotted fuse, transformer protection, relay, and circuit breaker curves, starting from the end load and working towards the main switchgear. The study was done on the 480, and 208-volt equipment shown on the one line drawing. The study contains time current curves, copies of the manufacturers' time current curves and tables of the low voltage circuit breaker settings.

The protective device coordination study was performed using the SKM PowerTools CAPTORS program. SKM Power Tools is a collection of programs that are used for design and analysis of power systems. The software was written and is distributed by SKM Systems Analysis Inc. of Manhattan Beach, CA.

The Time Current Curve (TCC) sheet #1 shows the plots of the fuse, transformer and downstream 480-Volt equipment. A typical curve shows the primary device followed by other devices downstream. A TCC ID # identifies each device on the curve. This ID number is used to locate the device in the equipment data/settings table and on the time current curve. Each time current curve contains a small one-line diagram that shows the plotted devices.

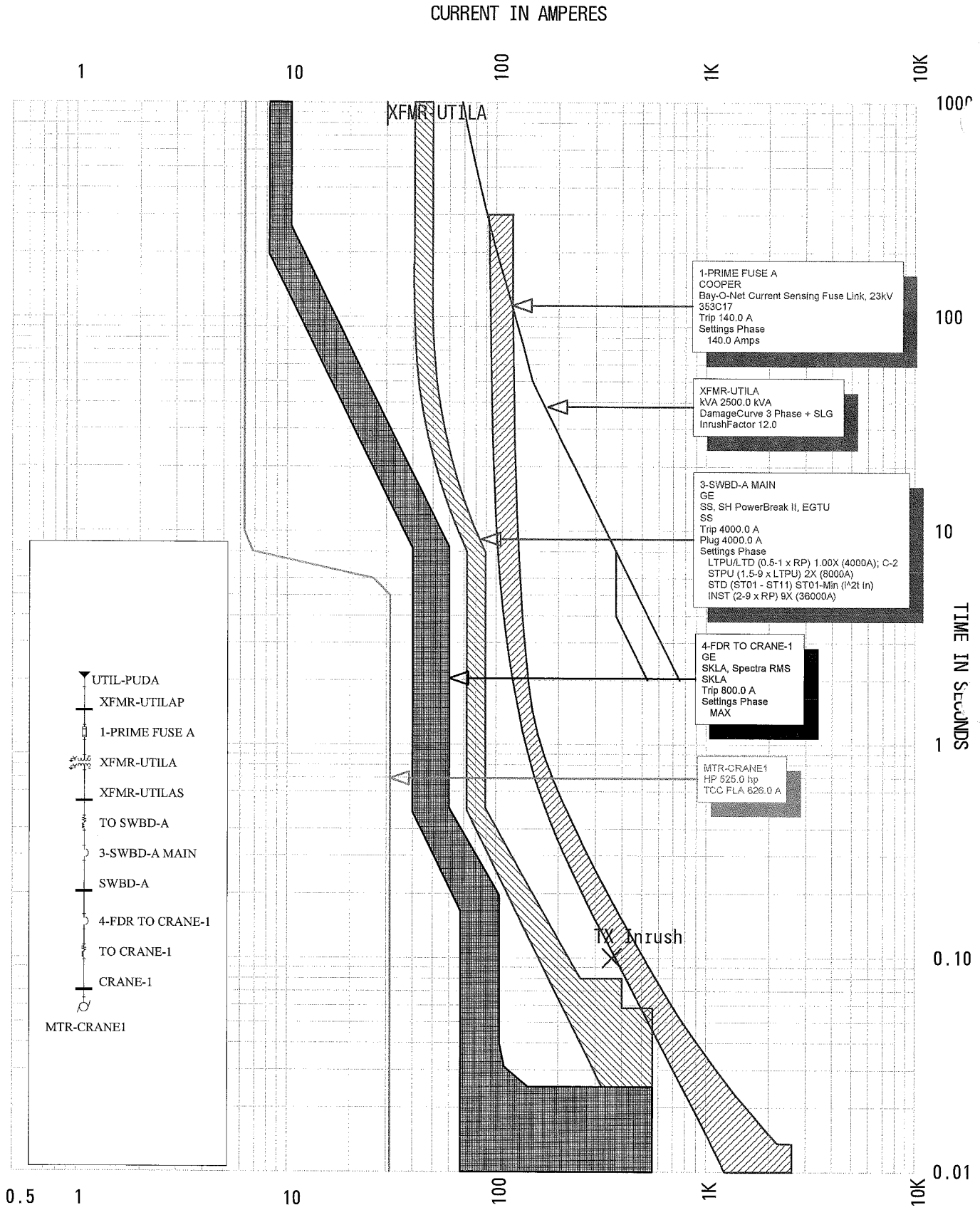
In general, most of the devices will not selectively coordinate in the instantaneous region. This is considered a tolerable situation in most cases due to the operating characteristics of these devices in that region. However, for elevator circuits, emergency systems, and

legally required standby systems this is not acceptable per NEC code 620.62 (People Transporting Equipment), 700.27 (Emergency Systems), and 701.18 (Legally Required Standby Systems). For these areas, selective coordination is required and the protective device curves shall not overlap. In the discussions that follow, no reference will be made to this issue unless the situation merits further comment.

Discussion of Time Current Curves

TCC#	1	**Equipment Name**	**Circuit Description**
Device#	1	XFMR-UTILAP	PRIME FUSE
	2	XFMR-UTILAP	Transformer Damage Curve
	3	SWBD-A	MAIN
	4	SWBD-A	CRANE 1
	5	MTR-CRANE1	Motor Starting Curve

There is overlap between the utility fuse (Device #1) and Switchboard A main breaker (Device #3). This overlap is considered acceptable since they are in series, if either devices trip, they will have the same affect. The curve also show the crane's motor starting curve with the assumption that the equipment doesn't have a VFD to minimize the inrush current.



TCC Sheet: 1-Utility Transformer, Transformer Damage Curve, SWBD-A Main, Feeder to Crane1, Crane1 Mtr Starter

Oneline: TCC1
March 2, 2011 11:18 AM
SKM Systems Analysis, Inc.

Current Scale x 100
Reference Voltage: 480
Fault Type: InitSym 3P

PowerStudies.com PS
Phone 253-639-8535 ■ Fax 253-639-8685 ■ 16122 SE 266th St, Covington, WA 98042

TAB 8

Solid State & Thermal/Magnetic Molded Case Circuit Breaker Settings (with Instantaneous Settings only)

• **Feeder Breakers Feeding Panelboards***	**Set instantaneous to Maximum**
• **Feeder Breakers Feeding Dry type transformers***	**Set instantaneous to Maximum**
• **Panelboard Main Breakers* -**	**Set instantaneous to Maximum**

• **Branch Breakers ***	**Set instantaneous to Minimum**

•Breaker Pick Up or Overload Settings for Motor Circuits*	
Motor Service Factor – 1.15	**Setting <125% x I(nameplate Amps)** (Up to 140% if nuisance tripping occurs)
Motor with Temp Rise 40° C	**Setting <125% x I(nameplate Amps)** (Up to 140% if nuisance tripping occurs)
All other Motors	**Setting <115% x I(nameplate Amps)** (Up to 130% if nuisance tripping occurs)

•Breaker Overcurrent for Motor Circuits*	
Inverse Time Breaker	**Setting <250% x I(nameplate Amps)**
Instantaneous Trip Breaker	**Setting <800% x I(nameplate Amps)** (For non Design E or B Energy Efficiency Motors) **Setting <1,100% x I(nameplate Amps)** (For Design E or B Energy Efficiency Motors)
Combination Controller - Instantaneous Trip Breaker (NEC Table 430.52 Exception if motor trips using the values above.)	**Setting <1,300% x I(nameplate Amps)** (For non Design E or B Energy Efficiency) **Setting <1,700% x I(nameplate Amps)** (For Design E or B Energy Efficiency Motors)

* - Use these settings above if no other settings are specified on the following device setting sheets.

Job Number: 1001055 Title: SR 520 Pontoon Project, Aberdeen, WA

Equipment Group	Vault Number	Building Number	Column	Floor
SR 520 Pontoon Project				

Equipment Name: Switchboard

Node ID	Node Name	Manufacturer	Type	Assumed Data	Comments
SWBD-A	SWBD A			☐	

Voltage	Main Amp	Sect Amp	Ntrl Amp	Interrupting Rating	Withstand Rating	LV DeviceType	Serial or Shop #	Year Installed
480				65.0		MCCB		

SWBD-A Low Voltage Circuit Breaker Data

Circuit Description	Posi-tion	Man or Elec	Mfg., Type	Frame Amps	Int Amps	Circt Amps	Abbreviated Trip Type	Mag Trip or Curr Sens Rating	Sens Tap or Rating Plug	Current Setting	Long Time Pkup	Long Time Delay	Short Time Pkup	Short Time Delay	Short Time I2T	Inst tanan eous Pkup	Inst tanan eous Delay	Grnd Fault Sensr	Grnd Fault Pkup	Grnd Fault Delay	Grnd Fault I2T	As sum ed Data
BATCH PLANT			GE SKL8	800	65000	800	RMS-1	800	800	N/A	FIXED	FIXED	FIXED	N/A	FIXED	MAX	FIXED	N/A	N/A	N/A	N/A	☐
CRANE 1			GE SKL8	800	65000	800	RMS-1	800	800	N/A	FIXED	FIXED	FIXED	N/A	FIXED	MAX	FIXED	N/A	N/A	N/A	N/A	☐
Device#: 4 TCC#(s): 1																						
CRANE 2			GE SKL8	800	65000	800	RMS-1	800	800	N/A	FIXED	FIXED	FIXED	N/A	FIXED	MAX	FIXED	N/A	N/A	N/A	N/A	☐
MAIN			GE SS 4000	4000	100000	4000	Entelliguard TU	4000	4000	N/A	1.00X	C-2	2X	ST01-MIN	IN	9X	FIXED	4000	0.3	GFD03	IN	☐
Device#: 3 TCC#(s): 1 Other: LSIG																						
PANEL A BUILDING			GE SELA 60	60	65000	50	RMS-1	60	50	N/A	FIXED	FIXED	FIXED	N/A	FIXED	MAX	FIXED	N/A	N/A	N/A	N/A	☐
PANEL A ILLUMINA			GE SFLA	250	65000	70	RMS-1	250	70	N/A	FIXED	FIXED	FIXED	N/A	FIXED	MAX	FIXED	N/A	N/A	N/A	N/A	☐
PANEL A-1			GE SGL6	600	65000	350	RMS-1	400	350	N/A	FIXED	FIXED	FIXED	N/A	FIXED	MAX	FIXED	N/A	N/A	N/A	N/A	☐
PANEL A-2			GE SGL6	600	65000	350	RMS-1	400	350	N/A	FIXED	FIXED	FIXED	N/A	FIXED	MAX	FIXED	N/A	N/A	N/A	N/A	☐
PANEL A-3			GE SGL6	600	65000	350	RMS-1	400	350	N/A	FIXED	FIXED	FIXED	N/A	FIXED	MAX	FIXED	N/A	N/A	N/A	N/A	☐
PANEL A-4			GE SGL6	600	65000	250	RMS-1	400	250	N/A	FIXED	FIXED	FIXED	N/A	FIXED	MAX	FIXED	N/A	N/A	N/A	N/A	☐
PANEL A-5			GE SGL6	600	65000	250	RMS-1	400	250	N/A	FIXED	FIXED	FIXED	N/A	FIXED	MAX	FIXED	N/A	N/A	N/A	N/A	☐
PANEL A-6			GE SFLA	250	25000	100	RMS-1	250	100	N/A	FIXED	FIXED	FIXED	N/A	FIXED	MAX	FIXED	N/A	N/A	N/A	N/A	☐

Equipment Group	Vault Number	Building Number	Column	Floor
SR 520 Pontoon Project				

Equipment Name: Switchboard

Node ID	Node Name	Manufacturer	Type	Assumed Data	Comments
SWBD-B	SWBD B			☐	

Voltage	Main Amp	Sect Amp	Ntrl Amp	Interrupting Rating	Withstand Rating	LV DeviceType	Serial or Shop #	Year Installed
480				65.0		MCCB		

SWBD-B Low Voltage Circuit Breaker Data

Circuit Description	Posi-tion	Man or Elec	Mfg., Type	Frame Amps	Int Amps	Circt Amps	Abbreviated Trip Type	Mag Trip or Curr Sens Rating	Sens Tap or Rating Plug	Current Setting	Long Time Pkup	Long Time Delay	Short Time Pkup	Short Time Delay	Short Time I2T	Inst tanan eous Pkup	Inst tanan eous Delay	Grnd Fault Sensr	Grnd Fault Pkup	Grnd Fault Delay	Grnd Fault I2T	As sum ed Data
CRANE 3			GE SKL8	800	65000	800	RMS-1	800	800	N/A	FIXED	FIXED	FIXED	N/A	FIXED	MAX	FIXED	N/A	N/A	N/A	N/A	☐
CRANE 4			GE SKL8	800	65000	800	RMS-1	800	800	N/A	FIXED	FIXED	FIXED	N/A	FIXED	MAX	FIXED	N/A	N/A	N/A	N/A	☐
MAIN			GE SS 4000	4000	100000	4000	Entelliguard TU	4000	4000	N/A	1.00X	C-2	2X	ST01-MIN	IN	9X	FIXED	4000	0.3	GFD03	IN	☐
Other: LSIG																						
PANEL B BUILDING			GE SELA 60	60	65000	50	RMS-1	60	50	N/A	FIXED	FIXED	FIXED	N/A	FIXED	MAX	FIXED	N/A	N/A	N/A	N/A	☐
PANEL B ILLUMINA			GE SFLA	250	65000	70	RMS-1	250	70	N/A	FIXED	FIXED	FIXED	N/A	FIXED	MAX	FIXED	N/A	N/A	N/A	N/A	☐
PANEL B-1			GE SGL6	600	65000	250	RMS-1	400	250	N/A	FIXED	FIXED	FIXED	N/A	FIXED	MAX	FIXED	N/A	N/A	N/A	N/A	☐
PANEL B-2			GE SGL6	600	65000	250	RMS-1	400	250	N/A	FIXED	FIXED	FIXED	N/A	FIXED	MAX	FIXED	N/A	N/A	N/A	N/A	☐
PANEL B-3			GE SGL6	600	65000	350	RMS-1	400	350	N/A	FIXED	FIXED	FIXED	N/A	FIXED	MAX	FIXED	N/A	N/A	N/A	N/A	☐
PANEL B-4			GE SGL6	600	65000	250	RMS-1	400	250	N/A	FIXED	FIXED	FIXED	N/A	FIXED	MAX	FIXED	N/A	N/A	N/A	N/A	☐
PANEL B-5			GE SGL6	600	65000	250	RMS-1	400	250	N/A	FIXED	FIXED	FIXED	N/A	FIXED	MAX	FIXED	N/A	N/A	N/A	N/A	☐
PANEL B-6			GE SGL6	600	65000	250	RMS-1	400	250	N/A	FIXED	FIXED	FIXED	N/A	FIXED	MAX	FIXED	N/A	N/A	N/A	N/A	☐
PANEL B-7			GE SFLA	250	65000	100	RMS-1	250	100	N/A	FIXED	FIXED	FIXED	N/A	FIXED	MAX	FIXED	N/A	N/A	N/A	N/A	☐

Equipment Group	Vault Number	Building Number	Column	Floor
SR 520 Pontoon Project				

Equipment Name: **Switchboard**

SWBD-B Low Voltage Circuit Breaker Data (Continued)

Circuit Description	Posi-tion	Man or Elec	Mfg., Type	Frame Amps	Int Amps	Circt Amps	Abbreviated Trip Type	Mag Trip or Curr Sens Rating	Sens Tap or Rating Plug	Current Setting	Long Time Pkup	Long Time Delay	Short Time Pkup	Short Time Delay	Short Time I2T	Inst tanan eous Pkup	Inst tanan eous Delay	Grnd Fault Sensr	Grnd Fault Pkup	Grnd Fault Delay	Grnd Fault I2T	As sum ed Data
PANEL B-8			GE SGL6	600	65000	350	RMS-1	400	350	N/A	FIXED	FIXED	FIXED	N/A	FIXED	MAX	FIXED	N/A	N/A	N/A	N/A	☐
PANEL TRAILER			GE SGL6	600	65000	600	RMS-1	600	600	N/A	FIXED	FIXED	FIXED	N/A	FIXED	MAX	FIXED	N/A	N/A	N/A	N/A	☐

Equipment Group	Vault Number	Building Number	Column	Floor
SR 520 Pontoon Project				

Equipment Name: Transformer

Primary	Secondary	Name	Type	Serial Number	Manufacturer	KVA (Air)	KVA (Fans)	KVA (Pumps)	Cool	Temp Rise
XFMR-UTILAP	**XFMR-UTILAS**	XFMR-UTILA	2500-3-L			2500			OA Oil Air	

Pri. Voltage	Connection	Sec.Voltage	Connection	Primary Ifl	Second. Ifl	No. of taps	Impedance %	HV BIL	LV BIL	Net Weight	Gallons of Oil	Year Installed	Assumed Data
12470	Y Solidly Grounded	480	Y Solidly Grounded				5.70						☐
Device#: 2 TCC#(s): 1													

Fuse Data

Fuse: Manufacturer, Type, Voltage, Amps, Model Fuse Holder: Manufacturer, Type, Voltage, BIL, Model	Interrupt Amps	Catalog Number	Min. Melt TCC#	Max. Melt TCC#	Assumed Data	Comment
COOPER BAY-O-NET 15500 140 Current Sensing	2500	4000353C17	R240-91-50 p. 1	R240-91-50 p. 2	☐	
Device#: 1 TCC#(s): 1						

Equipment Group	Vault Number	Building Number	Column	Floor
SR 520 Pontoon Project				

Equipment Name: Transformer

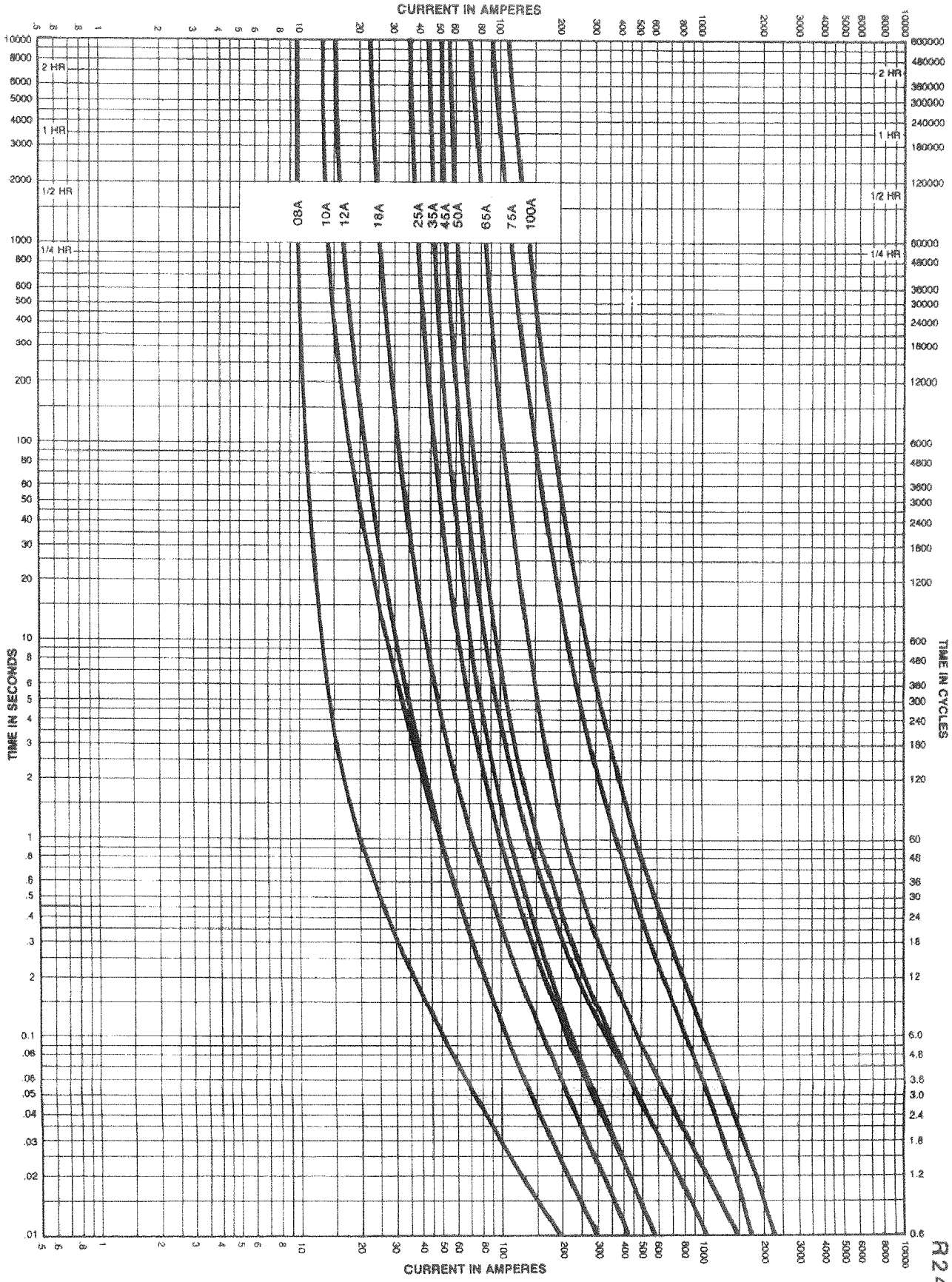
Primary	Secondary	Name	Type	Serial Number	Manufacturer	KVA (Air)	KVA (Fans)	KVA (Pumps)	Cool	Temp Rise
XFMR-UTILBP	**XFMR-UTILBS**	XFMR-UTILB	2500-3-L			2500			OA Oil Air	

Pri. Voltage	Connection	Sec.Voltage	Connection	Primary Ifl	Second. Ifl	No. of taps	Impedance %	HV BIL	LV BIL	Net Weight	Gallons of Oil	Year Installed	Assumed Data
12470	Y Solidly Grounded	480	Y Solidly Grounded				5.70						☐

Fuse Data

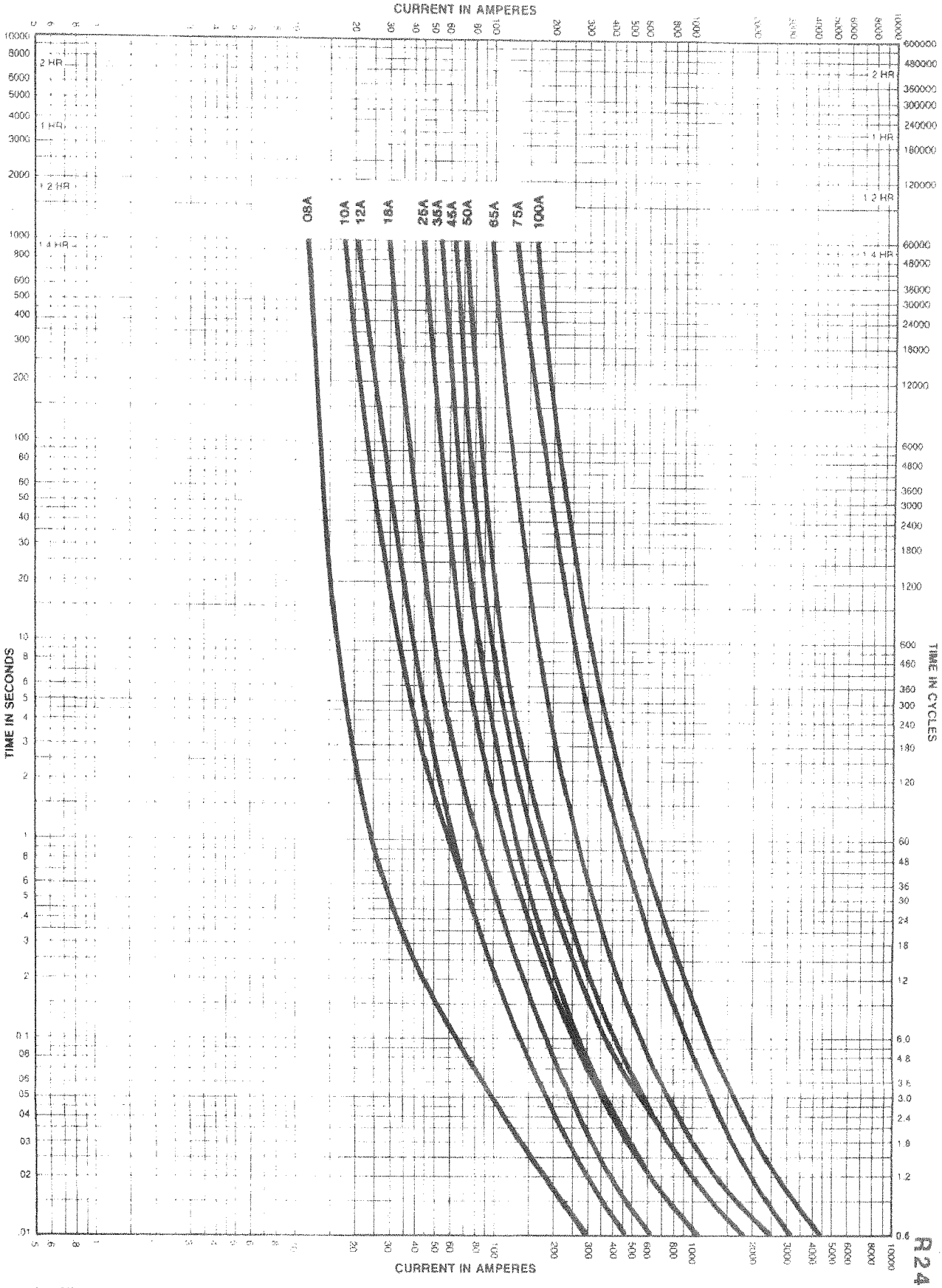
Fuse: Manufacturer, Type, Voltage, Amps, Model Fuse Holder: Manufacturer, Type, Voltage, BIL, Model	Interrupt Amps	Catalog Number	Min. Melt TCC#	Max. Melt TCC#	Assumed Data	Comment
COOPER BAY-O-NET 15500 140 Current Sensing	2500	4000353C17	R240-91-50 p. 1	R240-91-50 p. 2	☐	

TAB 9



COOPER COOPER POWER SYSTEMS DIVISION COMPONENTS AND PROTECTIVE EQUIPMENT	MINIMUM MELT TIME-CURRENT CHARACTERISTIC CURVES
	4.3kV X-LIMITER FULL RANGE FUSE
	Tests at rated volts AC, low pf, starting at no initial load 25°C — 4/87
	Basis for data: ANSI standard C37.47 (1961) — REVISED 1/30/91
	Minimum test points plotted so variations should be plus — TCC-302-M TTM-384

R240-91-105



COOPER

COOPER POWER SYSTEMS DIVISION
COMPONENTS AND PROTECTIVE EQUIPMENT

MAXIMUM CLEAR TIME-CURRENT CHARACTERISTIC CURVES

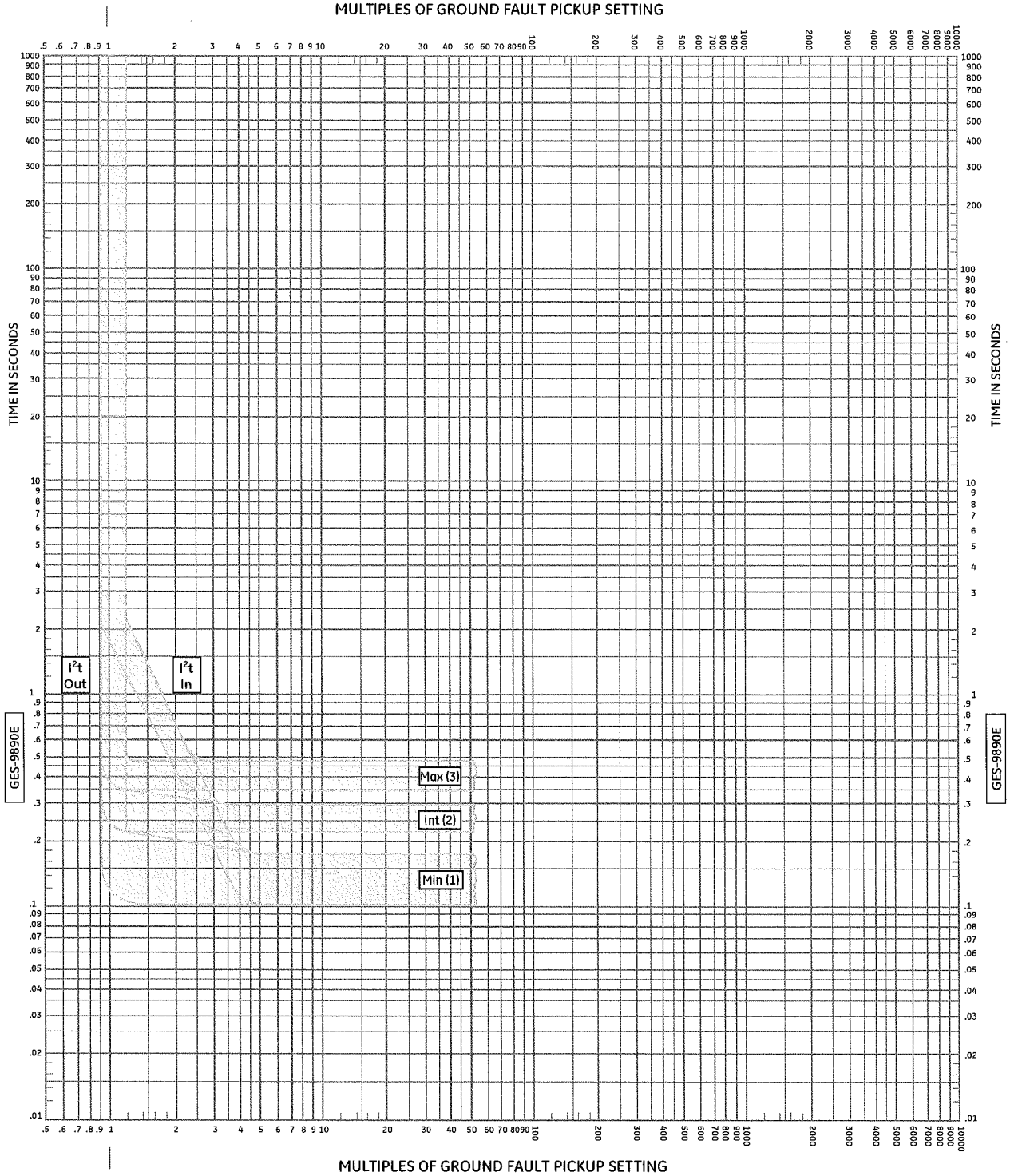
4.3kV X-LIMITER FULL RANGE FUSE

Tests at rated volts AC, low pf, starting at no initial load 25°C — **4/87**

Basis for data: ANSI standard C37.47 (1981) — **REVISED 1/30/91**

Maximum test points plotted so variations should be minus — **TCC-302-C** TTC-384

R240-91-105



GE Consumer & Industrial - Electrical Distribution

Insulated Case Circuit Breakers Power Break™ II

Types SS, SH
with Power+™, MicroVersaTrip Plus® or MicroVersaTrip® PM
Digital RMS Trip Units

Ground Fault Time-Current Curves

GES-9890E

Available Ratings (Amperes)

Frame	Current Sensor (S)
800	200, 400, 800
1600	800, 1000, 1600
2000	2000
2500	1000, 2000, 2500
3000	3000
4000	4000

Voltage Rating: 600 Vac, maximum

Curves apply at 50 to 60 Hertz
and from -20°C to +70°C breaker ambient.

Adjustments

Ground Fault Function:

*Pickup settings are in multiples of Current Sensor Rating (S)

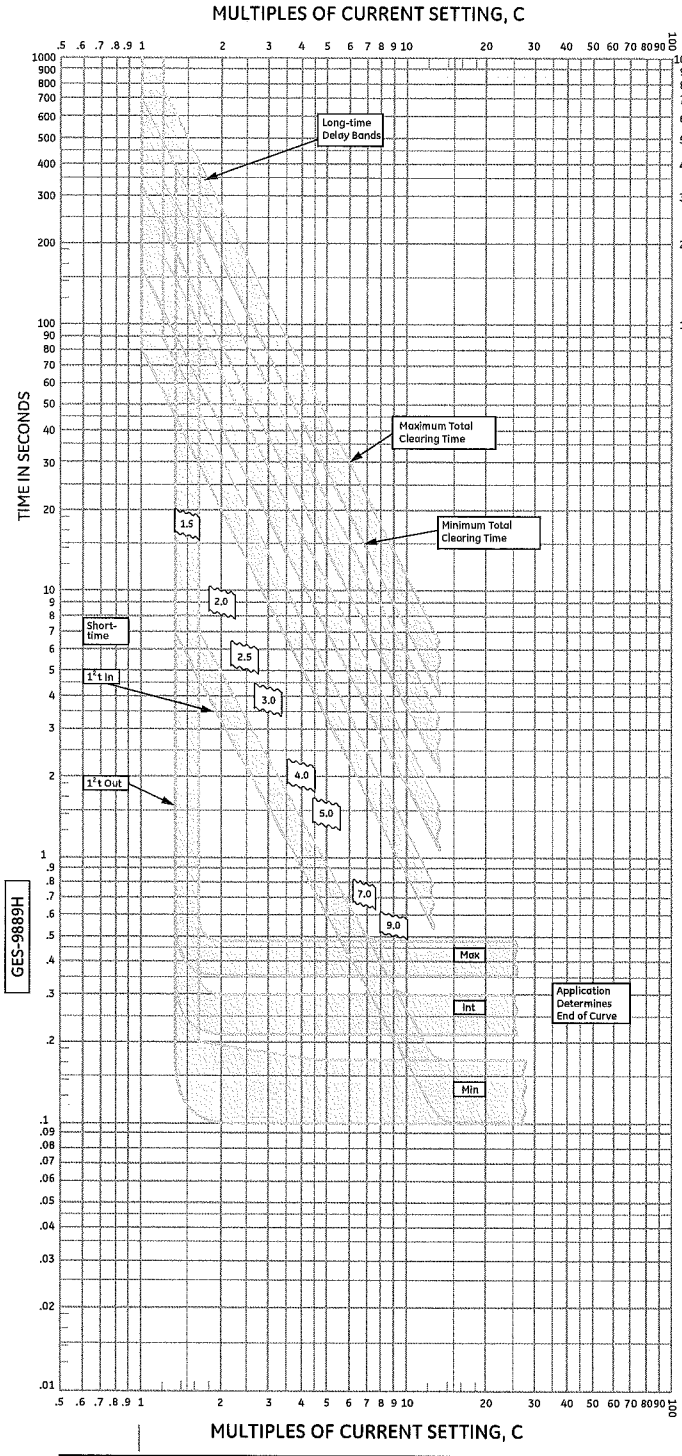
For (S) = 150 through 2000 amps
Pick-up setting: 0.20 to 0.60

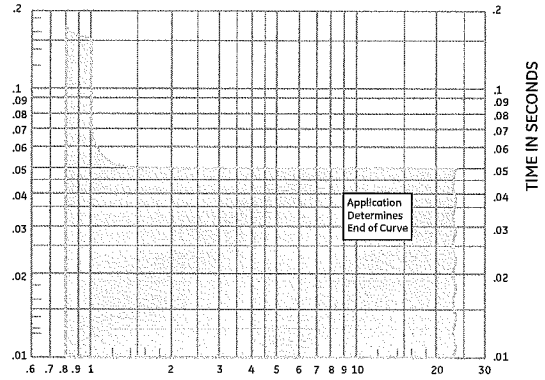
For (S) = 2500 through 3000 amps
Pick-up setting: 0.20 to 0.37

For (S) = 4000 amps
Pick-up setting: 0.20 to 0.30
Delay Bands: Min (1), Int (2), Max (3); I^2t In/Out

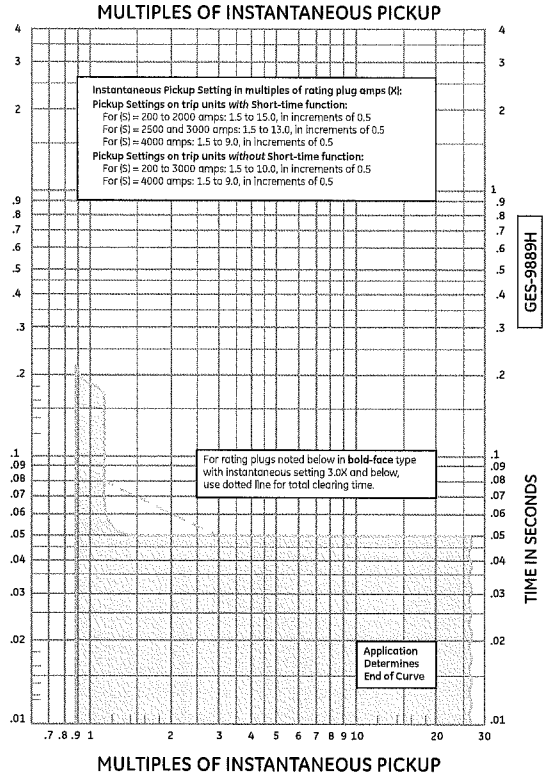
Settings Glossary

S = Current Sensor Rating in amps





Breaker Frame Amps	Short-time Rating (H) (Amps. rms symmetrical)
800	25,000
1600, 2000	40,000
2500, 3000, 4000	42,000



GE Consumer & Industrial - Electrical Distribution

Available Ratings (Amperes)

Frame	Current Sensor (S)	Rating Plug (X)
800	200	100, 150, 200
	400	**150***, 200, 225, 250, 300, 400
	800	**300***, 400, 450, 500, 600, 700, 800
1600	800	**300***, 400, 450, 500, 600, 700, 800
	1000	**400***, 600, 800, 1000
	1600	**600***, 800, 1000, 1100, 1200, 1600
2000	2000	**750***, **800***, 1000, 1200, 1500, 1600, 2000
2500	1000	**400***, 600, 800, 1000
	2000	**800***, 1000, 1200, 1600, 2000
	2500	1600, 2000, 2500
3000	3000	2000, 2500, 3000
4000	4000	1600, 2000, 2500, 3000, 4000

* Not available with Power+™ Trip Unit.

Voltage Rating: 600 Vac, maximum

PowerBreak™ II Insulated Case Circuit Breakers

Types SS, SH
with Power+™ MicroVersaTrip Plus™
or MicroVersaTrip PM™
Digital RMS Trip Units

Long-time Delay, Short-time Delay, and Instantaneous Time-Current Curves

Curves apply at 50 to 60 Hertz
and from -20°C to 70°C breaker ambient

GES-9889H

Programmer Adjustments

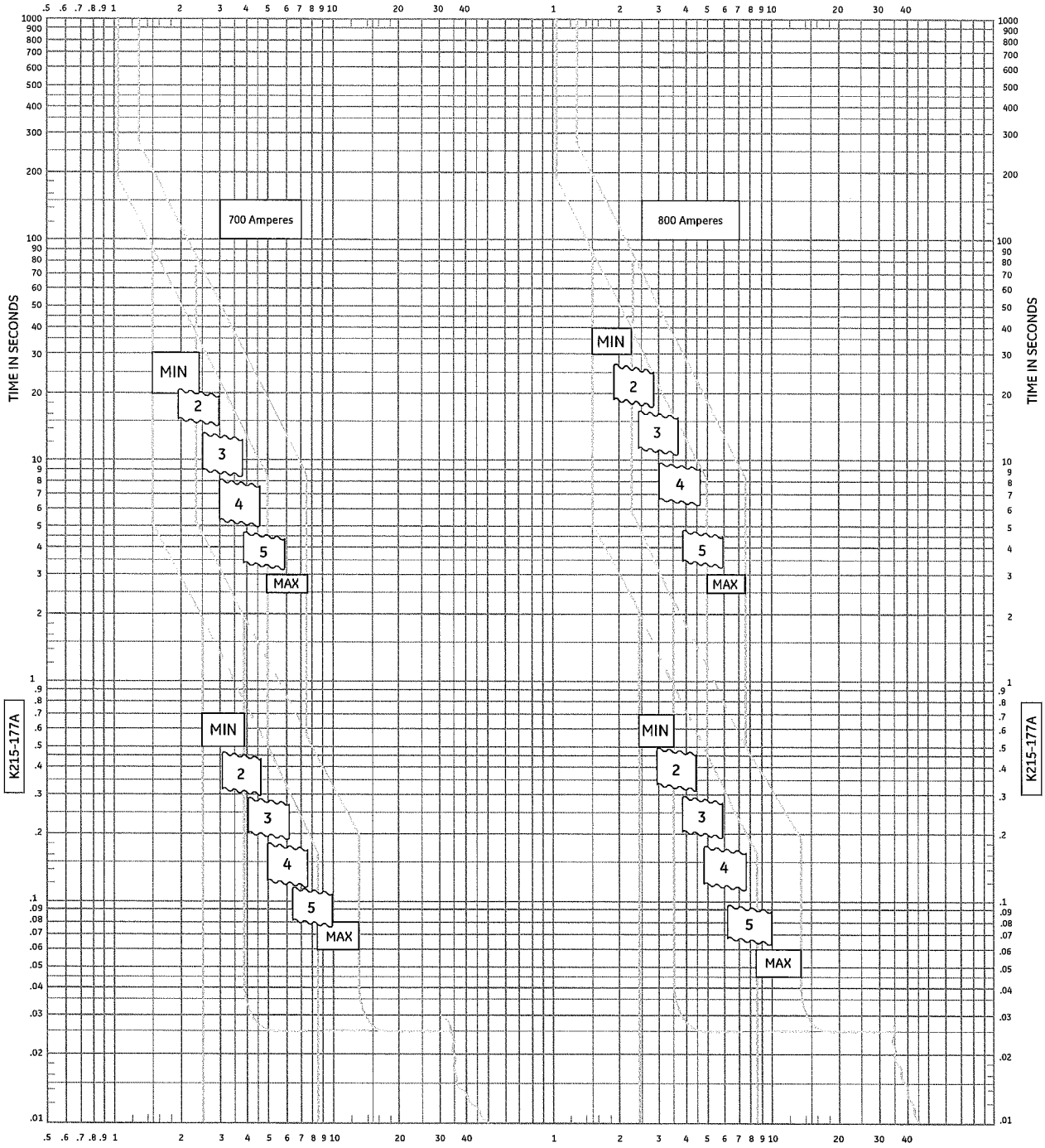
Long-time Function Current Settings (C):
0.50 to 1.0 multiples of rating plug amps (X).
Delay Bands: 1, 2, 3 and 4.

Short-time Function Pickup Settings:
1.5 to 9.0 multiples of current setting (C).
Delay Bands: MIN, INT, MAX; I^2t In/Out

Instantaneous Function:
See Table with Curves above.
(High-Range not available with Power+™

S: Current Sensor Amps
X: Rating Plug Amps
C: Current Setting Amps
H: Breaker Short-time Rating Amps

CURRENT IN MULTIPLES OF RATING PLUG AMPERES



CURRENT IN MULTIPLES OF RATING PLUG AMPERES

GE Consumer & Industrial - Electrical Distribution

Molded Case Circuit Breakers
Type SK with Spectra RMS®
Solid-state Trip

Long-time Delay and Instantaneous with Tracking Short-time Delay Time-current Curves

K215-177A

Current Ratings

Frame Amperes	Rating Plug Amperes
800	700/800

Voltage Ratings

240, 480, 600 Vac

Curves apply at 50 to 400 Hertz and from -20°C to 70°C breaker ambient

Adjustments

Instantaneous pick-up settings in multiples of rating plug rating: MIN, 2, 3, 4, 5, MAX

Note 1: Operation above 60 Hertz and 50°C play require thermal and interrupting derating of the circuit breaker. Refer to Selection and Application manual.

05.96 2M

TAB 10

ARC FLASH STUDY

Arc Flash Calculations

The protection engineer performed arc flash calculations to determine the incident energy and arc flash boundary for various locations throughout the power system. Once the incident energy and arc flash boundaries are known, the required PPE is determined and the appropriate arc flash warning labels are generated. The owner can then attach these warning labels to electrical equipment that would require servicing while energized. These labels will indicate to personnel what the arc flash boundary is and what the correct personal protective equipment (PPE) is that they are required to wear.

CAUTION!

The equations used for the calculation of the estimated maximum incident energy and the estimated arc flash boundary distance are still under review and testing by IEEE and others.

Users should be aware that the equations are based upon measured incident energy under a specific set of test conditions and on theoretical work. Actual arc flash exposures may be more or less severe than calculated by the PTW program. (A discussion of the PTW program used for our calculations follows.) Calculations are base on the installation and configuration of the electrical distribution system as initially constructed. Any changes or additions of the electrical distribution system may cause these calculations to be null & void. All short circuit and overcurrent protective devices (OCPD) must be replaced with the exact same manufacturer and model. Also, the user should beware of the potentially hazardous effects of molten copper splatter, pressure impulses (arc blast), toxic arc byproducts, and projectiles. These effects have not been considered in the equation.

Personal Protective Equipment (PPE) for the arc flash hazard is the last line-of-defense. It is not intended nor will it prevent all injuries. NFPA 70E (2009) PPE levels are intended to reduce the impact of an arc flash to 2nd degree burns for the torso and head only. NFPA 70E (2009) states that the incident energy exposure shall be based on the working distance of the employee's face and head (18"). Objects closer to the arc flash will be exposed to much greater levels of incident energy. Fire Rated (FR) clothing and PPE shall be used based upon the incident energy exposure. This means injuries to hands and arms are expected if an arc at the level calculated and protected against occurs. It is impossible to design PPE to prevent all injures since it would be very restrictive and difficult to work in.

> Incident energy levels are directly related to the clearing time of the upstream OCPD. Operation of the OCPD within the manufacturers design specifications is essential for limiting the incident energy due to arc flash hazards. The Arc Flash Hazard Study is calculated based on the manufacturers published time current curves for new equipment. Failure of the OCPD components to operate within the manufacturer's time current curves will compromise the results of this Arc Flash Study and will result in higher levels of incident energy to electrical workers. NFPA 70E (2009) & 70B standards recommend regularly scheduled maintenance and testing be performed on the electrical distribution system components to assure proper operation of all over current protective devices. Regular testing is required to protect electrical workers from greater arc flash energy hazards than are calculated in this study.

The engineer performed the arc flash calculations for the equipment shown on the electrical one line drawing contained in the report. The engineer started at the utility main service and continued downstream to include the equipment shown of the one line drawings.

PTW Arc Flash Evaluation Program

The protection engineer used the PTW (Power Tools for Windows) Arc Flash Evaluation program. SKM System Analysis, Inc. of Manhattan Beach, CA, wrote this program. It is an accepted industry standard for arc flash calculations. This program calculates the incident energy and arc flash boundary based upon the three-phase short circuit duties at each bus and through each protective device.

The arcing fault current through the protective devices is then calculated from the bolted fault value and used to automatically find the time duration of the arc from the time current coordination (TCC) curves. Incident energy and arc flash boundaries are calculated based on the bus three-phase fault current and arcing duration. Clothing requirements are specified from a user defined personal protective equipment table.

	Bus Name	Protective Device Name	kV	Bus Bolted Fault (kA)	Prot Dev Bolted Fault (kA)	Arcing Fault (kA)	Trip/ Delay Time (sec.)	Breaker Opening Time (sec.)	Ground	Equip Type	Gap (mm)	Arc Flash Boundary (in)	Working Distance (in)	Incident Energy (cal/cm2)	Required Protective FR Clothing Class
85	XFMRU2-SEC	#1-UTIL Relay	4.16	13.20	12.71	12.28	1.997	0.083	Yes	SWG	102	841	36	25.7	Class 4, Cotton Underwear + FR Shirt & Pant + Double Layer Switching Coat (*3)
86															(*1) - Out of IEEE 1584 Range
87															(*2) < 80% Contribution Accumulated
88															(*3) - 85% Arcing Current Used

The PTW Arc Flash program created the table above. Reading from left to right, the columns have the following definitions:

Bus Name:	Indicates the fault location.
Protective Device Name:	The first protective device in each parallel branch feeding the fault.
kV:	Bus voltage at the fault location.
Bus Bolted Fault:	Total symmetrical fault current at the fault location.
Prot Dev Bolted Fault:	Symmetrical fault current passing through the referenced protective device for a bolted fault at the fault location, referenced to bus voltage at fault location.
Arcing Fault:	Branch fault current passing through the referenced protective device for an arcing fault at the fault location, referenced to bus voltage at fault location.
Trip/Delay Time:	Time for referenced protective device to trip (clearing curve) at arcing fault branch current value.
Breaker Opening Time:	User-defined trip time for breaker used when protective device clearing curve does not include the breaker operating time. For example, published relay trip curves reflect only the trip time of the relay since they can be applied to many different breakers and therefore the breaker opening time needs to be included.
Ground:	'Yes' indicates that the fault bus is connected solidly to ground. 'No' indicates that the fault bus is resistance grounded or ungrounded. The empirical equations for incident energy vary for grounded and ungrounded systems.
In Box:	Identifies whether the fault location is in an enclosure or in open air. In open air the arc energy will radiate in all directions whereas an enclosure will focus the energy toward the enclosure opening. The In Box / Air selection is available when the NFPA 70E (2009) study option is selected. For the IEEE 1584 (2002) study selection the In Box or In Air is determined automatically from the Equipment Type specification.
Equip Type:	Used only in the IEEE 1584 (2002) method to determine In Box or In Air condition as well as to provide a default gap between bus bars and distance factor used in the incident energy calculation.
Gap:	Gap between conductors where arc will occur.

Arc Flash Boundary:	Minimum distance from the arc within which a second degree burn could occur if no protective clothing is worn.
Working Distance:	Closest distance a worker's body, excluding arms and hands, would be exposed to the arc.
Incident Energy:	Energy released at the specified working distance expressed in cal/cm2 or J/cm2.
Clothing Class:	Minimum clothing class designed to protect worker from second-degree burns.

The following assumptions have been made by the PTW programmers and PowerStudies.com Protection Engineer:

1. Arc Flash searches up to 5 branches away from the faulted bus to find the fastest protective device with an over-current trip curve. The device with the fastest trip time for the given arcing fault current is used. In most situations, this is the device closes to the faulted bus.

2. Worker is stationary during the entire arc flash incident (constant working distance) up to 2.0 seconds.

3. The maximum time that a worker will be exposed to the arc flash is 2.0 seconds. Either the person will move away or be blown away from the arcing fault location.

4. Induction motors are assumed to be operating. Fault current contribution from the motors lasts for 6 cycles only.

5. Current-limiting range for fuses is assumed to start where fuse clearing curve crosses 0.01 sec.

6. Current-limiting fuses operating in current limiting range are assumed to clear in ½ - ¼ cycle.

7. The Interrupting device is rated for available short circuit current.

8. Upstream branch devices are properly coordinated with downstream branch devices and are set to the values specified in the protective device coordination study performed by PowerStudies.com.

9. The engineer performed the arc flash calculations for the equipment shown on the electrical one line drawing contained in the report. The engineer started at the utility main service and continued downstream.

Theory

Arc Flash Evaluation is calculated using IEEE 1584 (2004a) Standard. The Arc Flash Evaluation Program uses the following calculation procedures to determine the values shown on the Arc Flash Warning Labels and in the Arc Flash Evaluation Bus Reports.:

Arc Flash Evaluation Using IEEE 1584 (2004a)

The following equations are reprinted with permission from IEEE 1584 (2004a) *Copyright 2004*, by IEEE. The IEEE disclaims any responsibility or liability resulting from the placement and use in the described manner.

1) Arc Flash Evaluation using IEEE 1584 (2002a) / D10 assumes that the following ranges are used.

   a) Range of the model

   b) Bus Voltage between 208V and 15kV

   c) Bolted fault current at the bus between 700A and 106kA

   d) Bus bar gap between 13mm and 153mm

   e) For systems outside these ranges, use the LEE equation instead

2) Determine the 3 Phase Fault at each bus in the power system, calculate or determine the Bolted Fault Current at the bus (IB) and the Bolted Fault Current through each protective device (IB br).

3) Determine the Arcing Fault Current at the bus (Ia) and through each protective device (Ia br).

   For low voltage distribution systems, nominal voltage < 1 kV and 700A ≤ IB ≤ 106kA

   lg (Ia) = K + 0.662 lg (IB) + 0.0966 V + 0.000526 G + 0.5588 V lg (IB) – 0.00304 G lg (IB)

lg	is log10
Ia	is arcing fault current at the bus
K	is –0.153 for open configuration and
	is –0.097 for box configuration
IB	is bolted fault current – 3phase sym rms kA at the bus
V	is bus voltage in kV
G	is bus bar gap between conductors in mm

   For medium voltage bus systems with nominal voltage ≥ 1 kV and 700A ≤ IB ≤ 106kA

lg (Ia) =0.00402 + 0.983 lg (IB)

Therefore, Ia = 10 lg (Ia)
Ia br = Ia * IB br / IB

IB br is the Bolted Fault Current through each protective device.
Ia br is the arcing fault current through each protective device.

*Note: Following IEEE 1584 (2002) - 5.2, we are calculating a second arcing fault current at 85% of the original, calculate the Trip Time and Incident Energy at both 85% and 100% arcing fault current and display the larger of the two Incident Energy values with the associated Trip Time.

4) Determine the Trip/Delay time for fuses from the Time Current Coordination Curve (TCC).

Standard fuses that have both minimum melting and total clearing curves available, use the trip time read from the total clearing time curve. For fuses with only the average melting time curve available, the time Tr used is from the average melting curve at the arcing current level. If Tr is less than or equal to 0.03 seconds, then 15% additional delay is added to Tr. If Tr is above 0.03 seconds, then 10% is added to Tr and this value is used for the total clearing time.

For standard fuses, if the arcing fault current is above the total clearing time at the bottom of the curve (0.01s), then 0.01s is used to Tr. (IEEE_P1584/D10 Pg 7)

For all current limiting fuses and breakers, if the trip time read from the TCC clearing curve at the branch arcing fault current is less than ½ cycles, then this value is used as the trip time. Otherwise, define the current at 0.01seconds as the IL, and Ia as the arcing fault current at the protective device:

Trip/Delay Time	Condition
Read from clearing curve	Ia < IL
1/2 cycles*	IL ≤ Ia ≤ 2 IL
1/4 cycles**	Ia > 2 IL

* - The Current limiting devices are not assumed to be current limiting for this lower value of Ia.
** - The current limiting devices are assumed to be current limiting for this higher value of Ia.

5) Determine the Trip/Delay time for relays from the TCC.

Use the TCC curve and read the Read Trip/Delay time. Use 16 ms for relays that operate instantaneously and add the circuit breaker opening time.

Breaker Opening Time For relays:

Breaker Opening Time	Breaker Rating and Type
1.5 cycle	< 1000 V molded case
3.0 cycle	< 1000 V power circuit
5.0 cycle	1 – 35 kV
8.0 cycle	> 35 kV

For low voltage circuit breakers that can be tripped by relays, use a breaker opening time of 3 cycles. For all other device categories, set the Breaker Opening Time to 0.0s since the Trip/Delay Time reading from the TCC include breaker opening time already

6) Determine the Arcing duration by adding the Trip/Delay time and Breaker Opening time.

7) Determine the Equipment Type and Bus Bar Gap.

IEEE1584 lists four Equipment Types. They are Switchgear, Panel, Cable, and Open Air. The following defaults are used according to the voltage level.

Equipment Type	**kV**
Panel	≤ 1
Switchgear	≤ 35
Air	> 35
Panel	≤ 1

Classes of Equipment	**Gap (mm)**
≤ 1kV Switchgear	32
≤ 1kV MCCs and Panelboards	25
1 – 5 kV Switchgear	104
> 5 kV Switchgear	153
All Cable	13
1 – 5 kV Open Air	104
> 5 kV Open Air	153

8) Determine the Working Distance

The working distance based on the voltage level and equipment type using the table below.

Working Distance	**Equipment Type**	**kV**
24 inches (610mm)	Switchgear	≤ 1

18 inches (455mm)	Panel	≤1
36 inches (910mm)	Switchgear	> 1 & < 35
72 inches (1829mm)	Switchgear	> 35
18 inches (455mm)	all others	

9) Determine whether the equipment is grounded or not

10) Calculate the Incident Energy

lg (En) = K1 + K2 + 1.081 lg (Ia) + 0.0011 G

En is incident energy (J/cm2) normalized for an arcing duration of 0.2s and working distance of 610mm
K1 is –0.792 for open configuration and
is –0.555 for box configuration (switchgear, panel, cable)
K2 is 0 for ungrounded and high resistance grounded systems and
is –0.113 for grounded systems
G is the gap between bus bar conductors in mm

solve En = 10lg En

Incident Energy is converted from normalized:

E = 4.184 Cf En (t/0.2) (610X / DX)

E is incident energy (J/cm2)
Cf is 1.0 for voltage above 1 kV and
is 1.5 for voltage at or below 1 kV
t is arcing duration in seconds
D is the working distance
x is the distance exponent

The distance exponent x based on the voltage level and equipment type shown in the table below.

x	Equipment Type	kV
1.473	Switchgear	≤ 1
1.641	Panel	≤ 1
0.973	Switchgear	> 1
2	all others	

11) Calculate the Arc Flash Boundary DB

DB = [4.184 Cf En (t/0.2) (610^X / EB)] ^ 1/X

DB is the arc flash boundary in mm at incident energy of EB
EB is the limit for a second-degree bare skin burn. EB = 5.0 (J/cm2)

For all current limiting fuses and breakers with the manufacturer's incident energy and flash boundary equations available, the manufacturer's current limiting equations are used instead of the above equations. The current limiting equations can be entered and are stored in the protective device library.

IE = A * Ibf + B - Incident Energy
Db = D * Ibf + D - Flash Boundary

Constants A, B, C and D are different for different manufacturers, frames/cartridges and current ratings. If the equation is available for Incident Energy, but NOT for Flash Boundary Db, calculate IE from the current limiting equation and Db using the standard IEEE1584 equation.

If a bus has multiple contributions, calculate the incident energy from each current limiting device using the current limiting equations. Subtract these contributions from current limiting devices out of the total bolted bus fault current. Use the remaining arcing fault current and the standard IEEE1584 incident energy equations to calculate the incident energy. Add the incident energy from current limiting and none-current limiting devices together. Always calculate the Flash Boundary using the standard IEEE1584 equation when multiple contributions exist at the bus.

*Note: Following IEEE 1584 (2002) - 5.2, The program calculates a second arcing fault current at 85% of the original. Then the Trip Time and Incident Energy at both 85% and 100% arcing fault current is compared and the larger of the two Incident Energy values with the associated Trip Time are displayed.

12) Determine the PPE Clothing Class

The PPE clothing class is determined based upon the incident energy and voltage class. This table (NPFA 70E Table 130.7.C) is shown on the next few pages.

Combined Personnel Protective Equipment Matrix Table

(Data From 2009 Edition of NFPA 70E Tables 130.7 (C)(10) and 130.7(C)(11))

Hazard/Risk Category	Protective Clothing and PPE	PPE Clothing Characteristics and Descriptions	Required Minimum Arc Rating of PPE [J/cm2(cal/cm2)]
Hazard/Risk Category 0 Protective Clothing, Non-melting (according to ASTM F 1506-00) or Untreated Natural Fiber FR Protective Equipment	Shirt (long sleeve) Pants (long) Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather gloves (AN) (Note 2)	Non-melting, flammable material (i.e., untreated cotton, wool, rayon, or silk, or blends of these materials) with a fabric weight at least 4.5 oz/yd^2	N/A
Hazard/Risk Category 1 FR Clothing, Minimum Arc Rating of 4 (Note 1) FR Protective Equipment	Arc-rated long-sleeve shirt (Note 3) Arc-rated pants (Note 3) Arc-rated coverall (Note 4) Arc-rated face shield or arc flash suit hood (Note 7) Arc-rated jacket, parka, or rainwear (AN) Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather gloves (Note 2) Leather work shoes (AN)	Arc-rated FR shirt and FR pants or FR coverall	16.74 **(4)**
Hazard/Risk Category 2 FR Clothing, Minimum Arc Rating of 8 (Note 1) FR Protective Equipment	Arc-rated long-sleeve shirt (Note 5) Arc-rated pants (Note 5) Arc-rated coverall (Note 6) Arc-rated face shield or arc flash suit hood (Note 7) Arc-rated jacket, parka, or rainwear (AN) Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather gloves (Note 2) Leather work shoes	Arc-rated FR shirt and FR pants or FR coverall	33.47 **(8)**

Hazard/Risk Category	Protective Clothing and PPE	PPE Clothing Characteristics and Descriptions	Required Minimum Arc Rating of PPE [J/cm2(cal/cm2)]
Hazard/Risk Category 3 FR Clothing, Minimum Arc Rating of 25 (Note 1) FR Protective Equipment	Arc-rated long-sleeve shirt (AR) (Note 8) Arc-rated pants (AR) (Note 8) Arc-rated coverall (AR) (Note 8) Arc-rated arc flash suit jacket & pants (AR) (Note 8) Arc-rated arc flash suit hood (Note 8) Arc-rated jacket, parka, or rainwear (AN) Hard hat FR hard hat liner (AR) Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Arc-rated gloves (Note 2) Leather work shoes	Arc-rated FR shirt and FR pants or FR coverall, and arc flash suit selected so that the system arc rating meets the required minimum	104.6 **(25)**
Hazard/Risk Category 4 FR Clothing, Minimum Arc Rating of 40 (Note 1) FR Protective Equipment	Arc-rated long-sleeve shirt (AR) (Note 9) Arc-rated pants (AR) (Note 9) Arc-rated coverall (AR) (Note 9) Arc-rated arc flash suit jacket & pants (AR) (Note 9) Arc-rated arc flash suit hood (Note 9) Arc-rated jacket, parka, or rainwear (AN) Hard hat FR hard hat liner (AR) Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Arc-rated gloves (Note 2) Leather work shoes	Arc-rated FR shirt and FR pants or FR coverall, and arc flash suit selected so that the system arc rating meets the required minimum	167.36 **(40)**

NFPA 70E Table 130.7(C)(10) Notes

Legend:
AN = As needed (optional)
AR = As required
SR = Selection required

Notes:

1. Information taken from Table 130.7(C)(11) and is shown in the last two columns. Arc rating for a garment or system of garments is expressed in cal/cm².
2. If rubber insulating gloves with leather protectors are required by Table 130.7(C)(9), additional leather or arc-rated gloves are not required. The combination of rubber insulating gloves with leather protectors satisfies the arc-flash protection requirement.
3. The FR shirt and pants used for Hazard/Risk Category 1 shall have a minimum arc rating of 4.
4. Alternate is to use FR coveralls (minimum arc flash rating of 4) instead of FR shirt and FR pants.
5. FR shirt and pants used for Hazard/Risk Category 2 shall have a minimum arc rating of 8.
6. Alternate is to use FR coveralls (minimum arc flash rating of 8) instead of FR shirt and FR pants.
7. A face shield with a minimum arc rating of 4 Hazard/Risk Category 1 or minimum are rating of 8 for Hazard/Risk Category 2, with wrap-around guarding to protect not only the face, but also the forehead, ears, and neck (or, alternatively, an arc-rated arc-flash suit hood), is required.
8. An alternate is to use a total Fr clothing system and hood, which shall have a minimum arc rating of 25 for Hazard/Risk 3.
9. The total clothing system consisting of FR short and pants and/or FR coveralls and/or arc-flash coat and pants and hood shall have a minimum arc rating of 40 for Hazard/Risk Category 4.
10. Alternate is to use a face shield with a minimum arc rating of 8 and a balaclava (sock hood) with a minimum arc rating of 8 and which covers the face, head and neck except for the eye and nose areas.

13) The Glove Rating class is determined based upon the voltage class.

14) Determine the Limited Approach Boundary

This is the distance from an exposed live part within which a shock hazard exists. This value is determined by NFPA 70E (2009) Table 130.2(C).

15) Determine the Prohibited Approach Boundary

This is the distance from an exposed live part within which work is considered the same as making contact with the live part. This value is determined by NFPA 70E (2009) Table 130.2(C).

16) Determine the Restricted Approach Boundary

This is the distance from an exposed live part within which there is an increased risk of shock, due to electrical arc over combined with inadvertent movement, for personnel working in close proximity to the live part. This value is determined by NFPA 70E (2009) Table 130.2(C) shown below.

(1) Nominal System Voltage Range, Phase to Phase	(2) Limited Approach Boundary – Exposed Movable Conductor		(3) Limited Approach Boundary – Exposed Fixed Circuit Part		(4) Restricted Approach Boundary – Includes Inadvertent Movement Adder		(5) Prohibited Approach Boundary	
Less than 50	Not Specified		Not Specified		Not Specified		Not Specified	
50 to 300	10 ft 0 in.	3.05 m	3 ft 6in	1.07 m	Avoid Contact		Avoid Contact	
301 to 750	10 ft 0 in.	3.05m	3 ft 6in.	1.07m	1 ft 0 in.	304.8 mm	0 ft 1 in.	25.4 mm
751 to 15 kV	10 ft 0 in.	3.05 m	5 ft 0 in.	1.53 m	2 ft 2 in.	660.4 mm	0 ft 7 in.	177.8 mm
15.1 kV to 36 kV	10 ft 0 in.	3.05 m	6 ft 0 in.	1.83 m	2 ft 7 in.	787.4 mm	0 ft 10 in.	254 mm
36.1 kV to 46 kV	10 ft 0 in.	3.05 m	8 ft 0 in.	2.44 m	2 ft 9 in.	838.2 mm	1 ft 5 in.	431.8 mm
46.1 kV to 72.5 kV	10 ft 0 in.	3.05 m	8 ft 0 in	2.44 m	3 ft 3 in.	1 m	2 ft 2 in.	660 mm
72.6 kV to 121 kV	10 ft 8 in.	3.25 m	8 ft 0 in.	2.44 m	3 ft 4 in.	1.29 m	2 ft 9 in.	838 mm
138 kV to 145 kV	11 ft 0 in.	3.36 m	10 ft 0 in.	3.05 m	3 ft 10 in.	1.15 m	3 ft 4 in.	102 mm

(1) Nominal System Voltage Range, Phase to Phase	(2) Limited Approach Boundary – Exposed Movable Conductor		(3) Limited Approach Boundary – Exposed Fixed Circuit Part		(4) Restricted Approach Boundary – Includes Inadvertent Movement Adder		(5) Prohibited Approach Boundary	
161 kV to 169 kV	11 ft 8 in.	3.56 m	11 ft 8 in.	3.56 m	4 ft 3 in.	1.29 m	3 ft 9 in.	1.14 m
230 kV to 242 kV	13 ft 0 in.	3.97 m	13 ft 0 in.	3.97 m	5 ft 8 in.	1.71 m	5 ft 2 in.	1.57 m
345 kV to 362 kV	15 ft 4 in.	4.68 m	15 ft 4 in.	4.68 m	9 ft 2 in.	2.77 m	8 ft 8 in.	2.78 m
500 kV to 550 kV	19 ft 0 in.	5.8 m	19 ft 0 in.	5.8 m	11 ft 10 in.	3.61 m	11 ft 4 in.	3.54 m
765 kV to 800 kV	23 ft 9 in.	7.24 m	23 ft 9 in.	7.24 m	15 ft 11 in.	4.84 m	15 ft 5 in.	4.7 m

General Statement. Columns 1 through 5 of Table 130.2(C) all show various distances from the exposed energized electrical conductors or circuit part. They include dimensions that are added to a basic minimum air insulation distance. That basic minimum air insulation distance for voltages 72.5 kV and under are based on ANSI/IEEE 4-1995, Standard Techniques for High-Voltage Testing, Appendix 2B; and for voltages over 72.5 kV, are based on ANSI/IEEE 516-1995, Guide for Maintenance Methods on Energized Power Lines. These minimum air insulation distances required to avoid flashover are:

Voltage	**Minimum Air Insulation Distances**
300 V and less	0 ft 0.03 in.
Over 300 V, not over 750 V	0 ft 0.07 in.
Over 750 V, not over 2 kV	0 ft 0.19 in.
Over 2 kV, not over 15 kV	0 ft 1.5 in.
Over 15 kV, not over 36 kV	0 ft 6.3 in.
Over 36 kV, not over 48.3 kV	0 ft 10.0 in.
Over 48.3 kV, not over 72.5 kV	1 ft 3.0 in.
Over 72.5 kV, not over 121 kV	2 ft 1.2 in.
Over 138 kV, not over 145 kV	2 ft 6.6 in.
Over 161 kV, not over 169 kV	3 ft 0.0 in.
Over 230 kV, not over 242 kV	4 ft 2.4 in.
Over 345 kV, not over 362 kV	7 ft 5.8 in.
Over 500 kV, not over 550 kV	10 ft 2.5 in.
Over 765 kV, not over 800 kV	13 ft 10.3 in.

Column No. 1 : The voltage ranges have been selected to group voltages that require similar approach distances based on the sum of the electrical withstand distance and an inadvertent movement factor. The value of the upper limit for a range is the maximum voltage for highest nominal voltage in the range based on ANSI C84.1-1995, Electric Power Systems and Equipment – Voltage Ratings (60 Hertz). For single-phase systems, select the range that is equal to the system's maximum phase-to-ground voltage times 1.732.

Column No. 2: The distances in this column are based on OSHA's rule for unqualified persons to maintain a 10 ft (3.05m) clearance for all voltages up to 50 kV (voltage-to-ground), plus 0.4 in. (102 mm) for each 1 kV over 50 kV.

Column No. 3: The distances are based on the following:

750 V and lower, use NEC Table 110-26(a) Working Clearances, Condition 2 for 151-600 V range.

For over 750 V, but not over 145 kV, use NEC Table 110-34(a) Working Space, Condition 2.

Over 145 kV, use OSHA's 10 ft (3.05m) rules as used in Column No. 2.

Column No. 4: The distances are based on adding to the flashover dimensions shown above the following inadvertent movement distance:

300 V and less, avoid contact.

Based on experience and precautions for household 120/240 V systems.

Over 300 V and not over 750 V, add 1 ft 0 in. inadvertent movement.

These values have been found to be adequate over years of use in ANSI C2, National Electrical Safety Code, in the approach distances for supply workers.

Over 72.5 kV, add 1 ft 0 in. inadvertent movement.

These values have been found to be adequate over years of use in the National Electrical Safety Code in the approach distances for supply workers.

Column No. 5: The distances are based on the following:

300 V and less, avoid contact.

Over 300 but less than 750 V use NEC Table 230-51(c), Clearances.

Between open conductors and surfaces, 600 V not exposed to weather.

Over 750 V but not over 2.0 kV, value selected that fits in with adjacent values.

Over 2 kV but not over 72.5 kV, use NEC Table 490-24, Minimum Clearance of Live Parts, outdoor phase-to-ground values.

Over 72.5 kV, add 0 ft 6 in. inadvertent movement.

These values have been found to be adequate over years of use where there has been a hazard/risk analysis, either formal or informal, of a special work procedure that allows closer approach than that permitted by the restricted approach boundary distance.

17) Create the Arc Flash Hazard Warning Label

The Arc Flash Label lists important information such as Flash Hazard Boundary, Incident Energy at the given Working Distance, PPE clothing Hazard Risk Category (HRC), and the shock boundaries for Limited, Restricted, and Prohibited Approaches. An example of an arc flash warning label is shown below.

WARNING

Arc Flash and Shock Hazard

5 Ft 5 In	Flash Hazard Boundary
9.9	cal/cm² Flash Hazard at 1 Ft 6 In
Category 3	FR Clothing Minimum Arc Rating of 25 (See NFPA 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
03/17/2009	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-LP1B (PANEL LP1B)
Protective Device:	PNL LP1B FDR

Scenario 2 - af with 2500kva xfmr

Study Performed By PowerStudies.com (253) 639-8535

Figure 2– Example Arc Flash Label

Figure 3 shows on the next page demonstrates how the four different protective boundaries are related and change depending upon the type of equipment, voltage rating, and incident energy used.

Limited Approach Boundary: An approach limit at a distance from an exposed live electrical conductor or circuit part within which a shock hazard exists. This value is determined by NFPA 70E (2009) Table 130.2(C).

Prohibited Approach Boundary: An approach limit at a distance from an exposed live electrical conductor or circuit part within which work is considered the same as making contact with the electrical conductor or circuit part. This value is determined by NFPA 70E (2009) Table 130.2(C).

Restricted Approach Boundary: An approach limit at a distance from an exposed live electrical conductor or circuit part within which there is an increased risk of shock, due to electrical arc over combined with inadvertent movement, for personnel working in close proximity to the energized electrical conductor or circuit part. This value is determined by NFPA 70E (2009) Table 130.2(C).

Arc Flash Boundary: When an arc flash hazard exists, an approach limit at a distance from a prospective arc source within which a person could receive a second degree burn if an electrical arc flash were to occur. This value is determined by the voltage,

type of equipment, and the time that the upstream protective device to clear the fault. The procedure is discussed in detail previously.

NFPA 70E (2209) Section130.3 Exception 1 states that an arc flash hazard analysis shall not be required where all of the following are met.

1. The circuit is rated 240 Volts or less
2. The circuit is supplied by one transformer
3. The transformer supplying the circuit is rated less than 125 kVA

For these locations, we assume that the Hazard Risk Category is 0 and we print labels stating as such. These labels also include the similar information as previously detailed and shown on the sample arc flash label.

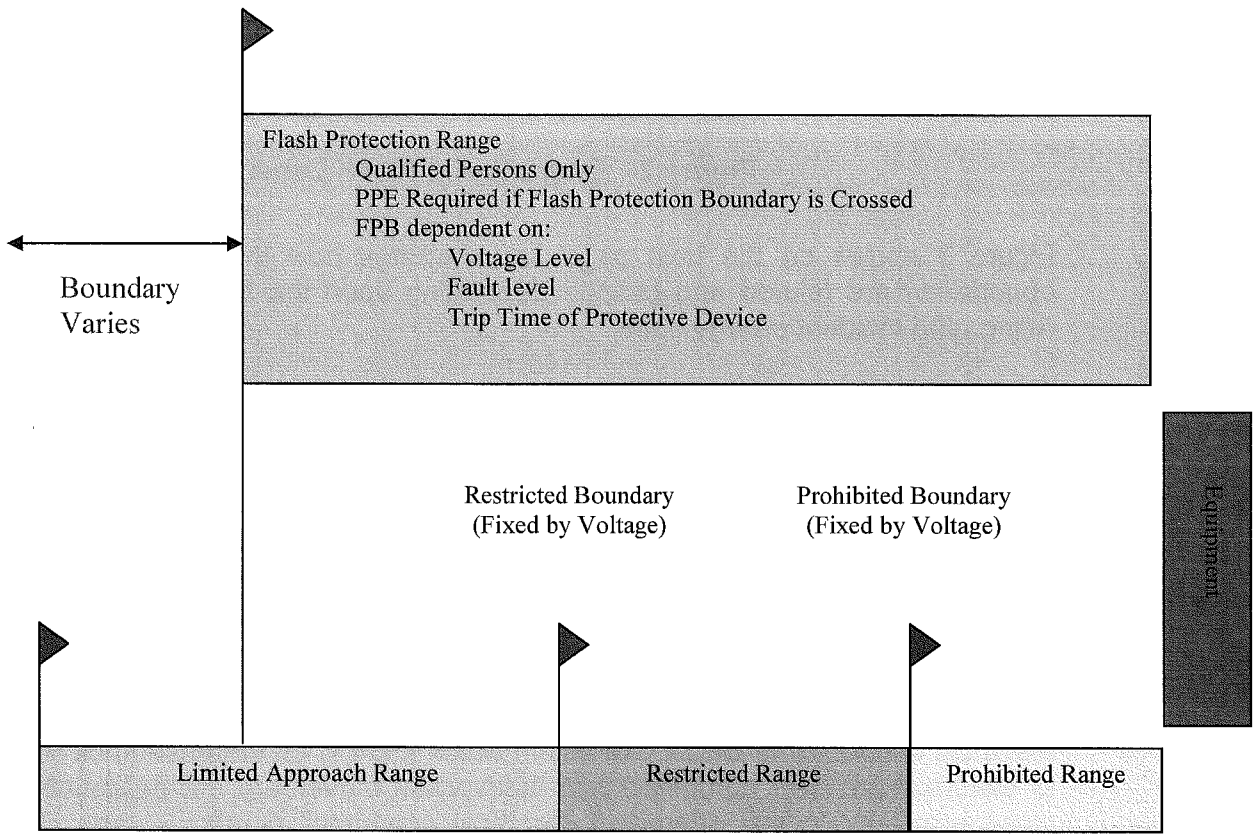


Figure 3 – Arc Flash Boundary Relationship and Determination

Results

The arc flash calculations show that PPE clothing can be worn to increase personnel protection for most of the locations. Arc flash warning labels provided for these locations indicate the PPE required to be worn. The engineer recommends that the arc flash warning labels be installed on the electrical equipment to warn personnel of the potential hazard.

The following is a list of locations where the available incident energy exceeds 40 Cal/cm^2. At these locations, the Required Protective FR Clothing Class is displayed as: "**** Dangerous!!! No FR Class Found. Before working on this equipment, the protection engineer strongly recommends that this equipment be de-energized.

Maximum Arc Flash Energy (US) – Danger Only

Scenario Descriptions

Scenario 1: Utility - Motors ON
Scenario 2: Utility - Motors OFF
Scenario 3: Generator

Calculation Details

IEEE 1584 - 2002/2004a Edition Bus + Line Side Report (Include Line Side + Load Side Contributions), 80% Cleared Fault Threshold, include Ind. Motors for 5.0 Cycles), mis-coordination checked

Hazard Categories

Category 0: Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
Category 1: FR Clothing Minimum Arc Rating of 4 (See NFPA 70E 130.7(C)(10) for additional PPE)
Category 2: FR Clothing Minimum Arc Rating of 8 (See NFPA 70E 130.7(C)(10) for additional PPE)
Category 3: FR Clothing Minimum Arc Rating of 25 (See NFPA 70E 130.7(C)(10) for additional PPE)
Category 4: FR Clothing Minimum Arc Rating of 40 (See NFPA 70E 130.7(C)(10) for additional PPE)
DANGEROUS!: No PPE Exists - Do Not Work on Equipment while Energized!

Arc Flash Notes

(*N1) Out of IEEE 1584 or NFPA 70E Ranges. LEE equation is used in this case and applicable for Open Air only.
(*N2) < 80% Cleared Fault Threshold
(*N3) Arcing Fault Current Low Tolerances Used.
(*N4) Equipment Specific Incident Energy and Flash Boundary Equations Used.
(*N5) Mis-coordinated, Upstream Device Tripped.
(*N6) Special Instantaneous Protection in Use. Refer to Bus Detail & Device Setting Sheets.
(*N7) Trip Time Unlinked with TCC.
(*N8) Fault Current Unlinked with Fault Study results.
(*N9) Max Arcing Duration Reached
(*N10) Fuse Cable Protector Modeled.
(*N11) Out of IEEE 1584 Range, Lee Equation Used. Applicable for Open Air only. Existing Equipment type is not Open Air!
(*N12) Out of IEEE 1584 Gap Range.
(*N13) PPE up one Category
(*N14) Zone Selective Interlock (ZSI) in Use.
(*N15) Report as category 0 if fed by one transformer size < 125 kVA
(*N16) Trip Time Recalculated
(*N20) Out of NESC Voltage Range
(*N21) Out of NESC Fault Current Range
(*N22) Out of NESC Max Clearing Range
(*N23) Out of NESC Voltage Range
(*N24) Out of NESC Altitude Range
(*N25) Out of NESC Max Over Voltage Factor Range
(*N26) NESC SLG Fault is Zero

Maximum Arc Flash Energy (US) – Danger Only

Bus Name	Scenario	Protective Device Name	Bus Volt (v)	Bus Bolted Fault (kA)	Prot Dev Bolted Fault (kA)	Prot Dev Arcing Fault (kA)	Trip/ Delay Time (sec)	Breaker Opening Time (sec)	Ground	Equip Type	Gap (mm)	Arc Flash Bndry (in)	Work Dist (in)	Incident Energy (cal/cm2)	Required Protective Clothing Class
PNL-TRAIL1 (PANEL TRAILER 1)	1	FDR TO XFMR TRAIL	208	22.16	22.16	7.61	2.00	0.000	Y	PNL	25	172	18	49.00	Dangerous! (*N9)
PNL-TRAIL2 (PANEL TRAILER 2)	1	FDR TO XFMR TRAIL	208	22.16	22.16	7.61	2.00	0.000	Y	PNL	25	172	18	49.00	Dangerous! (*N9)
SWBD-A (SWBD A) (3-SWBD-A MAIN LineSide)	1	1-PRIME FUSE A	480	57.33	50.64	21.88	0.50	0.000	Y	PNL	25	153	18	40.00	Dangerous! (*N3)
SWBD-B (SWBD B) (SWBD-B MAIN LineSide)	1	PRIME FUSE B	480	55.36	49.39	21.45	0.52	0.000	Y	PNL	25	155	18	41.00	Dangerous! (*N3)
XFMR-2BS (XFMR 2B SEC)	1	FDR TO XFMR TRAIL	208	22.99	22.99	7.81	2.00	0.000	Y	PNL	25	175	18	50.00	Dangerous! (*N9)
XFMR-UTILAP (XFMR UTILA PRI)	1	MaxTripTime @2.0s	12,470	1,000.23	1,000.00	1,000.00	2.00	0.000	Y	SWG	153	4068	36	15,260.00	Dangerous! (*N11) (*N2) (*N9)
XFMR-UTILBP (XFMR UTILB PRI)	1	MaxTripTime @2.0s	12,470	1,000.20	1,000.00	1,000.00	2.00	0.000	Y	SWG	153	4068	36	15,260.00	Dangerous! (*N11) (*N2) (*N9)

Ways to Reduce Arc Flash Energy

There are many ways to reduce arc flash energies within a facility. The best method is to de-energize the equipment before work is performed. This reduces the energy level to zero and then arc flash hazard no longer exists.

In many locations, the obvious solution above can not be implemented. Many times, breakers must be racked in and out while the equipment is energized. Sometimes, it can be extremely hazardous or expensive to de-energize or shut down the equipment. For these locations and facilities, several methods are available to reduce the arc flash energy levels.

The three major factors that affect the amount of arc flash energy at a particular location are:

1. Device Operation Time – The time it takes for the upstream device to operate
2. Fault Current – The amount of fault current that will flow through the upstream protective device and is available at the fault location.
3. Working Distance – The amount of distance between the fault point and the worker.

It is the device operation time that effects the calculations the most, followed by fault current and working distance. In most cases, concentrating more on time reduction will result in a greater reduction in arc flash energy.

Many facilities use thermal magnetic trip units in their low voltage circuit breakers. These breakers have a fixed thermal and adjustable or fixed instantaneous function. Specifying breakers with solid state trip units using long, short, instantaneous, and ground fault functions will increase both equipment protection and coordination between devices. Tighter coordination between devices will mean a reduction in device operating times and arc flash energies.

For double ended substations using a bus tie, the mains and bus tie breaker settings can be set to the same settings. This enables the main to be set with a lower time delay which will reduce energy levels. Sacrificing the selective coordination between these devices is minor since most facilities rarely close the bus tie breakers except for maintenance purposes.

Most modern low voltage switchboards or switchgear can be equipped with trip units that are zone interlocked. If a fault occurs on the main bus, then the main and tie breakers will trip instantaneously instead of using the normal delayed coordination settings.

New trip units are being manufactured with maintenance switches. When this trip unit is switched to maintenance mode, a low instantaneous function is enabled. Should a fault occur, the breaker will quickly trip and reduce the arc flash hazard downstream. These trip units are available on new breakers or retrofit kits for old style power circuit breakers.

Medium voltage relay operating times can be reduced using some of the same techniques used above for low voltage switchgear. The operating (trip) times can sometimes be reduced by changing the relay operating curve. These times can also be changed by reducing the selective coordination safety margin and by selecting a lower time dial setting.

Many newer protective relays have group settings. This allows the relay settings to change depending upon an input to the relay. A maintenance switch can be added and connected to the input of one of the relays. When the switch is turned to the on position, it tells the relay to use a lower set of relay settings. Should a fault occur downstream from the relay, the relay will trip sooner and reduce the arc flash energy.

Arc flash energy can also be reduced by modification of the work procedures. Examples of this are listed below:

1. Eliminating paralleling of transformers (reduces fault current and arc flash energy)
2. Eliminating work between Transformer Secondary and Main Breaker. (Normally, the primary device must sense the fault on the secondary side of the transformer. This lower level of fault current, seen by the primary devices causes the trip time to be long. This increased trip time means larger energy levels.
3. Implementing faster trip times for maintenance work (See descriptions in previous section)
    a) Circuit Breakers
    b) Relays
    c) Using infrared windows for infrared surveys
    d) Working at a greater distance
    e) Do not stand in front of electrical equipment when operating or inserting (racking in).
    f) Remote breaker racking

Arc Flash hazards exist in every facility. This hazard can be reduced by reviewing types of equipment used, device operation times, and working distance. Each location must be analyzed and the best engineered solution determined. In summary, Arc Flash Energy can be reduced by increasing the worker distance, reducing fault currents, and decreasing the trip times

TAB 11

Maximum Arc Flash Energy (US) – All

Scenario Descriptions

Scenario 1: Utility - Motors ON
Scenario 2: Utility - Motors OFF
Scenario 3: Generator

Calculation Details

IEEE 1584 - 2002/2004a Edition Bus + Line Side Report (Include Line Side + Load Side Contributions), 80% Cleared Fault Threshold, include Ind. Motors for 5.0 Cycles), mis-coordination checked

Hazard Categories

Category 0: Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
Category 1: FR Clothing Minimum Arc Rating of 4 (See NFPA 70E 130.7(C)(10) for additional PPE)
Category 2: FR Clothing Minimum Arc Rating of 8 (See NFPA 70E 130.7(C)(10) for additional PPE)
Category 3: FR Clothing Minimum Arc Rating of 25 (See NFPA 70E 130.7(C)(10) for additional PPE)
Category 4: FR Clothing Minimum Arc Rating of 40 (See NFPA 70E 130.7(C)(10) for additional PPE)
DANGEROUS!: No PPE Exists - Do Not Work on Equipment while Energized!

Arc Flash Notes

(*N1) Out of IEEE 1584 or NFPA 70E Ranges. LEE equation is used in this case and applicable for Open Air only.
(*N2) < 80% Cleared Fault Threshold
(*N3) Arcing Fault Current Low Tolerances Used.
(*N4) Equipment Specific Incident Energy and Flash Boundary Equations Used.
(*N5) Mis-coordinated, Upstream Device Tripped.
(*N6) Special Instantaneous Protection in Use. Refer to Bus Detail & Device Setting Sheets.
(*N7) Trip Time Unlinked with TCC.
(*N8) Fault Current Unlinked with Fault Study results.
(*N9) Max Arcing Duration Reached
(*N10) Fuse Cable Protector Modeled.
(*N11) Out of IEEE 1584 Range, Lee Equation Used. Applicable for Open Air only. Existing Equipment type is not Open Air!
(*N12) Out of IEEE 1584 Gap Range.
(*N13) PPE up one Category
(*N14) Zone Selective Interlock (ZSI) in Use.
(*N15) Report as category 0 if fed by one transformer size < 125 kVA
(*N16) Trip Time Recalculated
(*N20) Out of NESC Voltage Range
(*N21) Out of NESC Fault Current Range
(*N22) Out of NESC Max Clearing Range
(*N23) Out of NESC Voltage Range
(*N24) Out of NESC Altitude Range
(*N25) Out of NESC Max Over Voltage Factor Range
(*N26) NESC SLG Fault is Zero

Maximum Arc Flash Energy (US) – All

Bus Name	Scenario	Protective Device Name	Bus Volt (v)	Bus Bolted Fault (kA)	Prot Dev Bolted Fault (kA)	Prot Dev Arcing Fault (kA)	Trip/ Delay Time (sec)	Breaker Opening Time (sec)	Ground	Equip Type	Gap (mm)	Arc Flash Bndry (in)	Work Dist (in)	Incident Energy (cal/cm2)	Required Protective Clothing Class
AIR-COMP (AIR COMPRESSOR)	1	FDR TO ARI COMP	480	8.03	7.42	5.02	0.03	0.000	Y	PNL	25	10	18	0.43	Category 0
ATS-B-7 (ATS B-7)	3	GEN BRK	480	1.14	1.14	0.87	0.44	0.000	Y	PNL	25	17	18	1.00	Category 0 (*N3)
CRANE-1 (CRANE 1)	1	4-FDR TO CRANE-1	480	23.82	20.81	10.22	0.20	0.000	Y	PNL	25	54	18	7.30	Category 2 (*N3)
CRANE-2 (CRANE 2)	1	FDR TO CRANE-2	480	23.82	20.81	10.22	0.20	0.000	Y	PNL	25	54	18	7.30	Category 2 (*N3)
CRANE-3 (CRANE 3)	1	FDR TO CRANE3	480	21.99	18.99	9.44	0.23	0.000	Y	PNL	25	56	18	7.70	Category 2 (*N3)
CRANE-4 (CRANE 4)	1	FDR TO CRANE4	480	21.99	18.99	9.44	0.23	0.000	Y	PNL	25	56	18	7.70	Category 2 (*N3)
DISC-100ABP (DISC 100A BP)	2	FDR TO DISC 100A	480	3.94	3.94	2.52	0.04	0.000	Y	PNL	25	8	18	0.31	Category 0 (*N3)
DISC-800ABP (DISC 800A BP)	1	FDR TO 800A DISC	480	31.09	31.09	17.28	0.03	0.000	Y	PNL	25	21	18	1.50	Category 1
GEN-1 (GEN 1)	3	MaxTripTime @2.0s	480	1.14	1.14	1.03	2.00	0.000	Y	PNL	25	46	18	5.70	Category 2 (*N2) (*N9)
PNL-A-1 (PANEL A-1)	1	FDR TO PNL-A-1	480	25.86	25.86	14.76	0.03	0.000	Y	PNL	25	19	18	1.30	Category 1
PNL-A-1A (PANEL A-1A)	1	FDR TO XFMR A1A	240	2.97	2.97	1.91	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-A-1B (PANEL A-1B)	1	FDR TO XFMR A1B	208	2.98	2.98	1.86	1.67	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N15)
PNL-A-2 (PANEL A-2)	1	FDR TO PNL-A-2	480	14.46	14.46	8.98	0.03	0.000	Y	PNL	25	13	18	0.74	Category 0
PNL-A-2A (PANEL A-2A)	1	FDR TO XFMR A2A	240	2.84	2.84	1.85	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-A-2B (PANEL A-2B)	1	FDR TO XFMR A2B	208	2.87	2.87	1.81	1.75	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N15)
PNL-A-3 (PANEL A-3)	1	FDR TO PNL-A-3	480	11.09	10.44	6.74	0.03	0.000	Y	PNL	25	12	18	0.58	Category 0
PNL-A-3A (PANEL A-3A)	1	FDR TO XFMR A3A	240	2.77	2.77	1.81	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-A-4 (PANEL A-4)	1	FDR TO PNL-A-4	480	8.11	8.11	5.48	0.03	0.000	Y	PNL	25	10	18	0.43	Category 0
PNL-A-5 (PANEL A-5)	1	FDR TO PNL-A-5	480	6.76	6.76	4.69	0.03	0.000	Y	PNL	25	9	18	0.37	Category 0
PNL-A-6 (PANEL A-6)	1	FDR TO PNL-A-6	480	3.45	3.45	2.64	0.03	0.000	Y	PNL	25	6	18	0.20	Category 0
PNL-A-BLD (PANEL A BUILDING)	1	FDR TO XFMR PNLA	208	1.45	1.45	1.12	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-A-ILL (PANEL A ILLUMINA)	1	FDR TO PNL-A-ILL	480	42.06	42.06	22.37	0.03	0.000	Y	PNL	25	24	18	2.00	Category 1
PNL-B-1 (PANEL B-1)	1	FDR TO PNL-B-1	480	16.05	16.05	9.83	0.03	0.000	Y	PNL	25	14	18	0.81	Category 0
PNL-B-1A (PANEL B-1A)	1	FDR TO XFMR B1A	240	2.86	2.86	1.85	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-B-1B (PANEL B-1B)	1	FDR TO XFMR B1B	208	2.88	2.88	1.81	1.74	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N15)
PNL-B-2 (PANEL B-2)	1	FDR TO PNL-B-2	480	9.94	9.94	6.53	0.03	0.000	Y	PNL	25	11	18	0.52	Category 0
PNL-B-2A (PANEL B-2A)	1	FDR TO XFMR B2A	240	2.71	2.71	1.78	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-B-2B (PANEL B-2B)	1	FDR TO XFMR B2B	208	2.75	2.75	1.76	1.86	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N15)
PNL-B-3 (PANEL B-3)	1	FDR TO PNL-B-3	480	8.89	8.89	5.93	0.03	0.000	Y	PNL	25	10	18	0.47	Category 0
PNL-B-3A (PANEL B-3A)	1	FDR TO XFMR B3A	240	2.68	2.68	1.77	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-B-4 (PANEL B-4)	1	FDR TO PNL-B-4	480	7.92	7.92	5.37	0.03	0.000	Y	PNL	25	10	18	0.42	Category 0
PNL-B-5 (PANEL B-5)	1	FDR TO PNL-B-5	480	10.23	10.23	6.69	0.03	0.000	Y	PNL	25	11	18	0.54	Category 0
PNL-B-6 (PANEL B-6)	1	FDR TO PNL-B-6	480	6.81	6.81	4.72	0.03	0.000	Y	PNL	25	9	18	0.37	Category 0
PNL-B-7 (PANEL B-7)	3	GEN BRK	480	1.13	1.13	0.86	0.44	0.000	Y	PNL	25	17	18	1.00	Category 0 (*N3)
PNL-B-8 (PANEL B-8)	1	FDR TO PNL-B-8	480	16.78	16.78	10.20	0.03	0.000	Y	PNL	25	15	18	0.85	Category 0
PNL-B-8A (PANEL B-8A)	1	FDR TO XFMR B8A	240	3.01	3.01	1.92	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)

Maximum Arc Flash Energy (US) – All

Bus Name	Scenario	Protective Device Name	Bus Volt (v)	Bus Bolted Fault (kA)	Prot Dev Bolted Fault (kA)	Prot Dev Arcing Fault (kA)	Trip/ Delay Time (sec)	Breaker Opening Time (sec)	Ground	Equip Type	Gap (mm)	Arc Flash Bndry (in)	Work Dist (in)	Incident Energy (cal/cm2)	Required Protective Clothing Class
PNL-B-8B (PANEL B-8B)	1	FDR TO XFMR B8B	240	2.55	2.55	1.70	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-B-8C (PANEL B-8C)	1	FDR TO XFMR B8A	240	1.97	1.97	1.42	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-B-BLD (PANEL B BUILDING)	1	FDR TO XFMR PNLB	208	1.45	1.45	1.12	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-B-ILL (PANEL B ILLUMINA)	1	FDR TO PNL-B-ILL	480	40.96	40.96	21.87	0.03	0.000	Y	PNL	25	24	18	1.90	Category 1
PNL-TRAIL1 (PANEL TRAILER 1)	1	FDR TO XFMR TRAIL	208	22.16	22.16	7.61	2.00	0.000	Y	PNL	25	172	18	49.00	Dangerous! (*N9)
PNL-TRAIL2 (PANEL TRAILER 2)	1	FDR TO XFMR TRAIL	208	22.16	22.16	7.61	2.00	0.000	Y	PNL	25	172	18	49.00	Dangerous! (*N9)
SWBD-A (SWBD A)	1	3-SWBD-A MAIN	480	57.33	50.64	21.88	0.10	0.000	Y	PNL	25	62	18	9.00	Category 3 (*N3)
SWBD-A (SWBD A) (3-SWBD-A MAIN LineSide)	1	1-PRIME FUSE A	480	57.33	50.64	21.88	0.50	0.000	Y	PNL	25	153	18	40.00	Dangerous! (*N3)
SWBD-B (SWBD B)	1	SWBD-B MAIN	480	55.36	49.39	21.45	0.11	0.000	Y	PNL	25	62	18	9.00	Category 3 (*N3)
SWBD-B (SWBD B) (SWBD-B MAIN LineSide)	1	PRIME FUSE B	480	55.36	49.39	21.45	0.52	0.000	Y	PNL	25	155	18	41.00	Dangerous! (*N3)
XFMR-1AP (XFMR 1A PRI)	1	FDR TO XFMR PNLA	480	46.21	46.21	24.24	0.03	0.000	Y	PNL	25	26	18	2.20	Category 1
XFMR-1AS (XFMR 1A SEC)	1	FDR TO XFMR PNLA	208	1.47	1.47	1.13	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
XFMR-1BP (XFMR 1B PRI)	1	FDR TO XFMR PNLB	480	44.89	44.89	23.65	0.03	0.000	Y	PNL	25	25	18	2.10	Category 1
XFMR-1BS (XFMR 1B SEC)	1	FDR TO XFMR PNLB	208	1.47	1.47	1.13	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
XFMR-2BP (XFMR 2B PRI)	1	FDR TO XFMR TRAIL	480	52.93	52.93	27.23	0.03	0.000	Y	PNL	25	28	18	2.50	Category 1
XFMR-2BS (XFMR 2B SEC)	1	FDR TO XFMR TRAIL	208	22.99	22.99	7.81	2.00	0.000	Y	PNL	25	175	18	50.00	Dangerous! (*N9)
XFMR-A1AP (XFMR A1A PRI)	1	FDR TO XFMR A1A	480	22.87	22.87	13.30	0.03	0.000	Y	PNL	25	17	18	1.10	Category 0
XFMR-A1AS (XFMR A1A SEC)	1	FDR TO XFMR A1A	240	3.06	3.06	1.95	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
XFMR-A1BP (XFMR A1B PRI)	1	FDR TO XFMR A1B	480	20.07	20.07	11.89	0.01	0.000	Y	PNL	25	10	18	0.46	Category 0
XFMR-A1BS (XFMR A1B SEC)	1	FDR TO XFMR A1B	208	3.16	3.16	1.94	1.54	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N15)
XFMR-A2AP (XFMR A2A PRI)	1	FDR TO XFMR A2A	480	13.42	13.42	8.43	0.03	0.000	Y	PNL	25	13	18	0.69	Category 0
XFMR-A2AS (XFMR A2A SEC)	1	FDR TO XFMR A2A	240	2.92	2.92	1.88	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
XFMR-A2BP (XFMR A2B PRI)	1	FDR TO XFMR A2B	480	12.41	12.41	7.89	0.01	0.000	Y	PNL	25	8	18	0.31	Category 0
XFMR-A2BS (XFMR A2B SEC)	1	FDR TO XFMR A2B	208	3.04	3.04	1.88	1.62	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N15)
XFMR-A3AP (XFMR A3A PRI)	1	FDR TO XFMR A3A	480	10.47	10.47	6.82	0.03	0.000	Y	PNL	25	11	18	0.55	Category 0
XFMR-A3AS (XFMR A3A SEC)	1	FDR TO XFMR A3A	240	2.84	2.84	1.84	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
XFMR-B1AP (XFMR B1A PRI)	1	FDR TO XFMR B1A	480	14.62	14.62	9.07	0.03	0.000	Y	PNL	25	14	18	0.75	Category 0
XFMR-B1AS (XFMR B1A SEC)	1	FDR TO XFMR B1A	240	2.94	2.94	1.89	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
XFMR-B1BP (XFMR B1B PRI)	1	FDR TO XFMR B1B	480	13.16	13.16	8.29	0.01	0.000	Y	PNL	25	8	18	0.33	Category 0
XFMR-B1BS (XFMR B1B SEC)	1	FDR TO XFMR B1B	208	3.05	3.05	1.89	1.61	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N15)
XFMR-B2AP (XFMR B2A PRI)	1	FDR TO XFMR B2A	480	9.36	9.36	6.19	0.03	0.000	Y	PNL	25	11	18	0.49	Category 0
XFMR-B2AS (XFMR B2A SEC)	1	FDR TO XFMR B2A	240	2.78	2.78	1.82	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
XFMR-B2BP (XFMR B2B PRI)	1	FDR TO XFMR B2B	480	8.72	8.72	5.83	0.01	0.000	Y	PNL	25	6	18	0.22	Category 0
XFMR-B2BS (XFMR B2B SEC)	1	FDR TO XFMR B2B	208	2.90	2.90	1.83	1.72	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N15)
XFMR-B3AP (XFMR B3A PRI)	1	FDR TO XFMR B3A	480	8.48	8.48	5.70	0.03	0.000	Y	PNL	25	10	18	0.45	Category 0

Maximum Arc Flash Energy (US) – All

Bus Name	Scenario	Protective Device Name	Bus Volt (v)	Bus Bolted Fault (kA)	Prot Dev Bolted Fault (kA)	Prot Dev Arcing Fault (kA)	Trip/ Delay Time (sec)	Breaker Opening Time (sec)	Ground	Equip Type	Gap (mm)	Arc Flash Bndry (in)	Work Dist (in)	Incident Energy (cal/cm2)	Required Protective Clothing Class
XFMR-B3AS (XFMR B3A SEC)	1	FDR TO XFMR B3A	240	2.75	2.75	1.80	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
XFMR-B8AP (XFMR B8A PRI)	1	FDR TO XFMR B8A	480	6.51	6.51	4.54	0.03	0.000	Y	PNL	25	9	18	0.35	Category 0
XFMR-B8AS (XFMR B8A SEC)	1	FDR TO XFMR B8A	240	3.09	3.09	1.96	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
XFMR-B8BP (XFMR B8B PRI)	1	FDR TO XFMR B8B	480	14.20	14.20	8.85	0.03	0.000	Y	PNL	25	13	18	0.73	Category 0
XFMR-B8BS (XFMR B8B SEC)	1	FDR TO XFMR B8B	240	2.94	2.94	1.89	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
XFMR-UTILAP (XFMR UTILA PRI)	1	MaxTripTime @2.0s	12,470	1,000.23	1,000.00	1,000.00	2.00	0.000	Y	SWG	153	4068	36	15,260.00	Dangerous! (*N11) (*N2) (*N9)
XFMR-UTILAS (XFMR UTILA SEC)	1	1-PRIME FUSE A	480	59.30	52.65	22.64	0.46	0.000	Y	PNL	25	149	18	39.00	Category 4 (*N3)
XFMR-UTILBP (XFMR UTILB PRI)	1	MaxTripTime @2.0s	12,470	1,000.20	1,000.00	1,000.00	2.00	0.000	Y	SWG	153	4068	36	15,260.00	Dangerous! (*N11) (*N2) (*N9)
XFMR-UTILBS (XFMR UTILB SEC)	1	PRIME FUSE B	480	58.56	52.65	22.68	0.46	0.000	Y	PNL	25	149	18	38.00	Category 4 (*N3)

Arc Flash Energy All Scenarios (US) - All

Scenario Descriptions

Scenario 1: Utility - Motors ON
Scenario 2: Utility - Motors OFF
Scenario 3: Generator

Calculation Details

IEEE 1584 - 2002/2004a Edition Bus + Line Side Report (Include Line Side + Load Side Contributions), 80% Cleared Fault Threshold, include Ind. Motors for 5.0 Cycles), mis-coordination checked

Hazard Categories

Category 0: Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
Category 1: FR Clothing Minimum Arc Rating of 4 (See NFPA 70E 130.7(C)(10) for additional PPE)
Category 2: FR Clothing Minimum Arc Rating of 8 (See NFPA 70E 130.7(C)(10) for additional PPE)
Category 3: FR Clothing Minimum Arc Rating of 25 (See NFPA 70E 130.7(C)(10) for additional PPE)
Category 4: FR Clothing Minimum Arc Rating of 40 (See NFPA 70E 130.7(C)(10) for additional PPE)
DANGEROUS!: No PPE Exists - Do Not Work on Equipment while Energized!

Arc Flash Notes

(*N1) Out of IEEE 1584 or NFPA 70E Ranges. LEE equation is used in this case and applicable for Open Air only.
(*N2) < 80% Cleared Fault Threshold
(*N3) Arcing Fault Current Low Tolerances Used.
(*N4) Equipment Specific Incident Energy and Flash Boundary Equations Used.
(*N5) Mis-coordinated, Upstream Device Tripped.
(*N6) Special Instantaneous Protection in Use. Refer to Bus Detail & Device Setting Sheets.
(*N7) Trip Time Unlinked with TCC.
(*N8) Fault Current Unlinked with Fault Study results.
(*N9) Max Arcing Duration Reached
(*N10) Fuse Cable Protector Modeled.
(*N11) Out of IEEE 1584 Range, Lee Equation Used. Applicable for Open Air only. Existing Equipment type is not Open Air!
(*N12) Out of IEEE 1584 Gap Range.
(*N13) PPE up one Category
(*N14) Zone Selective Interlock (ZSI) in Use.
(*N15) Report as category 0 if fed by one transformer size < 125 kVA
(*N16) Trip Time Recalculated
(*N20) Out of NESC Voltage Range
(*N21) Out of NESC Fault Current Range
(*N22) Out of NESC Max Clearing Range
(*N23) Out of NESC Voltage Range
(*N24) Out of NESC Altitude Range

(*N25) Out of NESC Max Over Voltage Factor Range
(*N26) NESC SLG Fault is Zero

Arc Flash Energy All Scenarios (US) - All

Bus Name	Scenario	Protective Device Name	Bus Volt (v)	Bus Bolted Fault (kA)	Prot Dev Bolted Fault (kA)	Prot Dev Arcing Fault (kA)	Trip/ Delay Time (sec)	Breaker Opening Time (sec)	Ground	Equip Type	Gap (mm)	Arc Flash Bndry (in)	Work Dist (in)	Incident Energy (cal/cm2)	Required Protective Clothing Class
AIR-COMP (AIR COMPRESSOR)	1	FDR TO ARI COMP	480	8.03	7.42	5.02	0.03	0.000	Y	PNL	25	10	18	0.43	Category 0
AIR-COMP (AIR COMPRESSOR)	2	FDR TO ARI COMP	480	7.32	7.32	5.03	0.03	0.000	Y	PNL	25	9	18	0.39	Category 0
ATS-B-7 (ATS B-7)	1	FDR TO ATS	480	3.74	3.74	2.83	0.03	0.000	Y	PNL	25	6	18	0.21	Category 0
ATS-B-7 (ATS B-7)	2	FDR TO ATS	480	3.72	3.72	2.82	0.03	0.000	Y	PNL	25	6	18	0.21	Category 0
ATS-B-7 (ATS B-7)	3	GEN BRK	480	1.14	1.14	0.87	0.44	0.000	Y	PNL	25	17	18	1.00	Category 0 (*N3)
CRANE-1 (CRANE 1)	1	4-FDR TO CRANE-1	480	23.82	20.81	10.22	0.20	0.000	Y	PNL	25	54	18	7.30	Category 2 (*N3)
CRANE-1 (CRANE 1)	2	4-FDR TO CRANE-1	480	20.29	20.29	10.20	0.20	0.000	Y	PNL	25	52	18	6.90	Category 2 (*N3)
CRANE-2 (CRANE 2)	1	FDR TO CRANE-2	480	23.82	20.81	10.22	0.20	0.000	Y	PNL	25	54	18	7.30	Category 2 (*N3)
CRANE-2 (CRANE 2)	2	FDR TO CRANE-2	480	20.29	20.29	10.20	0.20	0.000	Y	PNL	25	52	18	6.90	Category 2 (*N3)
CRANE-3 (CRANE 3)	1	FDR TO CRANE3	480	21.99	18.99	9.44	0.23	0.000	Y	PNL	25	56	18	7.70	Category 2 (*N3)
CRANE-3 (CRANE 3)	2	FDR TO CRANE3	480	18.62	18.62	9.48	0.23	0.000	Y	PNL	25	54	18	7.20	Category 2 (*N3)
CRANE-4 (CRANE 4)	1	FDR TO CRANE4	480	21.99	18.99	9.44	0.23	0.000	Y	PNL	25	56	18	7.70	Category 2 (*N3)
CRANE-4 (CRANE 4)	2	FDR TO CRANE4	480	18.62	18.62	9.48	0.23	0.000	Y	PNL	25	54	18	7.20	Category 2 (*N3)
DISC-100ABP (DISC 100A BP)	1	FDR TO DISC 100A	480	3.96	3.96	2.53	0.04	0.000	Y	PNL	25	8	18	0.30	Category 0 (*N3)
DISC-100ABP (DISC 100A BP)	2	FDR TO DISC 100A	480	3.94	3.94	2.52	0.04	0.000	Y	PNL	25	8	18	0.31	Category 0 (*N3)
DISC-800ABP (DISC 800A BP)	1	FDR TO 800A DISC	480	31.09	31.09	17.28	0.03	0.000	Y	PNL	25	21	18	1.50	Category 1
DISC-800ABP (DISC 800A BP)	2	FDR TO 800A DISC	480	29.13	29.13	16.34	0.03	0.000	Y	PNL	25	20	18	1.40	Category 1
GEN-1 (GEN 1)	3	MaxTripTime @2.0s	480	1.14	1.14	1.03	2.00	0.000	Y	PNL	25	46	18	5.70	Category 2 (*N2) (*N9)
PNL-A-1 (PANEL A-1)	1	FDR TO PNL-A-1	480	25.86	25.86	14.76	0.03	0.000	Y	PNL	25	19	18	1.30	Category 1
PNL-A-1 (PANEL A-1)	2	FDR TO PNL-A-1	480	24.46	24.46	14.08	0.03	0.000	Y	PNL	25	18	18	1.20	Category 1
PNL-A-1A (PANEL A-1A)	1	FDR TO XFMR A1A	240	2.97	2.97	1.91	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-A-1A (PANEL A-1A)	2	FDR TO XFMR A1A	240	2.97	2.97	1.90	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-A-1B (PANEL A-1B)	1	FDR TO XFMR A1B	208	2.98	2.98	1.86	1.67	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N15)
PNL-A-1B (PANEL A-1B)	2	FDR TO XFMR A1B	208	2.97	2.97	1.86	1.67	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N15)
PNL-A-2 (PANEL A-2)	1	FDR TO PNL-A-2	480	14.46	14.46	8.98	0.03	0.000	Y	PNL	25	13	18	0.74	Category 0
PNL-A-2 (PANEL A-2)	2	FDR TO PNL-A-2	480	14.02	14.02	8.75	0.03	0.000	Y	PNL	25	13	18	0.72	Category 0
PNL-A-2A (PANEL A-2A)	1	FDR TO XFMR A2A	240	2.84	2.84	1.85	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-A-2A (PANEL A-2A)	2	FDR TO XFMR A2A	240	2.84	2.84	1.84	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-A-2B (PANEL A-2B)	1	FDR TO XFMR A2B	208	2.87	2.87	1.81	1.75	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N15)
PNL-A-2B (PANEL A-2B)	2	FDR TO XFMR A2B	208	2.86	2.86	1.81	1.76	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N15)
PNL-A-3 (PANEL A-3)	1	FDR TO PNL-A-3	480	11.09	10.44	6.74	0.03	0.000	Y	PNL	25	12	18	0.58	Category 0
PNL-A-3 (PANEL A-3)	2	FDR TO PNL-A-3	480	10.23	10.23	6.69	0.03	0.000	Y	PNL	25	11	18	0.54	Category 0

Arc Flash Energy All Scenarios (US) - All

Bus Name	Scenario	Protective Device Name	Bus Volt (v)	Bus Bolted Fault (kA)	Prot Dev Bolted Fault (kA)	Prot Dev Arcing Fault (kA)	Trip/ Delay Time (sec)	Breaker Opening Time (sec)	Ground	Equip Type	Gap (mm)	Arc Flash Bndry (in)	Work Dist (in)	Incident Energy (cal/cm2)	Required Protective Clothing Class
PNL-A-3A (PANEL A-3A)	1	FDR TO XFMR A3A	240	2.77	2.77	1.81	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-A-3A (PANEL A-3A)	2	FDR TO XFMR A3A	240	2.74	2.74	1.80	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-A-4 (PANEL A-4)	1	FDR TO PNL-A-4	480	8.11	8.11	5.48	0.03	0.000	Y	PNL	25	10	18	0.43	Category 0
PNL-A-4 (PANEL A-4)	2	FDR TO PNL-A-4	480	8.00	8.00	5.42	0.03	0.000	Y	PNL	25	10	18	0.43	Category 0
PNL-A-5 (PANEL A-5)	1	FDR TO PNL-A-5	480	6.76	6.76	4.69	0.03	0.000	Y	PNL	25	9	18	0.37	Category 0
PNL-A-5 (PANEL A-5)	2	FDR TO PNL-A-5	480	6.67	6.67	4.64	0.03	0.000	Y	PNL	25	9	18	0.36	Category 0
PNL-A-6 (PANEL A-6)	1	FDR TO PNL-A-6	480	3.45	3.45	2.64	0.03	0.000	Y	PNL	25	6	18	0.20	Category 0
PNL-A-6 (PANEL A-6)	2	FDR TO PNL-A-6	480	3.43	3.43	2.63	0.03	0.000	Y	PNL	25	6	18	0.20	Category 0
PNL-A-BLD (PANEL A BUILDING)	1	FDR TO XFMR PNLA	208	1.45	1.45	1.12	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-A-BLD (PANEL A BUILDING)	2	FDR TO XFMR PNLA	208	1.45	1.45	1.12	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-A-ILL (PANEL A ILLUMINA)	1	FDR TO PNL-A-ILL	480	42.06	42.06	22.37	0.03	0.000	Y	PNL	25	24	18	2.00	Category 1
PNL-A-ILL (PANEL A ILLUMINA)	2	FDR TO PNL-A-ILL	480	38.72	38.72	20.84	0.03	0.000	Y	PNL	25	23	18	1.80	Category 1
PNL-B-1 (PANEL B-1)	1	FDR TO PNL-B-1	480	16.05	16.05	9.83	0.03	0.000	Y	PNL	25	14	18	0.81	Category 0
PNL-B-1 (PANEL B-1)	2	FDR TO PNL-B-1	480	15.59	15.59	9.58	0.03	0.000	Y	PNL	25	14	18	0.79	Category 0
PNL-B-1A (PANEL B-1A)	1	FDR TO XFMR B1A	240	2.86	2.86	1.85	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-B-1A (PANEL B-1A)	2	FDR TO XFMR B1A	240	2.85	2.85	1.85	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-B-1B (PANEL B-1B)	1	FDR TO XFMR B1B	208	2.88	2.88	1.81	1.74	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N15)
PNL-B-1B (PANEL B-1B)	2	FDR TO XFMR B1B	208	2.87	2.87	1.81	1.75	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N15)
PNL-B-2 (PANEL B-2)	1	FDR TO PNL-B-2	480	9.94	9.94	6.53	0.03	0.000	Y	PNL	25	11	18	0.52	Category 0
PNL-B-2 (PANEL B-2)	2	FDR TO PNL-B-2	480	9.77	9.77	6.43	0.03	0.000	Y	PNL	25	11	18	0.51	Category 0
PNL-B-2A (PANEL B-2A)	1	FDR TO XFMR B2A	240	2.71	2.71	1.78	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-B-2A (PANEL B-2A)	2	FDR TO XFMR B2A	240	2.70	2.70	1.78	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-B-2B (PANEL B-2B)	1	FDR TO XFMR B2B	208	2.75	2.75	1.76	1.86	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N15)
PNL-B-2B (PANEL B-2B)	2	FDR TO XFMR B2B	208	2.74	2.74	1.75	1.86	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N15)
PNL-B-3 (PANEL B-3)	1	FDR TO PNL-B-3	480	8.89	8.89	5.93	0.03	0.000	Y	PNL	25	10	18	0.47	Category 0
PNL-B-3 (PANEL B-3)	2	FDR TO PNL-B-3	480	8.73	8.73	5.84	0.03	0.000	Y	PNL	25	10	18	0.47	Category 0
PNL-B-3A (PANEL B-3A)	1	FDR TO XFMR B3A	240	2.68	2.68	1.77	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-B-3A (PANEL B-3A)	2	FDR TO XFMR B3A	240	2.68	2.68	1.77	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-B-4 (PANEL B-4)	1	FDR TO PNL-B-4	480	7.92	7.92	5.37	0.03	0.000	Y	PNL	25	10	18	0.42	Category 0
PNL-B-4 (PANEL B-4)	2	FDR TO PNL-B-4	480	7.81	7.81	5.31	0.03	0.000	Y	PNL	25	10	18	0.42	Category 0
PNL-B-5 (PANEL B-5)	1	FDR TO PNL-B-5	480	10.23	10.23	6.69	0.03	0.000	Y	PNL	25	11	18	0.54	Category 0
PNL-B-5 (PANEL B-5)	2	FDR TO PNL-B-5	480	10.05	10.05	6.59	0.03	0.000	Y	PNL	25	11	18	0.53	Category 0

Arc Flash Energy All Scenarios (US) - All

Bus Name	Scenario	Protective Device Name	Bus Volt (v)	Bus Bolted Fault (kA)	Prot Dev Bolted Fault (kA)	Prot Dev Arcing Fault (kA)	Trip/ Delay Time (sec)	Breaker Opening Time (sec)	Ground	Equip Type	Gap (mm)	Arc Flash Bndry (in)	Work Dist (in)	Incident Energy (cal/cm2)	Required Protective Clothing Class
PNL-B-6 (PANEL B-6)	1	FDR TO PNL-B-6	480	6.81	6.81	4.72	0.03	0.000	Y	PNL	25	9	18	0.37	Category 0
PNL-B-6 (PANEL B-6)	2	FDR TO PNL-B-6	480	6.72	6.72	4.67	0.03	0.000	Y	PNL	25	9	18	0.36	Category 0
PNL-B-7 (PANEL B-7)	1	FDR TO ATS	480	3.62	3.62	2.75	0.03	0.000	Y	PNL	25	6	18	0.21	Category 0
PNL-B-7 (PANEL B-7)	2	FDR TO ATS	480	3.60	3.60	2.74	0.03	0.000	Y	PNL	25	6	18	0.20	Category 0
PNL-B-7 (PANEL B-7)	3	GEN BRK	480	1.13	1.13	0.86	0.44	0.000	Y	PNL	25	17	18	1.00	Category 0 (*N3)
PNL-B-8 (PANEL B-8)	1	FDR TO PNL-B-8	480	16.78	16.78	10.20	0.03	0.000	Y	PNL	25	15	18	0.85	Category 0
PNL-B-8 (PANEL B-8)	2	FDR TO PNL-B-8	480	16.22	16.22	9.91	0.03	0.000	Y	PNL	25	14	18	0.82	Category 0
PNL-B-8A (PANEL B-8A)	1	FDR TO XFMR B8A	240	3.01	3.01	1.92	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-B-8A (PANEL B-8A)	2	FDR TO XFMR B8A	240	3.00	3.00	1.92	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-B-8B (PANEL B-8B)	1	FDR TO XFMR B8B	240	2.55	2.55	1.70	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-B-8B (PANEL B-8B)	2	FDR TO XFMR B8B	240	2.54	2.54	1.70	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-B-8C (PANEL B-8C)	1	FDR TO XFMR B8A	240	1.97	1.97	1.42	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-B-8C (PANEL B-8C)	2	FDR TO XFMR B8A	240	1.96	1.96	1.41	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-B-BLD (PANEL B BUILDING)	1	FDR TO XFMR PNLB	208	1.45	1.45	1.12	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-B-BLD (PANEL B BUILDING)	2	FDR TO XFMR PNLB	208	1.45	1.45	1.12	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
PNL-B-ILL (PANEL B ILLUMINA)	1	FDR TO PNL-B-ILL	480	40.96	40.96	21.87	0.03	0.000	Y	PNL	25	24	18	1.90	Category 1
PNL-B-ILL (PANEL B ILLUMINA)	2	FDR TO PNL-B-ILL	480	37.93	37.93	20.48	0.03	0.000	Y	PNL	25	23	18	1.80	Category 1
PNL-TRAIL1 (PANEL TRAILER 1)	1	FDR TO XFMR TRAIL	208	22.16	22.16	7.61	2.00	0.000	Y	PNL	25	172	18	49.00	Dangerous! (*N9)
PNL-TRAIL1 (PANEL TRAILER 1)	2	FDR TO XFMR TRAIL	208	21.71	21.71	7.50	2.00	0.000	Y	PNL	25	172	18	49.00	Dangerous! (*N9)
PNL-TRAIL2 (PANEL TRAILER 2)	1	FDR TO XFMR TRAIL	208	22.16	22.16	7.61	2.00	0.000	Y	PNL	25	172	18	49.00	Dangerous! (*N9)
PNL-TRAIL2 (PANEL TRAILER 2)	2	FDR TO XFMR TRAIL	208	21.71	21.71	7.50	2.00	0.000	Y	PNL	25	172	18	49.00	Dangerous! (*N9)
SWBD-A (SWBD A)	1	3-SWBD-A MAIN	480	57.33	50.64	21.88	0.10	0.000	Y	PNL	25	62	18	9.00	Category 3 (*N3)
SWBD-A (SWBD A)	2	3-SWBD-A MAIN	480	50.64	50.64	22.28	0.10	0.000	Y	PNL	25	57	18	8.00	Category 2 (*N3)
SWBD-A (SWBD A) (3-SWBD-A MAIN LineSide)	1	1-PRIME FUSE A	480	57.33	50.64	21.88	0.50	0.000	Y	PNL	25	153	18	40.00	Dangerous! (*N3)
SWBD-A (SWBD A) (3-SWBD-A MAIN LineSide)	2	1-PRIME FUSE A	480	50.64	50.64	22.28	0.48	0.000	Y	PNL	25	148	18	38.00	Category 4 (*N3)
SWBD-B (SWBD B)	1	SWBD-B MAIN	480	55.36	49.39	21.45	0.11	0.000	Y	PNL	25	62	18	9.00	Category 3 (*N3)
SWBD-B (SWBD B)	2	SWBD-B MAIN	480	49.39	49.39	21.81	0.10	0.000	Y	PNL	25	58	18	8.10	Category 3 (*N3)
SWBD-B (SWBD B) (SWBD-B MAIN LineSide)	1	PRIME FUSE B	480	55.36	49.39	21.45	0.52	0.000	Y	PNL	25	155	18	41.00	Dangerous! (*N3)
SWBD-B (SWBD B) (SWBD-B MAIN LineSide)	2	PRIME FUSE B	480	49.39	49.39	21.81	0.50	0.000	Y	PNL	25	150	18	39.00	Category 4 (*N3)

Arc Flash Energy All Scenarios (US) - All

Bus Name	Scenario	Protective Device Name	Bus Volt (v)	Bus Bolted Fault (kA)	Prot Dev Bolted Fault (kA)	Prot Dev Arcing Fault (kA)	Trip/ Delay Time (sec)	Breaker Opening Time (sec)	Ground	Equip Type	Gap (mm)	Arc Flash Bndry (in)	Work Dist (in)	Incident Energy (cal/cm2)	Required Protective Clothing Class
XFMR-1AP (XFMR 1A PRI)	1	FDR TO XFMR PNLA	480	46.21	46.21	24.24	0.03	0.000	Y	PNL	25	26	18	2.20	Category 1
XFMR-1AP (XFMR 1A PRI)	2	FDR TO XFMR PNLA	480	42.11	42.11	22.39	0.03	0.000	Y	PNL	25	25	18	2.00	Category 1
XFMR-1AS (XFMR 1A SEC)	1	FDR TO XFMR PNLA	208	1.47	1.47	1.13	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
XFMR-1AS (XFMR 1A SEC)	2	FDR TO XFMR PNLA	208	1.47	1.47	1.13	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
XFMR-1BP (XFMR 1B PRI)	1	FDR TO XFMR PNLB	480	44.89	44.89	23.65	0.03	0.000	Y	PNL	25	25	18	2.10	Category 1
XFMR-1BP (XFMR 1B PRI)	2	FDR TO XFMR PNLB	480	41.17	41.17	21.97	0.03	0.000	Y	PNL	25	24	18	1.90	Category 1
XFMR-1BS (XFMR 1B SEC)	1	FDR TO XFMR PNLB	208	1.47	1.47	1.13	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
XFMR-1BS (XFMR 1B SEC)	2	FDR TO XFMR PNLB	208	1.47	1.47	1.13	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
XFMR-2BP (XFMR 2B PRI)	1	FDR TO XFMR TRAIL	480	52.93	52.93	27.23	0.03	0.000	Y	PNL	25	28	18	2.50	Category 1
XFMR-2BP (XFMR 2B PRI)	2	FDR TO XFMR TRAIL	480	47.46	47.46	24.80	0.03	0.000	Y	PNL	25	26	18	2.20	Category 1
XFMR-2BS (XFMR 2B SEC)	1	FDR TO XFMR TRAIL	208	22.99	22.99	7.81	2.00	0.000	Y	PNL	25	175	18	50.00	Dangerous! (*N9)
XFMR-2BS (XFMR 2B SEC)	2	FDR TO XFMR TRAIL	208	22.50	22.50	7.69	2.00	0.000	Y	PNL	25	175	18	50.00	Dangerous! (*N9)
XFMR-A1AP (XFMR A1A PRI)	1	FDR TO XFMR A1A	480	22.87	22.87	13.30	0.03	0.000	Y	PNL	25	17	18	1.10	Category 0
XFMR-A1AP (XFMR A1A PRI)	2	FDR TO XFMR A1A	480	21.81	21.81	12.77	0.03	0.000	Y	PNL	25	17	18	1.10	Category 0
XFMR-A1AS (XFMR A1A SEC)	1	FDR TO XFMR A1A	240	3.06	3.06	1.95	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
XFMR-A1AS (XFMR A1A SEC)	2	FDR TO XFMR A1A	240	3.05	3.05	1.94	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
XFMR-A1BP (XFMR A1B PRI)	1	FDR TO XFMR A1B	480	20.07	20.07	11.89	0.01	0.000	Y	PNL	25	10	18	0.46	Category 0
XFMR-A1BP (XFMR A1B PRI)	2	FDR TO XFMR A1B	480	19.32	19.32	11.51	0.01	0.000	Y	PNL	25	10	18	0.45	Category 0
XFMR-A1BS (XFMR A1B SEC)	1	FDR TO XFMR A1B	208	3.16	3.16	1.94	1.54	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N15)
XFMR-A1BS (XFMR A1B SEC)	2	FDR TO XFMR A1B	208	3.16	3.16	1.94	1.54	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N15)
XFMR-A2AP (XFMR A2A PRI)	1	FDR TO XFMR A2A	480	13.42	13.42	8.43	0.03	0.000	Y	PNL	25	13	18	0.69	Category 0
XFMR-A2AP (XFMR A2A PRI)	2	FDR TO XFMR A2A	480	13.06	13.06	8.24	0.03	0.000	Y	PNL	25	13	18	0.67	Category 0
XFMR-A2AS (XFMR A2A SEC)	1	FDR TO XFMR A2A	240	2.92	2.92	1.88	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
XFMR-A2AS (XFMR A2A SEC)	2	FDR TO XFMR A2A	240	2.92	2.92	1.88	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
XFMR-A2BP (XFMR A2B PRI)	1	FDR TO XFMR A2B	480	12.41	12.41	7.89	0.01	0.000	Y	PNL	25	8	18	0.31	Category 0
XFMR-A2BP (XFMR A2B PRI)	2	FDR TO XFMR A2B	480	12.11	12.11	7.72	0.01	0.000	Y	PNL	25	8	18	0.30	Category 0
XFMR-A2BS (XFMR A2B SEC)	1	FDR TO XFMR A2B	208	3.04	3.04	1.88	1.62	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N15)
XFMR-A2BS (XFMR A2B SEC)	2	FDR TO XFMR A2B	208	3.03	3.03	1.88	1.63	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N15)
XFMR-A3AP (XFMR A3A PRI)	1	FDR TO XFMR A3A	480	10.47	10.47	6.82	0.03	0.000	Y	PNL	25	11	18	0.55	Category 0
XFMR-A3AP (XFMR A3A PRI)	2	FDR TO XFMR A3A	480	9.70	9.70	6.39	0.03	0.000	Y	PNL	25	11	18	0.51	Category 0
XFMR-A3AS (XFMR A3A SEC)	1	FDR TO XFMR A3A	240	2.84	2.84	1.84	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
XFMR-A3AS (XFMR A3A SEC)	2	FDR TO XFMR A3A	240	2.81	2.81	1.83	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)

Arc Flash Energy All Scenarios (US) - All

Bus Name	Scenario	Protective Device Name	Bus Volt (v)	Bus Bolted Fault (kA)	Prot Dev Bolted Fault (kA)	Prot Dev Arcing Fault (kA)	Trip/ Delay Time (sec)	Breaker Opening Time (sec)	Ground	Equip Type	Gap (mm)	Arc Flash Bndry (in)	Work Dist (in)	Incident Energy (cal/cm2)	Required Protective Clothing Class
XFMR-B1AP (XFMR B1A PRI)	1	FDR TO XFMR B1A	480	14.62	14.62	9.07	0.03	0.000	Y	PNL	25	14	18	0.75	Category 0
XFMR-B1AP (XFMR B1A PRI)	2	FDR TO XFMR B1A	480	14.25	14.25	8.87	0.03	0.000	Y	PNL	25	13	18	0.73	Category 0
XFMR-B1AS (XFMR B1A SEC)	1	FDR TO XFMR B1A	240	2.94	2.94	1.89	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
XFMR-B1AS (XFMR B1A SEC)	2	FDR TO XFMR B1A	240	2.93	2.93	1.89	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
XFMR-B1BP (XFMR B1B PRI)	1	FDR TO XFMR B1B	480	13.16	13.16	8.29	0.01	0.000	Y	PNL	25	8	18	0.33	Category 0
XFMR-B1BP (XFMR B1B PRI)	2	FDR TO XFMR B1B	480	12.88	12.88	8.14	0.01	0.000	Y	PNL	25	8	18	0.32	Category 0
XFMR-B1BS (XFMR B1B SEC)	1	FDR TO XFMR B1B	208	3.05	3.05	1.89	1.61	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N15)
XFMR-B1BS (XFMR B1B SEC)	2	FDR TO XFMR B1B	208	3.05	3.05	1.89	1.62	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N15)
XFMR-B2AP (XFMR B2A PRI)	1	FDR TO XFMR B2A	480	9.36	9.36	6.19	0.03	0.000	Y	PNL	25	11	18	0.49	Category 0
XFMR-B2AP (XFMR B2A PRI)	2	FDR TO XFMR B2A	480	9.21	9.21	6.11	0.03	0.000	Y	PNL	25	10	18	0.49	Category 0
XFMR-B2AS (XFMR B2A SEC)	1	FDR TO XFMR B2A	240	2.78	2.78	1.82	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
XFMR-B2AS (XFMR B2A SEC)	2	FDR TO XFMR B2A	240	2.78	2.78	1.81	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
XFMR-B2BP (XFMR B2B PRI)	1	FDR TO XFMR B2B	480	8.72	8.72	5.83	0.01	0.000	Y	PNL	25	6	18	0.22	Category 0
XFMR-B2BP (XFMR B2B PRI)	2	FDR TO XFMR B2B	480	8.60	8.60	5.76	0.01	0.000	Y	PNL	25	6	18	0.22	Category 0
XFMR-B2BS (XFMR B2B SEC)	1	FDR TO XFMR B2B	208	2.90	2.90	1.83	1.72	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N15)
XFMR-B2BS (XFMR B2B SEC)	2	FDR TO XFMR B2B	208	2.90	2.90	1.82	1.73	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N15)
XFMR-B3AP (XFMR B3A PRI)	1	FDR TO XFMR B3A	480	8.48	8.48	5.70	0.03	0.000	Y	PNL	25	10	18	0.45	Category 0
XFMR-B3AP (XFMR B3A PRI)	2	FDR TO XFMR B3A	480	8.34	8.34	5.62	0.03	0.000	Y	PNL	25	10	18	0.44	Category 0
XFMR-B3AS (XFMR B3A SEC)	1	FDR TO XFMR B3A	240	2.75	2.75	1.80	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
XFMR-B3AS (XFMR B3A SEC)	2	FDR TO XFMR B3A	240	2.75	2.75	1.80	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
XFMR-B8AP (XFMR B8A PRI)	1	FDR TO XFMR B8A	480	6.51	6.51	4.54	0.03	0.000	Y	PNL	25	9	18	0.35	Category 0
XFMR-B8AP (XFMR B8A PRI)	2	FDR TO XFMR B8A	480	6.43	6.43	4.50	0.03	0.000	Y	PNL	25	9	18	0.35	Category 0
XFMR-B8AS (XFMR B8A SEC)	1	FDR TO XFMR B8A	240	3.09	3.09	1.96	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
XFMR-B8AS (XFMR B8A SEC)	2	FDR TO XFMR B8A	240	3.08	3.08	1.95	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
XFMR-B8BP (XFMR B8B PRI)	1	FDR TO XFMR B8B	480	14.20	14.20	8.85	0.03	0.000	Y	PNL	25	13	18	0.73	Category 0
XFMR-B8BP (XFMR B8B PRI)	2	FDR TO XFMR B8B	480	13.82	13.82	8.64	0.03	0.000	Y	PNL	25	13	18	0.71	Category 0
XFMR-B8BS (XFMR B8B SEC)	1	FDR TO XFMR B8B	240	2.94	2.94	1.89	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
XFMR-B8BS (XFMR B8B SEC)	2	FDR TO XFMR B8B	240	2.93	2.93	1.89	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
XFMR-UTILAP (XFMR UTILA PRI)	1	MaxTripTime @2.0s	12,470	1,000.23	1,000.00	1,000.00	2.00	0.000	Y	SWG	153	4068	36	15,260.00	Dangerous! (*N11) (*N2) (*N9)
XFMR-UTILAP (XFMR UTILA PRI)	2	MaxTripTime @2.0s	12,470	1,000.00	1,000.00	1,000.00	2.00	0.000	Y	SWG	153	4068	36	15,260.00	Dangerous! (*N11) (*N2) (*N9)
XFMR-UTILAS (XFMR UTILA SEC)	1	1-PRIME FUSE A	480	59.30	52.65	22.64	0.46	0.000	Y	PNL	25	149	18	39.00	Category 4 (*N3)

Arc Flash Energy All Scenarios (US) - All

Bus Name	Scenario	Protective Device Name	Bus Volt (v)	Bus Bolted Fault (kA)	Prot Dev Bolted Fault (kA)	Prot Dev Arcing Fault (kA)	Trip/ Delay Time (sec)	Breaker Opening Time (sec)	Ground	Equip Type	Gap (mm)	Arc Flash Bndry (in)	Work Dist (in)	Incident Energy (cal/cm2)	Required Protective Clothing Class
XFMR-UTILAS (XFMR UTILA SEC)	2	1-PRIME FUSE A	480	52.65	52.65	23.03	0.44	0.000	Y	PNL	25	144	18	36.00	Category 4 (*N3)
XFMR-UTILBP (XFMR UTILB PRI)	1	MaxTripTime @2.0s	12,470	1,000.20	1,000.00	1,000.00	2.00	0.000	Y	SWG	153	4068	36	15,260.00	Dangerous! (*N11) (*N2) (*N9)
XFMR-UTILBP (XFMR UTILB PRI)	2	MaxTripTime @2.0s	12,470	1,000.00	1,000.00	1,000.00	2.00	0.000	Y	SWG	153	4068	36	15,260.00	Dangerous! (*N11) (*N2) (*N9)
XFMR-UTILBS (XFMR UTILB SEC)	1	PRIME FUSE B	480	58.56	52.65	22.68	0.46	0.000	Y	PNL	25	149	18	38.00	Category 4 (*N3)
XFMR-UTILBS (XFMR UTILB SEC)	2	PRIME FUSE B	480	52.65	52.65	23.03	0.44	0.000	Y	PNL	25	144	18	36.00	Category 4 (*N3)

TAB 12

Arc Flash Label Installation Instructions

1) Before applying the labels to the equipment, read the important information listed below.

2) Always clean the surface with detergent to remove all grease and dirt. Wipe surface dry before applying the label.

3) Where possible, apply labels at eye level on equipment covers

4) The labels are **CUSTOM MADE** and are specific for each piece of electrical equipment. Each label has an alpha-numeric ID and Name. The name is shown in parenthesis. Care must be taken when attaching the labels to the equipment.

   a) **VERIFY THAT YOU ARE ATTACHING THE CORRECT LABEL TO THE EQUIPMENT!!!**
   b) **If you are unsure, please contact our office immediately at 253-639-8535.**

5) Some locations will have a Line Side Label and a bus label. They should be installed at locations where maintenance staff could be exposed to energized parts on the line side of a fuse or circuit breaker. Examples of this are Main Breakers in Switchboards and Switchgear. Bus labels are for the main bus of the equipment and are located downstream from the main breaker (if the main breaker exists). Both the bus ID and name will be the same. The difference is that a line side label will state, Line Side 6-DBA MAIN

a) Attach the line side label at the main breaker line side. Usually this is located on the top of the main breaker but please verify before attaching the label.

b) Attach the bus label downstream from the main breaker.

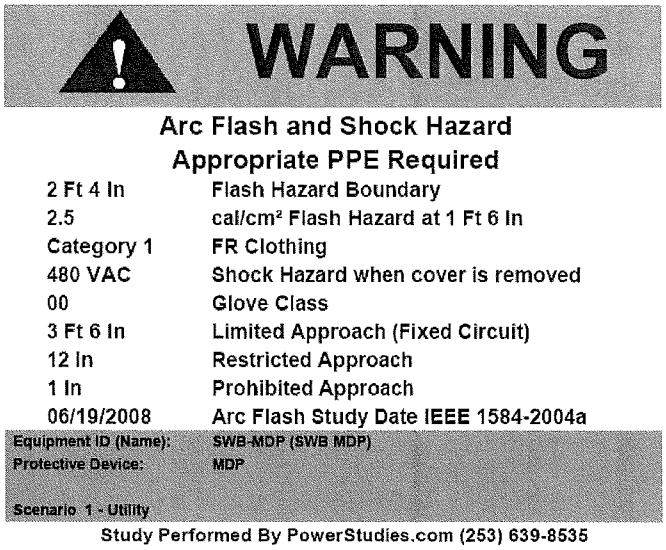


Figure 4 – Example of Bus Side Label

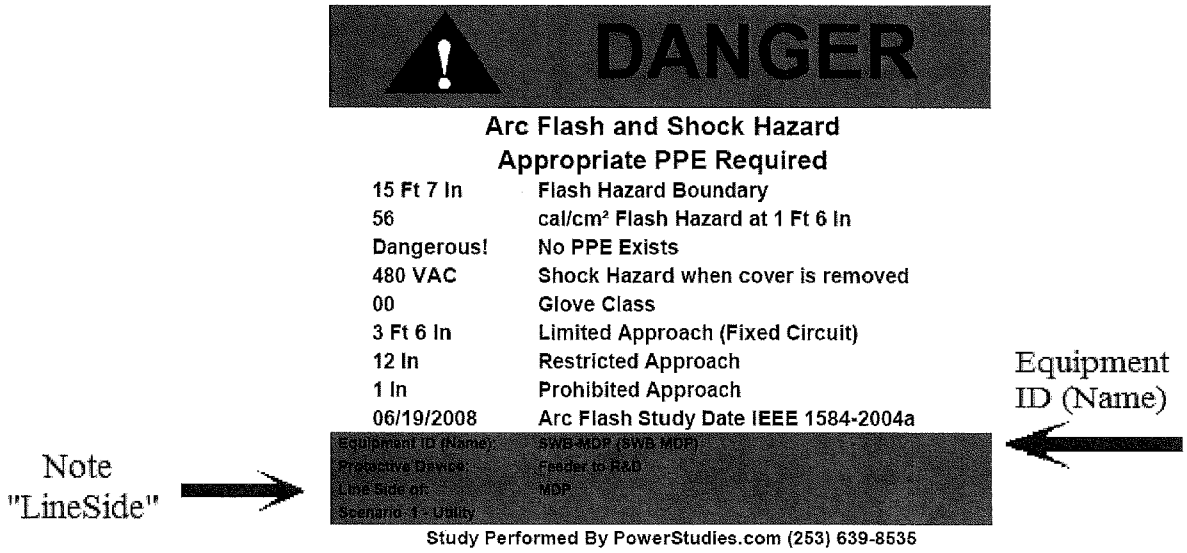


Figure 5 – Example of Line Side of a Protective Device

6) Transformers will have two labels provided. One label will be for the primary and the other label for the secondary. Place the labels on the appropriate ends (or sides) of the transformer. If the transformer is a small distribution type (i.e. 480 / 208 V) place both the primary and secondary labels on the front of the transformer.

7) Locations where the label will be exposed to direct sun light should be brought to the attention of PowerStudies.com. We will provide a special UV resistant label.

WARNING

Arc Flash and Shock Hazard

0 Ft 10 In	Flash Hazard Boundary
0.43	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	AIR-COMP (AIR COMPRESSOR)
Protective Device:	FDR TO ARI COMP

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

1 Ft 5 In	Flash Hazard Boundary
1	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	ATS-B-7 (ATS B-7)
Protective Device:	GEN BRK

Scenario 3 - Generator

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

4 Ft 6 In	Flash Hazard Boundary
7.3	cal/cm² Flash Hazard at 1 Ft 6 In
Category 2	FR Clothing Minimum Arc Rating of 8 (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	CRANE-1 (CRANE 1)
Protective Device:	4-FDR TO CRANE-1

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

4 Ft 6 In	Flash Hazard Boundary
7.3	cal/cm² Flash Hazard at 1 Ft 6 In
Category 2	FR Clothing Minimum Arc Rating of 8 (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	CRANE-2 (CRANE 2)
Protective Device:	FDR TO CRANE-2

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

4 Ft 8 In	Flash Hazard Boundary
7.7	cal/cm² Flash Hazard at 1 Ft 6 In
Category 2	FR Clothing Minimum Arc Rating of 8 (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	CRANE-3 (CRANE 3)
Protective Device:	FDR TO CRANE3

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

4 Ft 8 In	Flash Hazard Boundary
7.7	cal/cm² Flash Hazard at 1 Ft 6 In
Category 2	FR Clothing Minimum Arc Rating of 8 (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	CRANE-4 (CRANE 4)
Protective Device:	FDR TO CRANE4

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

0 Ft 8 In	Flash Hazard Boundary
0.31	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	DISC-100ABP (DISC 100A BP)
Protective Device:	FDR TO DISC 100A

Scenario 2 - Utility - Motors OFF

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

1 Ft 9 In	Flash Hazard Boundary
1.5	cal/cm² Flash Hazard at 1 Ft 6 In
Category 1	FR Clothing Minimum Arc Rating of 4 (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	DISC-800ABP (DISC 800A BP)
Protective Device:	FDR TO 800A DISC

Scenario 1 - Utility - Motors ON

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WARNING

Arc Flash and Shock Hazard

3 Ft 10 In	Flash Hazard Boundary
5.7	cal/cm² Flash Hazard at 1 Ft 6 In
Category 2	FR Clothing Minimum Arc Rating of 8 (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	GEN-1 (GEN 1)
Protective Device:	MaxTripTime @2.0s

Scenario 3 - Generator

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

1 Ft 7 In	Flash Hazard Boundary
1.3	cal/cm² Flash Hazard at 1 Ft 6 In
Category 1	FR Clothing Minimum Arc Rating of 4 (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-A-1 (PANEL A-1)
Protective Device:	FDR TO PNL-A-1

Scenario 1 - Utility - Motors ON

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WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
240 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-A-1A (PANEL A-1A)
Protective Device:	FDR TO XFMR A1A

Scenario 1 - Utility - Motors ON

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WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
208 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-A-1B (PANEL A-1B)
Protective Device:	FDR TO XFMR A1B

Scenario 1 - Utility - Motors ON

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WARNING

Arc Flash and Shock Hazard

1 Ft 1 In	Flash Hazard Boundary
0.74	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-A-2 (PANEL A-2)
Protective Device:	FDR TO PNL-A-2

Scenario 1 - Utility - Motors ON

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WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
240 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-A-2A (PANEL A-2A)
Protective Device:	FDR TO XFMR A2A

Scenario 1 - Utility - Motors ON

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WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
208 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-A-2B (PANEL A-2B)
Protective Device:	FDR TO XFMR A2B

Scenario 1 - Utility - Motors ON

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WARNING

Arc Flash and Shock Hazard

1 Ft 0 In	Flash Hazard Boundary
0.58	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-A-3 (PANEL A-3)
Protective Device:	FDR TO PNL-A-3

Scenario 1 - Utility - Motors ON

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WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
240 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-A-3A (PANEL A-3A)
Protective Device:	FDR TO XFMR A3A

Scenario 1 - Utility - Motors ON

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WARNING

Arc Flash and Shock Hazard

0 Ft 10 In	Flash Hazard Boundary
0.43	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-A-4 (PANEL A-4)
Protective Device:	FDR TO PNL-A-4

Scenario 1 - Utility - Motors ON

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WARNING

Arc Flash and Shock Hazard

0 Ft 9 In	Flash Hazard Boundary
0.37	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-A-5 (PANEL A-5)
Protective Device:	FDR TO PNL-A-5

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

0 Ft 6 In	Flash Hazard Boundary
0.2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-A-6 (PANEL A-6)
Protective Device:	FDR TO PNL-A-6

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
208 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-A-BLD (PANEL A BUILDING)
Protective Device:	FDR TO XFMR PNLA

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

2 Ft 0 In	Flash Hazard Boundary
2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 1	FR Clothing Minimum Arc Rating of 4 (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-A-ILL (PANEL A ILLUMINA)
Protective Device:	FDR TO PNL-A-ILL

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

1 Ft 2 In	Flash Hazard Boundary
0.81	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-B-1 (PANEL B-1)
Protective Device:	FDR TO PNL-B-1

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
240 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-B-1A (PANEL B-1A)
Protective Device:	FDR TO XFMR B1A

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
208 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-B-1B (PANEL B-1B)
Protective Device:	FDR TO XFMR B1B

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

0 Ft 11 In	Flash Hazard Boundary
0.52	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-B-2 (PANEL B-2)
Protective Device:	FDR TO PNL-B-2

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
240 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-B-2A (PANEL B-2A)
Protective Device:	FDR TO XFMR B2A

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
208 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-B-2B (PANEL B-2B)
Protective Device:	FDR TO XFMR B2B

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

0 Ft 10 In	Flash Hazard Boundary
0.47	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-B-3 (PANEL B-3)
Protective Device:	FDR TO PNL-B-3

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
240 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-B-3A (PANEL B-3A)
Protective Device:	FDR TO XFMR B3A

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

0 Ft 10 In	Flash Hazard Boundary
0.42	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-B-4 (PANEL B-4)
Protective Device:	FDR TO PNL-B-4

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

0 Ft 11 In	Flash Hazard Boundary
0.54	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-B-5 (PANEL B-5)
Protective Device:	FDR TO PNL-B-5

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

0 Ft 9 In	Flash Hazard Boundary
0.37	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-B-6 (PANEL B-6)
Protective Device:	FDR TO PNL-B-6

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

1 Ft 5 In	Flash Hazard Boundary
1	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-B-7 (PANEL B-7)
Protective Device:	GEN BRK

Scenario 3 - Generator

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

1 Ft 3 In	Flash Hazard Boundary
0.85	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-B-8 (PANEL B-8)
Protective Device:	FDR TO PNL-B-8

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
240 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-B-8A (PANEL B-8A)
Protective Device:	FDR TO XFMR B8A

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
240 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-B-8B (PANEL B-8B)
Protective Device:	FDR TO XFMR B8B

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
240 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-B-8C (PANEL B-8C)
Protective Device:	FDR TO XFMR B8A

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
208 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-B-BLD (PANEL B BUILDING)
Protective Device:	FDR TO XFMR PNLB

Scenario 1 - Utility - Motors ON

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WARNING

Arc Flash and Shock Hazard

2 Ft 0 In	Flash Hazard Boundary
1.9	cal/cm² Flash Hazard at 1 Ft 6 In
Category 1	FR Clothing Minimum Arc Rating of 4 (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	PNL-B-ILL (PANEL B ILLUMINA)
Protective Device:	FDR TO PNL-B-ILL

Scenario 1 - Utility - Motors ON

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DANGER

Arc Flash and Shock Hazard

14 Ft 4 In	Flash Hazard Boundary
49	cal/cm² Flash Hazard at 1 Ft 6 In
Dangerous!	No PPE Exists - Do Not Work on Equipment while Energized!
208 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a

Equipment ID (Name): PNL-TRAIL1 (PANEL TRAILER 1)
Protective Device: FDR TO XFMR TRAIL

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

DANGER

Arc Flash and Shock Hazard

14 Ft 4 In	Flash Hazard Boundary
49	cal/cm² Flash Hazard at 1 Ft 6 In
Dangerous!	No PPE Exists - Do Not Work on Equipment while Energized!
208 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a

Equipment ID (Name): PNL-TRAIL2 (PANEL TRAILER 2)
Protective Device: FDR TO XFMR TRAIL

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

5 Ft 2 In	Flash Hazard Boundary
9	cal/cm² Flash Hazard at 1 Ft 6 In
Category 3	FR Clothing Minimum Arc Rating of 25 (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a

Equipment ID (Name): SWBD-A (SWBD A)
Protective Device: 3-SWBD-A MAIN

Scenario 1 - Utility - Motors ON

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DANGER

Arc Flash and Shock Hazard

12 Ft 9 In	Flash Hazard Boundary
40	cal/cm² Flash Hazard at 1 Ft 6 In
Dangerous!	No PPE Exists - Do Not Work on Equipment while Energized!
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a

Equipment ID (Name): SWBD-A (SWBD A)
Protective Device: 1-PRIME FUSE A
Line Side of: 3-SWBD-A MAIN

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

5 Ft 2 In	Flash Hazard Boundary
9	cal/cm² Flash Hazard at 1 Ft 6 In
Category 3	FR Clothing Minimum Arc Rating of 25 (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a

Equipment ID (Name): SWBD-B (SWBD B)
Protective Device: SWBD-B MAIN

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

DANGER

Arc Flash and Shock Hazard

12 Ft 11 In	Flash Hazard Boundary
41	cal/cm² Flash Hazard at 1 Ft 6 In
Dangerous!	No PPE Exists - Do Not Work on Equipment while Energized!
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a

Equipment ID (Name): SWBD-B (SWBD B)
Protective Device: PRIME FUSE B
Line Side of: SWBD-B MAIN

Scenario 1 - Utility - Motors ON

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WARNING

Arc Flash and Shock Hazard

2 Ft 2 In	Flash Hazard Boundary
2.2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 1	FR Clothing Minimum Arc Rating of 4 (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a

Equipment ID (Name): XFMR-1AP (XFMR 1A PRI)
Protective Device: FDR TO XFMR PNLA

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
208 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a

Equipment ID (Name): XFMR-1AS (XFMR 1A SEC)
Protective Device: FDR TO XFMR PNLA

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

2 Ft 1 In	Flash Hazard Boundary
2.1	cal/cm² Flash Hazard at 1 Ft 6 In
Category 1	FR Clothing Minimum Arc Rating of 4 (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-1BP (XFMR 1B PRI)
Protective Device:	FDR TO XFMR PNLB

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
208 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-1BS (XFMR 1B SEC)
Protective Device:	FDR TO XFMR PNLB

Scenario 1 - Utility - Motors ON

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WARNING

Arc Flash and Shock Hazard

2 Ft 4 In	Flash Hazard Boundary
2.5	cal/cm² Flash Hazard at 1 Ft 6 In
Category 1	FR Clothing Minimum Arc Rating of 4 (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-2BP (XFMR 2B PRI)
Protective Device:	FDR TO XFMR TRAIL

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

DANGER

Arc Flash and Shock Hazard

14 Ft 7 In	Flash Hazard Boundary
50	cal/cm² Flash Hazard at 1 Ft 6 In
Dangerous!	No PPE Exists - Do Not Work on Equipment while Energized!
208 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-2BS (XFMR 2B SEC)
Protective Device:	FDR TO XFMR TRAIL

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

1 Ft 5 In	Flash Hazard Boundary
1.1	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-A1AP (XFMR A1A PRI)
Protective Device:	FDR TO XFMR A1A

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
240 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-A1AS (XFMR A1A SEC)
Protective Device:	FDR TO XFMR A1A

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

0 Ft 10 In	Flash Hazard Boundary
0.46	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-A1BP (XFMR A1B PRI)
Protective Device:	FDR TO XFMR A1B

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
208 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-A1BS (XFMR A1B SEC)
Protective Device:	FDR TO XFMR A1B

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

1 Ft 1 In	Flash Hazard Boundary
0.69	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-A2AP (XFMR A2A PRI)
Protective Device:	FDR TO XFMR A2A

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
240 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-A2AS (XFMR A2A SEC)
Protective Device:	FDR TO XFMR A2A

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

0 Ft 8 In	Flash Hazard Boundary
0.31	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-A2BP (XFMR A2B PRI)
Protective Device:	FDR TO XFMR A2B

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
208 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-A2BS (XFMR A2B SEC)
Protective Device:	FDR TO XFMR A2B

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

0 Ft 11 In	Flash Hazard Boundary
0.55	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-A3AP (XFMR A3A PRI)
Protective Device:	FDR TO XFMR A3A

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
240 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-A3AS (XFMR A3A SEC)
Protective Device:	FDR TO XFMR A3A

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

1 Ft 2 In	Flash Hazard Boundary
0.75	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-B1AP (XFMR B1A PRI)
Protective Device:	FDR TO XFMR B1A

Scenario 1 - Utility - Motors ON

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WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
240 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-B1AS (XFMR B1A SEC)
Protective Device:	FDR TO XFMR B1A

Scenario 1 - Utility - Motors ON

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WARNING

Arc Flash and Shock Hazard

0 Ft 8 In	Flash Hazard Boundary
0.33	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-B1BP (XFMR B1B PRI)
Protective Device:	FDR TO XFMR B1B

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
208 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-B1BS (XFMR B1B SEC)
Protective Device:	FDR TO XFMR B1B

Scenario 1 - Utility - Motors ON

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WARNING

Arc Flash and Shock Hazard

0 Ft 11 In	Flash Hazard Boundary
0.49	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-B2AP (XFMR B2A PRI)
Protective Device:	FDR TO XFMR B2A

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
240 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-B2AS (XFMR B2A SEC)
Protective Device:	FDR TO XFMR B2A

Scenario 1 - Utility - Motors ON

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WARNING

Arc Flash and Shock Hazard

0 Ft 6 In	Flash Hazard Boundary
0.22	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-B2BP (XFMR B2B PRI)
Protective Device:	FDR TO XFMR B2B

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
208 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-B2BS (XFMR B2B SEC)
Protective Device:	FDR TO XFMR B2B

Scenario 1 - Utility - Motors ON

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WARNING

Arc Flash and Shock Hazard

0 Ft 10 In	Flash Hazard Boundary
0.45	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-B3AP (XFMR B3A PRI)
Protective Device:	FDR TO XFMR B3A

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
240 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-B3AS (XFMR B3A SEC)
Protective Device:	FDR TO XFMR B3A

Scenario 1 - Utility - Motors ON

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WARNING

Arc Flash and Shock Hazard

0 Ft 9 In	Flash Hazard Boundary
0.35	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-B8AP (XFMR B8A PRI)
Protective Device:	FDR TO XFMR B8A

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
240 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-B8AS (XFMR B8A SEC)
Protective Device:	FDR TO XFMR B8A

Scenario 1 - Utility - Motors ON

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WARNING

Arc Flash and Shock Hazard

1 Ft 1 In	Flash Hazard Boundary
0.73	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-B8BP (XFMR B8B PRI)
Protective Device:	FDR TO XFMR B8B

Scenario 1 - Utility - Motors ON

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WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm² Flash Hazard at 1 Ft 6 In
Category 0	Non Melting Clothing (See NFPA 70E 130.7(C)(10) for additional PPE)
240 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
Avoid Contact	Restricted Approach
Avoid Contact	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-B8BS (XFMR B8B SEC)
Protective Device:	FDR TO XFMR B8B

Scenario 1 - Utility - Motors ON

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DANGER

Arc Flash and Shock Hazard

339 Ft 0 In	Flash Hazard Boundary
15260	cal/cm² Flash Hazard at 3 Ft 0 In
Dangerous!	No PPE Exists - Do Not Work on Equipment while Energized!
12,470 VAC	Shock Hazard when cover is removed
2	Glove Class
5 Ft	Limited Approach (Fixed Circuit)
26 In	Restricted Approach
7 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-UTILAP (XFMR UTILA PRI)
Protective Device:	MaxTripTime @2.0s

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

12 Ft 5 In	Flash Hazard Boundary
39	cal/cm² Flash Hazard at 1 Ft 6 In
Category 4	FR Clothing Minimum Arc Rating of 40 (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-UTILAS (XFMR UTILA SEC)
Protective Device:	1-PRIME FUSE A

Scenario 1 - Utility - Motors ON

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DANGER

Arc Flash and Shock Hazard

339 Ft 0 In	Flash Hazard Boundary
15260	cal/cm² Flash Hazard at 3 Ft 0 In
Dangerous!	No PPE Exists - Do Not Work on Equipment while Energized!
12,470 VAC	Shock Hazard when cover is removed
2	Glove Class
5 Ft	Limited Approach (Fixed Circuit)
26 In	Restricted Approach
7 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-UTILBP (XFMR UTILB PRI)
Protective Device:	MaxTripTime @2.0s

Scenario 1 - Utility - Motors ON

Study Performed By PowerStudies.com (253) 639-8535

WARNING

Arc Flash and Shock Hazard

12 Ft 5 In	Flash Hazard Boundary
38	cal/cm² Flash Hazard at 1 Ft 6 In
Category 4	FR Clothing Minimum Arc Rating of 40 (See NFPA 70E 130.7(C)(10) for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
12 In	Restricted Approach
1 In	Prohibited Approach
06/09/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	XFMR-UTILBS (XFMR UTILB SEC)
Protective Device:	PRIME FUSE B

Scenario 1 - Utility - Motors ON

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TAB 13

Project Name: 1001055(Base Project)

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Device Name:	GEN BRK	TCC Name:	
Bus Name:	GEN-1	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	70-250A		
Type:	SFLA, Spectra RMS		
AIC Rating:	65kA	Fault Duty:	4832.5A
Frame:	SFLA 480V 250A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	100A		
Setting: 1) MAX			

Device Name:	FDR TO XFMR A1B	TCC Name:	
Bus Name:	PNL-A-1	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	15-100A		
Type:	FB, 2 & 3-Pole 480V		
AIC Rating:	35kA	Fault Duty:	25870.5A
Frame:	FBV 480V 70A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	70A		
Setting: 1) Fixed			

Device Name:	FDR TO XFMR A1A	TCC Name:	
Bus Name:	PNL-A-1	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	70-250A		
Type:	SFHA, Spectra RMS		
AIC Rating:	35kA	Fault Duty:	25870.5A
Frame:	SFHA 480V 250A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	150A		
Setting: 1) MAX			

Device Name:	FDR TO XFMR A2A	TCC Name:	
Bus Name:	PNL-A-2	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	70-250A		
Type:	SFHA, Spectra RMS		
AIC Rating:	35kA	Fault Duty:	14461.8A
Frame:	SFHA 480V 250A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	150A		
Setting: 1) MAX			

Device Name:	FDR TO XFMR A2B	TCC Name:	
Bus Name:	PNL-A-2	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	15-100A		
Type:	FB, 2 & 3-Pole 480V		
AIC Rating:	35kA	Fault Duty:	14461.8A
Frame:	FBV 480V 70A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	70A		
Setting: 1) Fixed			

Device Name:	FDR TO ARI COMP	TCC Name:	
Bus Name:	PNL-A-3	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	70-250A		
Type:	SFHA, Spectra RMS		
AIC Rating:	35kA	Fault Duty:	11155.0A
Frame:	SFHA 480V 250A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	250A		
Setting: 1) MAX			

Device Name:	FDR TO XFMR A3A	TCC Name:	
Bus Name:	PNL-A-3	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	70-250A		
Type:	SFHA, Spectra RMS		
AIC Rating:	35kA	Fault Duty:	11155.0A
Frame:	SFHA 480V 250A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	150A		
Setting: 1) MAX			

Device Name:	FDR TO XFMR B1B	TCC Name:	
Bus Name:	PNL-B-1	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	15-100A		
Type:	FB, 2 & 3-Pole 480V		
AIC Rating:	35kA	Fault Duty:	16057.2A
Frame:	FBV 480V 70A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	70A		
Setting: 1) Fixed			

Device Name:	FDR TO XFMR B1A	TCC Name:	
Bus Name:	PNL-B-1	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	70-250A		
Type:	SFHA, Spectra RMS		
AIC Rating:	35kA	Fault Duty:	16057.2A
Frame:	SFHA 480V 250A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	150A		
Setting: 1) MAX			

Device Name:	FDR TO XFMR B2A	TCC Name:	
Bus Name:	PNL-B-2	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	70-250A		
Type:	SFHA, Spectra RMS		
AIC Rating:	35kA	Fault Duty:	9922.5A
Frame:	SFHA 480V 250A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	150A		
Setting: 1) MAX			

Device Name:	FDR TO XFMR B2B	TCC Name:	
Bus Name:	PNL-B-2	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	15-100A		
Type:	FB, 2 & 3-Pole 480V		
AIC Rating:	35kA	Fault Duty:	9922.5A
Frame:	FBV 480V 70A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	70A		
Setting: 1) Fixed			

Device Name:	FDR TO XFMR B3A	TCC Name:	
Bus Name:	PNL-B-3	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	70-250A		
Type:	SFHA, Spectra RMS		
AIC Rating:	35kA	Fault Duty:	8874.7A
Frame:	SFHA 480V 250A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	150A		
Setting: 1) MAX			

Device Name:	FDR TO DISC 100A	TCC Name:	
Bus Name:	PNL-B-8	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	15-100A		
Type:	FB, 2 & 3-Pole 480V		
AIC Rating:	35kA	Fault Duty:	16801.6A
Frame:	FBV 480V 100A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	100A		
Setting: 1) Fixed			

Device Name:	FDR TO XFMR B8B	TCC Name:	
Bus Name:	PNL-B-8	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	70-250A		
Type:	SFHA, Spectra RMS		
AIC Rating:	35kA	Fault Duty:	16801.6A
Frame:	SFHA 480V 250A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	150A		
Setting: 1) MAX			

Device Name:	FDR TO XFMR B8A	TCC Name:	
Bus Name:	PNL-B-8	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	70-250A		
Type:	SFHA, Spectra RMS		
AIC Rating:	35kA	Fault Duty:	16801.6A
Frame:	SFHA 480V 250A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	200A		
Setting: 1) MAX			

Device Name: 3-SWBD-A MAIN
Bus Name: SWBD-A
Function Name: Phase
Manufacturer: GE
Description: LSI (CB), 4000AF, UL 489
Type: SS, SH PowerBreak II, EGTU
AIC Rating: 100kA Override:50 ShortTime:42
Frame: SS 480V 4000A
Time Multiplier: 1
Sensor: 4000A
Plug: 4000A
Setting: 1) LTPU/LTD (0.5-1 x RP 1.00X (4000A)C-2
2) STPU (1.5-9 x LTPU) 2X (8000A)
3) STD (ST01 - ST11) ST01-Min I^2 t In
4) INST (2-9 x RP) 9X (36000A)

TCC Name: 1-Utility Transformer, Transformer Damage Curve, SWBD-A Main, Feede Cr
Bus Voltage: 480.0V
Fault Duty: 57401.5A
Curve Multiplier: 1
Time Adder: 0

Function Name: Ground
Manufacturer: GE
Description: GF, 4000AF
Type: SS, SH PowerBreak I & II, EGTU
AIC Rating: 100kA ShortTime:42
Frame: SS 480V 4000A
Time Multiplier: 1
Sensor: 4000A
Plug: 4000A
Setting: 1) GFPU (0.2-0.6 x S) 0.6 (1200A)
2) GFD I2T (1-13 Bands) GFD03 I^2 t In

Fault Duty: 57401.5A
Curve Multiplier: 1
Time Adder: 0

Device Name: 4-FDR TO CRANE-1
Bus Name: SWBD-A
Function Name: Phase
Manufacturer: GE
Description: 300-1200A
Type: SKLA, Spectra RMS
AIC Rating: 65kA
Frame: SKLA 480V 800A
Time Multiplier: 1
Trip: 800A
Setting: 1) MAX

TCC Name: 1-Utility Transformer, Transformer Damage Curve, SWBD-A Main, Feeder to Cr
Bus Voltage: 480.0V
Fault Duty: 57401.5A
Curve Multiplier: 1
Time Adder: 0

Device Name: FDR TO 800A DISC
Bus Name: SWBD-A
Function Name: Phase
Manufacturer: GE
Description: 300-1200A
Type: SKLA, Spectra RMS
AIC Rating: 65kA
Frame: SKLA 480V 800A
Time Multiplier: 1
Trip: 800A
Setting: 1) MAX

TCC Name:
Bus Voltage: 480.0V
Fault Duty: 57401.5A
Curve Multiplier: 1
Time Adder: 0

Device Name:	FDR TO CRANE-2	TCC Name:	
Bus Name:	SWBD-A	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	300-1200A		
Type:	SKLA, Spectra RMS		
AIC Rating:	65kA	Fault Duty:	57401.5A
Frame:	SKLA 480V 800A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	800A		
Setting: 1) MAX			

Device Name:	FDR TO PNL-A-1	TCC Name:	
Bus Name:	SWBD-A	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	125-600A		
Type:	SGLA, Spectra RMS		
AIC Rating:	65kA	Fault Duty:	57401.5A
Frame:	SGLA 480V 400A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	350A		
Setting: 1) MAX			

Device Name:	FDR TO PNL-A-2	TCC Name:	
Bus Name:	SWBD-A	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	125-600A		
Type:	SGLA, Spectra RMS		
AIC Rating:	65kA	Fault Duty:	57401.5A
Frame:	SGLA 480V 400A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	350A		
Setting: 1) MAX			

Device Name:	FDR TO PNL-A-3	TCC Name:	
Bus Name:	SWBD-A	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	125-600A		
Type:	SGLA, Spectra RMS		
AIC Rating:	65kA	Fault Duty:	57401.5A
Frame:	SGLA 480V 400A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	350A		
Setting: 1) MAX			

Device Name:	FDR TO PNL-A-4	TCC Name:	
Bus Name:	SWBD-A	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	125-600A		
Type:	SGLA, Spectra RMS		
AIC Rating:	65kA	Fault Duty:	57401.5A
Frame:	SGLA 480V 400A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	250A		
Setting: 1) MAX			

Device Name:	FDR TO PNL-A-5	TCC Name:	
Bus Name:	SWBD-A	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	125-600A		
Type:	SGLA, Spectra RMS		
AIC Rating:	65kA	Fault Duty:	57401.5A
Frame:	SGLA 480V 400A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	250A		
Setting: 1) MAX			

Device Name:	FDR TO PNL-A-6	TCC Name:	
Bus Name:	SWBD-A	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	70-250A		
Type:	SFLA, Spectra RMS		
AIC Rating:	65kA	Fault Duty:	57401.5A
Frame:	SFLA 480V 250A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	100A		
Setting: 1) MAX			

Device Name:	FDR TO PNL-A-ILL	TCC Name:	
Bus Name:	SWBD-A	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	70-250A		
Type:	SFLA, Spectra RMS		
AIC Rating:	65kA	Fault Duty:	57401.5A
Frame:	SFLA 480V 250A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	70A		
Setting: 1) MAX			

Device Name:	FDR TO XFMR PNLA	TCC Name:	
Bus Name:	SWBD-A	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	15-150A		
Type:	SELA, Spectra RMS		
AIC Rating:	65kA	Fault Duty:	57401.5A
Frame:	SELA 480V 50A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	50A		
Setting: 1) MAX			

Device Name:	FDR TO ATS	TCC Name:	
Bus Name:	SWBD-B	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	70-250A		
Type:	SFLA, Spectra RMS		
AIC Rating:	65kA	Fault Duty:	56468.6A
Frame:	SFLA 480V 250A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	100A		
Setting: 1) MAX			

Device Name:	FDR TO CRANE3	TCC Name:	
Bus Name:	SWBD-B	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	300-1200A		
Type:	SKLA, Spectra RMS		
AIC Rating:	65kA	Fault Duty:	56468.6A
Frame:	SKLA 480V 800A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	800A		
Setting: 1) MAX			

Device Name:	FDR TO CRANE4	TCC Name:	
Bus Name:	SWBD-B	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	300-1200A		
Type:	SKLA, Spectra RMS		
AIC Rating:	65kA	Fault Duty:	56468.6A
Frame:	SKLA 480V 800A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	800A		
Setting: 1) MAX			

Device Name:	FDR TO PNL-B-1	TCC Name:	
Bus Name:	SWBD-B	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	125-600A		
Type:	SGLA, Spectra RMS		
AIC Rating:	65kA	Fault Duty:	56468.6A
Frame:	SGLA 480V 400A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	250A		
Setting: 1) MAX			

Device Name:	FDR TO PNL-B-2	TCC Name:	
Bus Name:	SWBD-B	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	125-600A		
Type:	SGLA, Spectra RMS		
AIC Rating:	65kA	Fault Duty:	56468.6A
Frame:	SGLA 480V 400A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	250A		
Setting: 1) MAX			

Device Name:	FDR TO PNL-B-3	TCC Name:	
Bus Name:	SWBD-B	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	125-600A		
Type:	SGLA, Spectra RMS		
AIC Rating:	65kA	Fault Duty:	56468.6A
Frame:	SGLA 480V 400A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	350A		
Setting: 1) MAX			

Device Name:	FDR TO PNL-B-4	TCC Name:	
Bus Name:	SWBD-B	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	125-600A		
Type:	SGLA, Spectra RMS		
AIC Rating:	65kA	Fault Duty:	56468.6A
Frame:	SGLA 480V 400A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	250A		
Setting: 1) MAX			

Device Name:	FDR TO PNL-B-5	TCC Name:	
Bus Name:	SWBD-B	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	125-600A		
Type:	SGLA, Spectra RMS		
AIC Rating:	65kA	Fault Duty:	56468.6A
Frame:	SGLA 480V 400A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	250A		
Setting: 1) MAX			

Device Name:	FDR TO PNL-B-6	TCC Name:	
Bus Name:	SWBD-B	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	125-600A		
Type:	SGLA, Spectra RMS		
AIC Rating:	65kA	Fault Duty:	56468.6A
Frame:	SGLA 480V 400A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	250A		
Setting: 1) MAX			

Device Name:	FDR TO PNL-B-8	TCC Name:	
Bus Name:	SWBD-B	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	125-600A		
Type:	SGLA, Spectra RMS		
AIC Rating:	65kA	Fault Duty:	56468.6A
Frame:	SGLA 480V 400A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	350A		
Setting: 1) MAX			

Device Name:	FDR TO PNL-B-ILL	TCC Name:	
Bus Name:	SWBD-B	Bus Voltage:	480.0V
Function Name:	Phase		
Manufacturer:	GE		
Description:	70-250A		
Type:	SFLA, Spectra RMS		
AIC Rating:	65kA	Fault Duty:	56468.6A
Frame:	SFLA 480V 250A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Trip:	70A		
Setting: 1) MAX			

Device Name: FDR TO XFMR PNLB
Bus Name: SWBD-B
Function Name: Phase
Manufacturer: GE
Description: 15-150A
Type: SELA, Spectra RMS
AIC Rating: 65kA
Frame: SELA 480V 50A
Time Multiplier: 1
Trip: 50A
Setting: 1) MAX

TCC Name:
Bus Voltage: 480.0V
Fault Duty: 56468.6A
Curve Multiplier: 1
Time Adder: 0

Device Name: FDR TO XFMR TRAIL
Bus Name: SWBD-B
Function Name: Phase
Manufacturer: GE
Description: 125-600A
Type: SGLA, Spectra RMS
AIC Rating: 65kA
Frame: SGLA 480V 600A
Time Multiplier: 1
Trip: 600A
Setting: 1) MAX

TCC Name:
Bus Voltage: 480.0V
Fault Duty: 56468.6A
Curve Multiplier: 1
Time Adder: 0

Device Name: SWBD-B MAIN
Bus Name: SWBD-B
Function Name: Phase
Manufacturer: GE
Description: LSI (CB), 4000AF, UL 489
Type: SS, SH PowerBreak II, EGTU
AIC Rating: 100kA Override:50 ShortTime:42
Frame: SS 480V 4000A
Time Multiplier: 1
Sensor: 4000A
Plug: 4000A
Setting: 1) LTPU/LTD (0.5-1 x RP 1.00X (4000A)C-2
2) STPU (1.5-9 x LTPU) 2X (8000A)
3) STD (ST01 - ST11) ST01-Min I^2 t In
4) INST (2-9 x RP) 9X (36000A)

TCC Name:
Bus Voltage: 480.0V
Fault Duty: 56468.6A
Curve Multiplier: 1
Time Adder: 0

Function Name: Ground
Manufacturer: GE
Description: GF, 4000AF
Type: SS, SH PowerBreak I & II, EGTU
AIC Rating: 100kA ShortTime:42
Frame: SS 480V 4000A
Time Multiplier: 1
Sensor: 4000A
Plug: 4000A
Setting: 1) GFPU (0.2-0.6 x S) 0.6 (1200A)
2) GFD I2T (1-13 Bands) GFD03 I^2 t In

Fault Duty: 56468.6A
Curve Multiplier: 1
Time Adder: 0

Device Name:	1-PRIME FUSE A	TCC Name:	1-Utility Transformer, Transformer Damage Curve, SWBD-A Main, Feeder to Cr
Bus Name:	XFMR-UTILAP	Bus Voltage:	12470.0V
Function Name:	Phase		
Manufacturer:	COOPER		
Description:	C4-C17		
Type:	Bay-O-Net Current Sensing Fuse Link, 23kV		
AIC Rating:	4kA	Fault Duty:	1000229.6A
Cartridge:	353C17 8300V 140A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Size:	140A		

Device Name:	PRIME FUSE B	TCC Name:	
Bus Name:	XFMR-UTILBP	Bus Voltage:	12470.0V
Function Name:	Phase		
Manufacturer:	COOPER		
Description:	C4-C17		
Type:	Bay-O-Net Current Sensing Fuse Link, 23kV		
AIC Rating:	3kA	Fault Duty:	1000238.1A
Cartridge:	353C17 15500V 140A	Curve Multiplier:	1
Time Multiplier:	1	Time Adder:	0
Size:	140A		

TAB 14

HARMONIC STUDY

Harmonics - General

Harmonics are multiples of the fundamental frequency of an electrical power system. If, for example, the fundamental frequency is 60 Hz, then the 5th harmonic is five times that frequency, or 300 Hz. Likewise, the 7th harmonic is seven times the fundamental or 420 Hz, and so on for higher order harmonics.

Harmonics can be discussed in terms of current or voltage. A 5th harmonic current is simply a current flowing at 300 Hz on a 60 Hz system. The 5th harmonic current flowing through the system impedance creates a 5th harmonic voltage. Total Harmonic Distortion (THD) sometimes expresses the amount of harmonics. The following is the formula for calculating the THD for current:

$$I_{THD} = \frac{\sqrt{\sum_{h=2}^{\infty} I_h^2}}{I_1} x100\%$$

For example...

I_1 = current at 60 Hz = 250 Amps
I_5 = current at 300 Hz = 50 Amps
I_7 = current at 420 Hz = 35 Amps

Then...

$$I_{THD} = \sqrt{\frac{(50^2 + 35^2)}{250}} \quad x \ 100 = 24\%$$

When harmonic currents flow in a power system, they are known as poor "power quality" or "dirty power". Other causes of poor power quality include transients such as voltage spikes, surges, sags, and ringing. Because they repeat every cycle, harmonics are regarded as a steady-state cause of poor power quality.

Devices that draw non-sinusoidal currents when a sinusoidal voltage is applied create harmonics. Frequently these are devices that convert AC to DC. Listed below are some of these devices.

- Adjustable Speed Drives (ASDs)
- DC Drives
- Variable Frequency Drives (VFDs)
- 6-pulse Converters
- Power Rectifiers (e.g., plating systems)
- Uninterruptible Power Supplies (UPSs)

These devices use power electronics like SCRs, diodes, and thyristors, which are a growing percentage of the load in industrial power systems. The majority use a 6-pulse converter.

Loads, which cause harmonics, do so as a steady-state phenomenon. A snap shot reading of an operating load, that is suspected to be non-linear, can determine if it is producing harmonics.

Normally each load would manifest a specific harmonic spectrum. The 6-pulse converter, for example, is the most common industrial harmonic source. It exhibits a spectrum starting with the 5th harmonic and decreases in amplitude with increasing frequency throughout its spectrum.

A switch-mode power supply used for personal computers is another common spectrum. It has a spectrum starting with the 3rd harmonic and continuing with the triplens as the most dominant. It is found in commercial applications.

$$h = 3, 9, 15, 21, 27, \ldots$$

Another common spectrum is produced by large UPS (Uninterruptible Power Supply) systems which use a 12-pulse converter. They have the following spectrum:

$$h = np \pm 1$$

Where...

$$h = \text{harmonic numbers of the spectrum}$$
$$n = 1, 2, 3, \ldots$$
$$p = 12 \text{ for a 12-pulse converter}$$

Then...

$$h = 11, 13, 23, 25, 35, 37, \ldots$$

Many problems can arise from harmonic currents in a power system. Some problems are easy to detect, others exist and persist because harmonics are not suspected. Higher

RMS current and voltage in the system are caused by harmonic currents, which can result in any of the problems listed below:

- Failed Power Factor Correction Capacitors
- Blown Fuses (no apparent fault)
- Misfiring of AC and DC Drives
- Worn Conductor Insulation
- Overheated Transformers
- Tripped Circuit Breakers
- Overheated Conductors

A big problem is overheating transformers. Just a 10°C rise in the temperature of transformers, motors, or capacitors can reduce equipment life by 50%. Harmonic currents have higher frequencies. They travel toward the outside (skin effect) of the conductors, resulting in insulation breakdown.

One of the most common problems for industrial power users is meeting the IEEE standard 519-1992. This standard was developed for utility companies and their customers to limit harmonic content and provide all users with better power quality. See Tables 1 and 2 for some key areas of this standard.

Voltage Distortion Limits

Bus Voltage at PCC*	Individual Voltage Distortion (%)	Total Voltage Distortion THD (%)
69 kV and below	3.0	5.0
69.001 kV trough 161 kV	1.5	2.5
161.001 kV and above	1	1.5

NOTE: High-voltage systems can have up to 2% THD where the cause is an HVDC terminal that will attenuate by the time it is tapped for a user.

*PCC is Point of Common Coupling

Current Distortion Limits for General Distribution Systems End-User (120 Volts through 69,000 Volts)

Maximum harmonic Current Distortion in % of I_L

Individual Harmonic Order (Odd Harmonics)

I_{SC}/I_L	<11	<11≤h<17	17≤h<23	23≤h<35	35≤h	TDD
<20*	4.0	2.0	1.5	0.6	0.3	5.0
20<50	7.0	3.5	2.5	1.0	0.5	8.0
50<100	10.0	4.5	4.0	1.5	0.7	12.0
100<1000	12.0	5.5	5.0	2.0	1.0	15.0
>1000	15.0	7.0	6.0	2.5	1.4	20.0

Harmonics are limited to 25% of the odd harmonic limits above

Current distortions that cause a dc offset, i.e., half-wave converters, are not allowed

*All power generation equipment is limited to these values of current distortion, regardless of the

actual I_{sc} / I_L
Where:
I_{sc} = maximum short-circuit current at PCC**
I_L = maximum demand load current (fundamental frequency component) at PCC
**PCC is Point of Common Coupling

Harmonics Calculation Program

The harmonic study was performed using the SKM Power Tools HIWAVE program. The program calculates the voltage and current THD% for multiple sources on a bus or system. The THD% values are then compared to the IEEE 519-1992 Standards. The intent is to not exceed these standards. The program also plots the distortion waveform and harmonic spectrum of voltage and current at the PCC.

Harmonics Modeling & Assumptions

The Harmonic study was performed to analyze the harmonic voltages and currents that were most likely to be produced on the power distribution system due to the operation of non-linear load. The study data was based on the harmonic configuration shown on the one-line diagram. At the time of the study, the engineer had not received any submittals for the Variable Frequency Drives associated with the cranes. Therefore, the engineer assumed the VFDs were typical 6 or 12 pulse devices.

- In Scenario 1, the engineer ran the calculation with the assumption that a typical 6 pulse drive with both cranes running at each switchboard.

- In Scenario 2, the engineer ran the calculation with the assumption that a typical 12 pulse drive with both cranes running at each switchboard.

Results

Table 1 & 2 shows the voltage and current THD% at the point of common couplings. Voltage and current waveforms for the most significant locations/branches can be found under the harmonic computer printouts tab.

Bus	Bus Voltage THD% (Scenario 1)	Bus Voltage THD% (Scenario 2)	V_THD % IEEE – 519
Switchboard A	4.7	1.4	5
Switchboard B	5.0	1.5	5

Table 1: Bus Voltage THD

Bus	Current THD% (Scenario 1)	Current THD% (Scenario 2)	I_THD % IEEE – 519
Switchboard A	19.4	3.0	8
Switchboard B	12.1	1.9	8

Table 2: Current THD

As can be seen from the tables above, the total voltage harmonic distortions are below the IEEE - 519 limits for either scenario. The total current harmonic distortions are above IEEE – 519 limits under scenario 1 but meets IEEE – 519 limits under scenario 2.

The engineer recommends using a typical 12 pulse Variable Frequency Drive in order to meet IEEE – 519 requirements.

The following graphs show the distortion waveform and harmonic spectrum of voltage and current at the Switchboards for the study case.

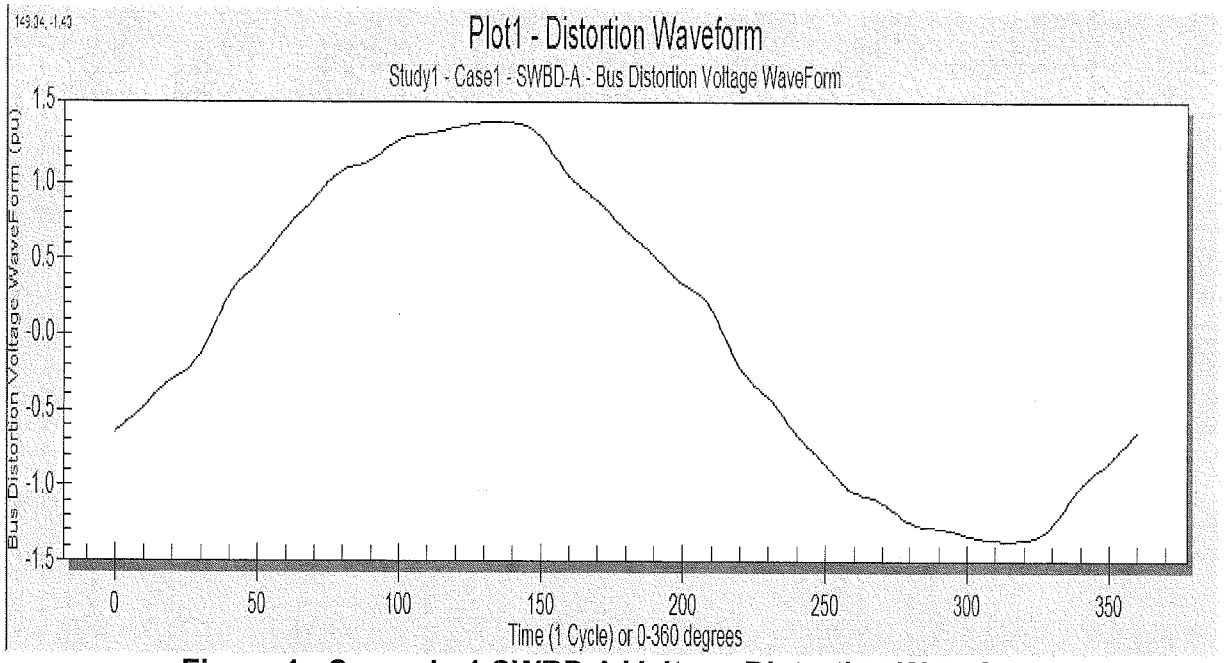


Figure 1: Scenario 1 SWBD A Voltage Distortion Waveform

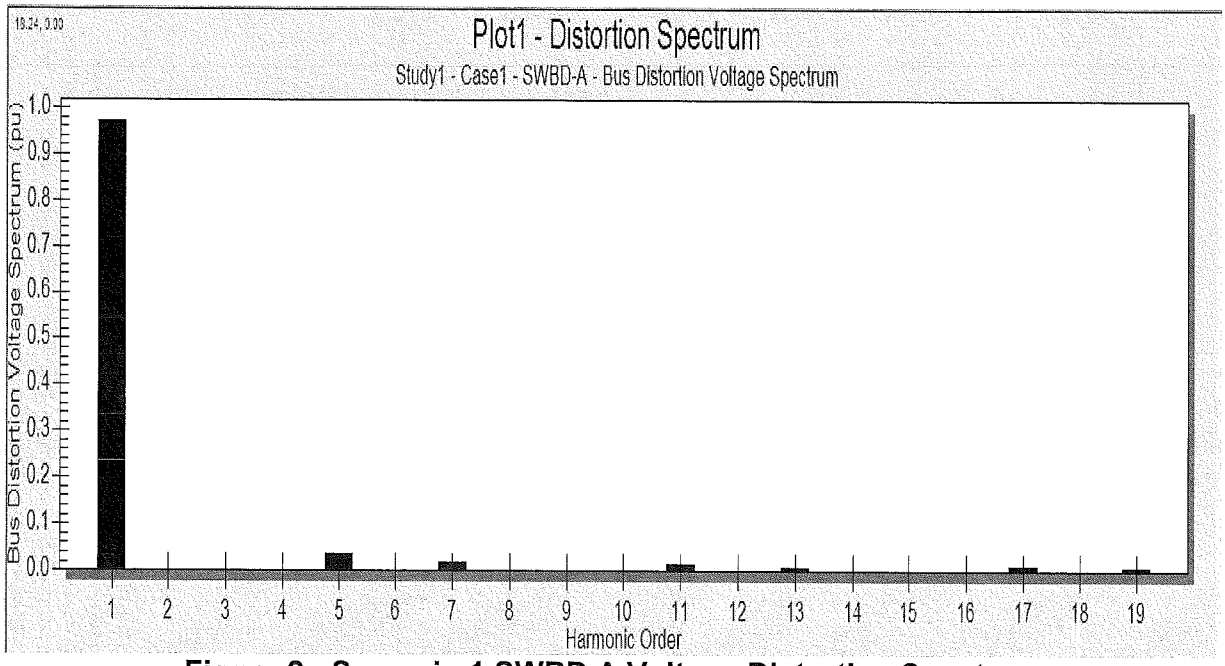


Figure 2: Scenario 1 SWBD A Voltage Distortion Spectrum

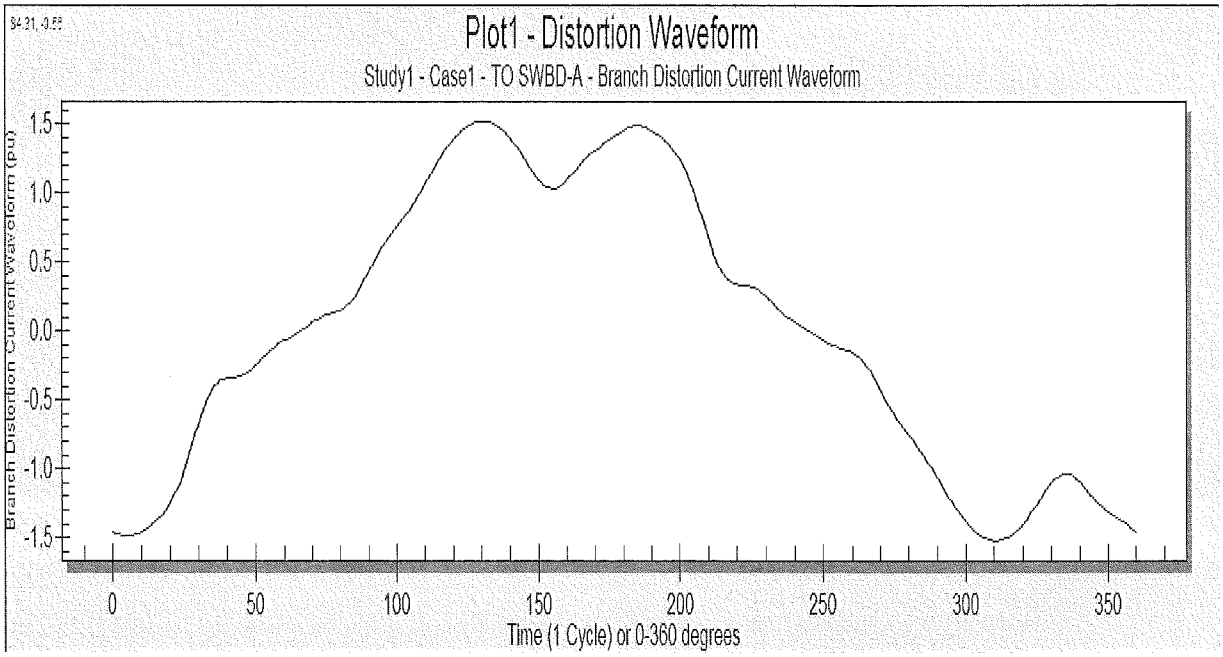


Figure 3: Scenario 1 SWBD A Current Distortion Waveform

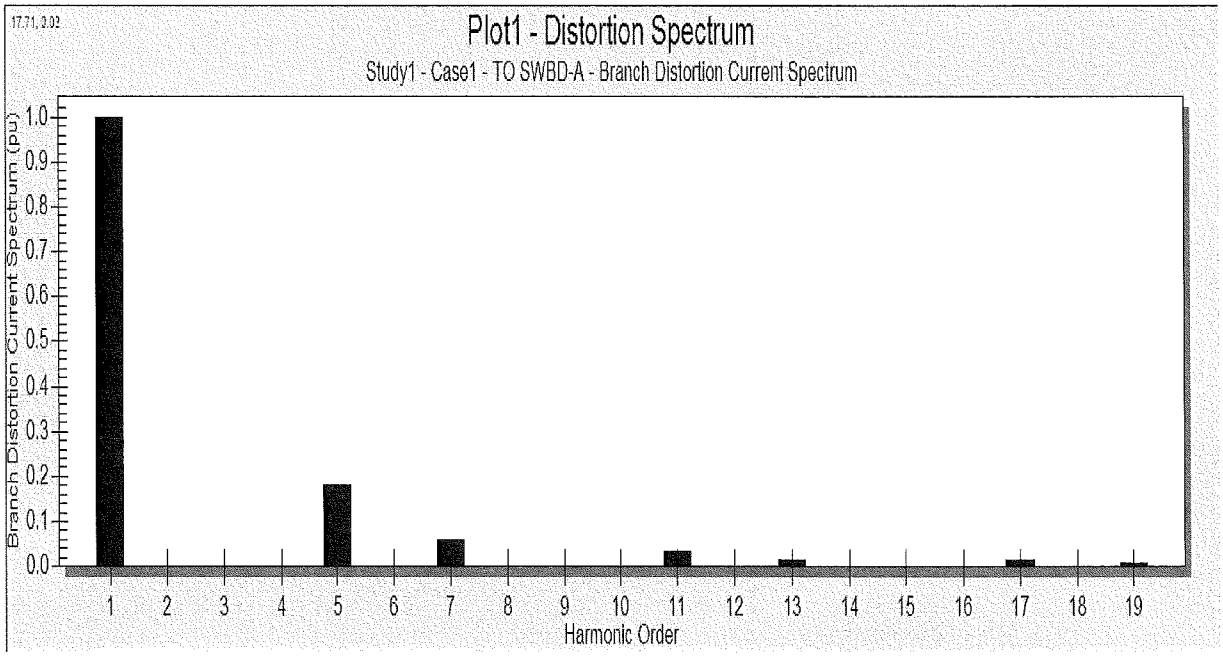


Figure 4: Scenario 1 SWBD A Current Distortion Spectrum

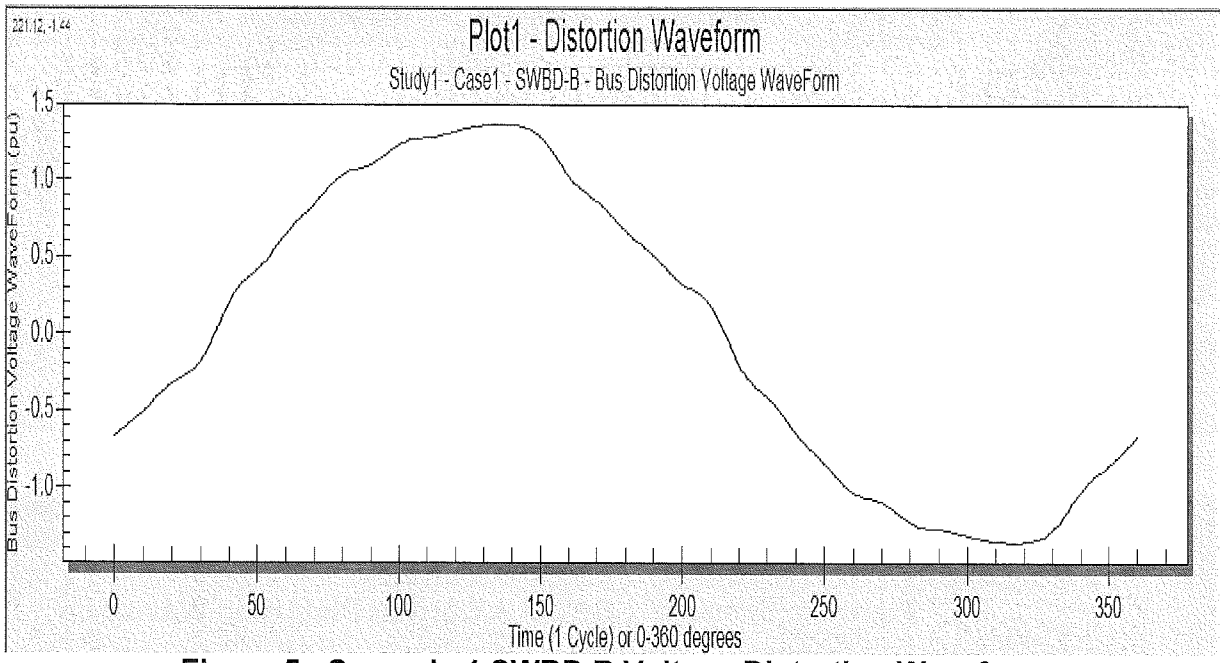


Figure 5: Scenario 1 SWBD B Voltage Distortion Waveform

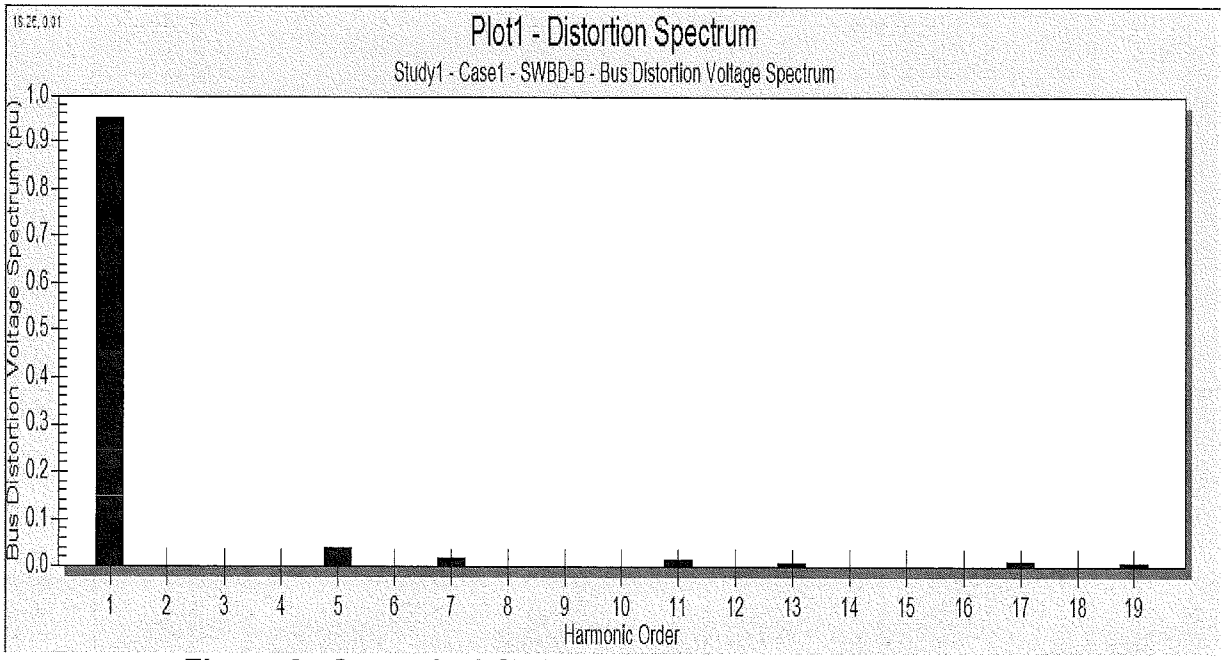


Figure 6: Scenario 1 SWBD B Voltage Distortion Spectrum

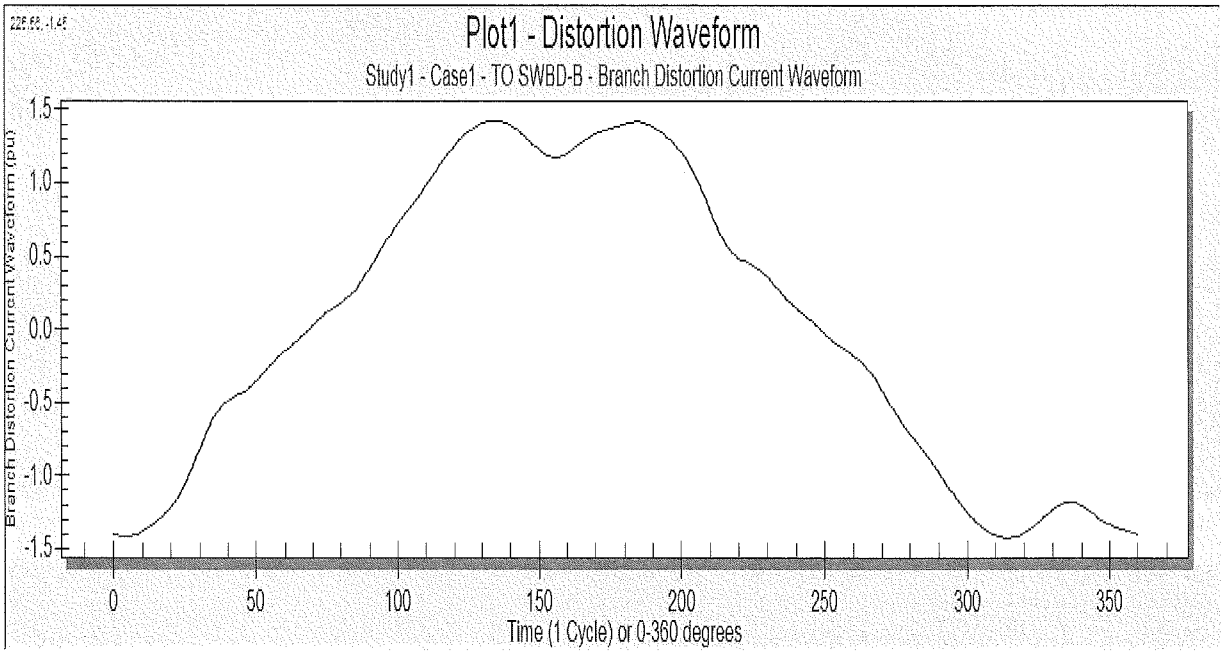


Figure 7: Scenario 1 SWBD B Current Distortion Waveform

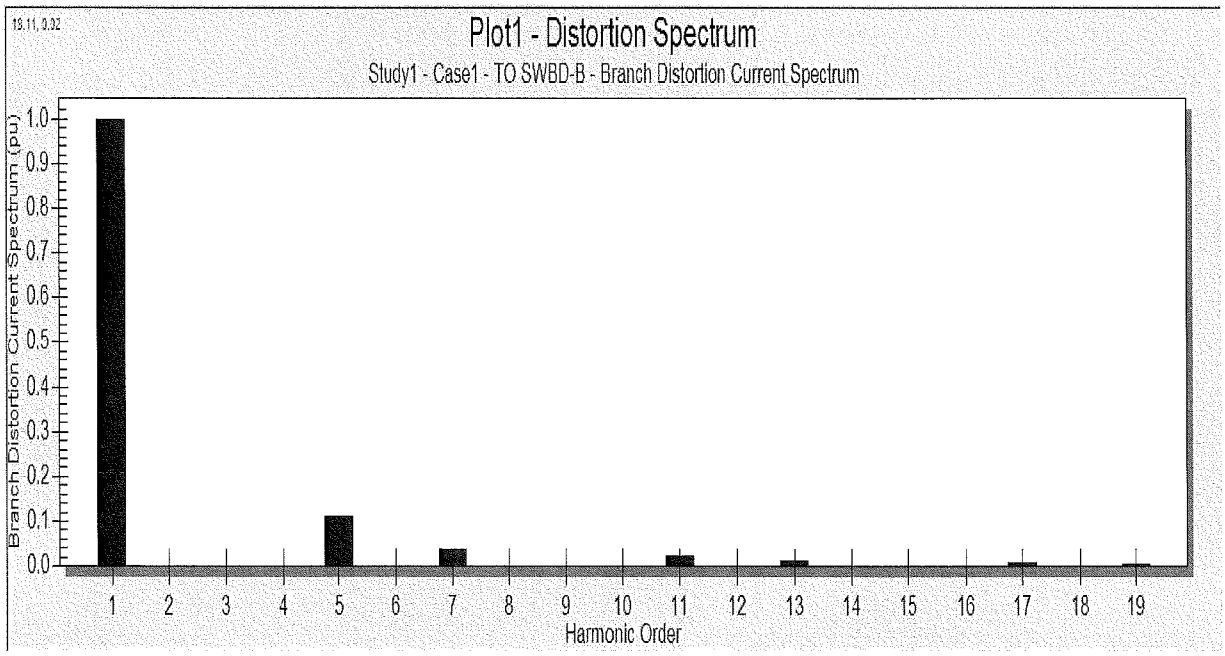


Figure 8: Scenario 1 SWBD B Current Distortion Spectrum

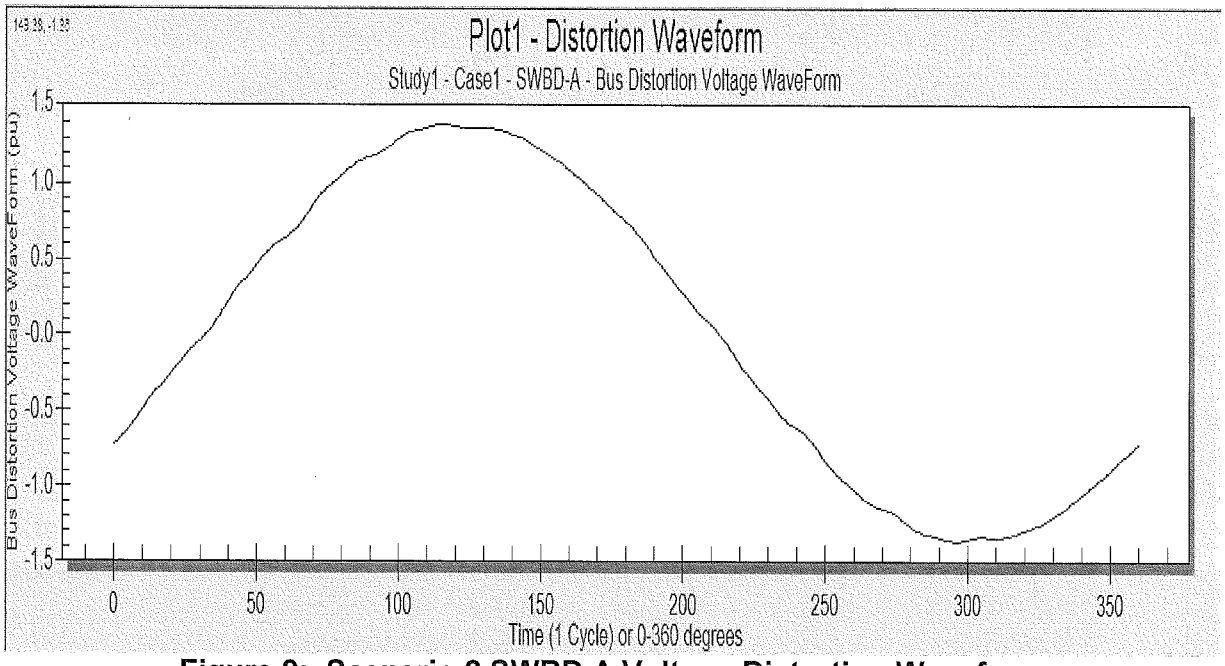


Figure 9: Scenario 2 SWBD A Voltage Distortion Waveform

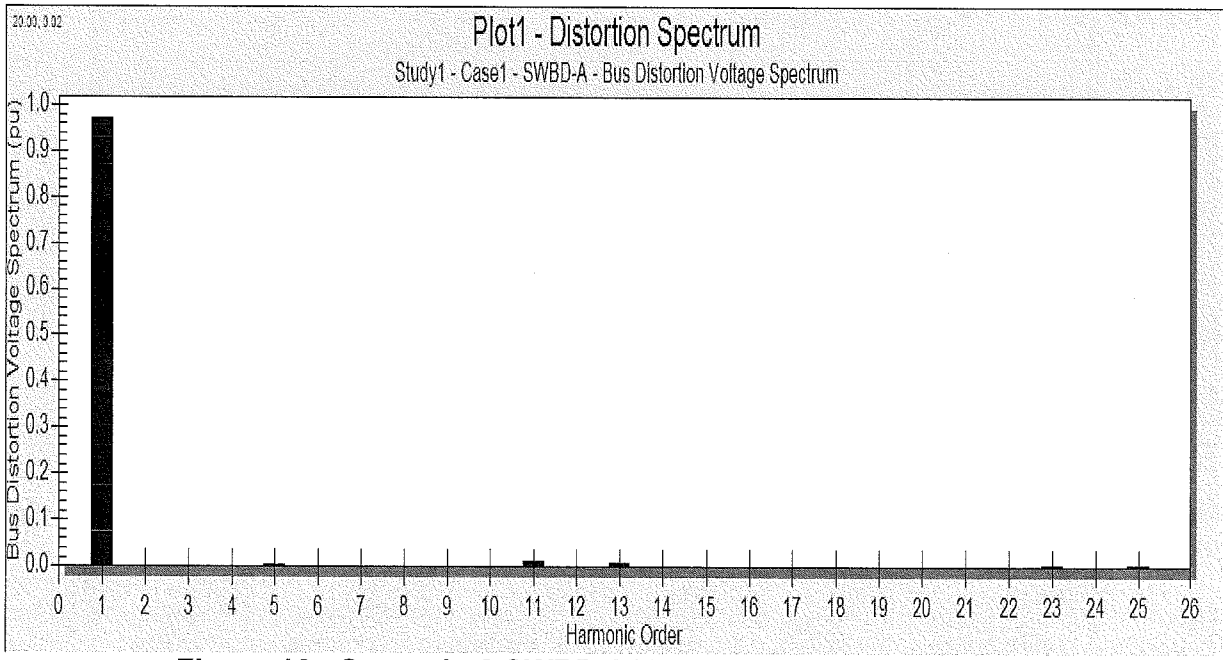


Figure 10: Scenario 2 SWBD A Voltage Distortion Spectrum

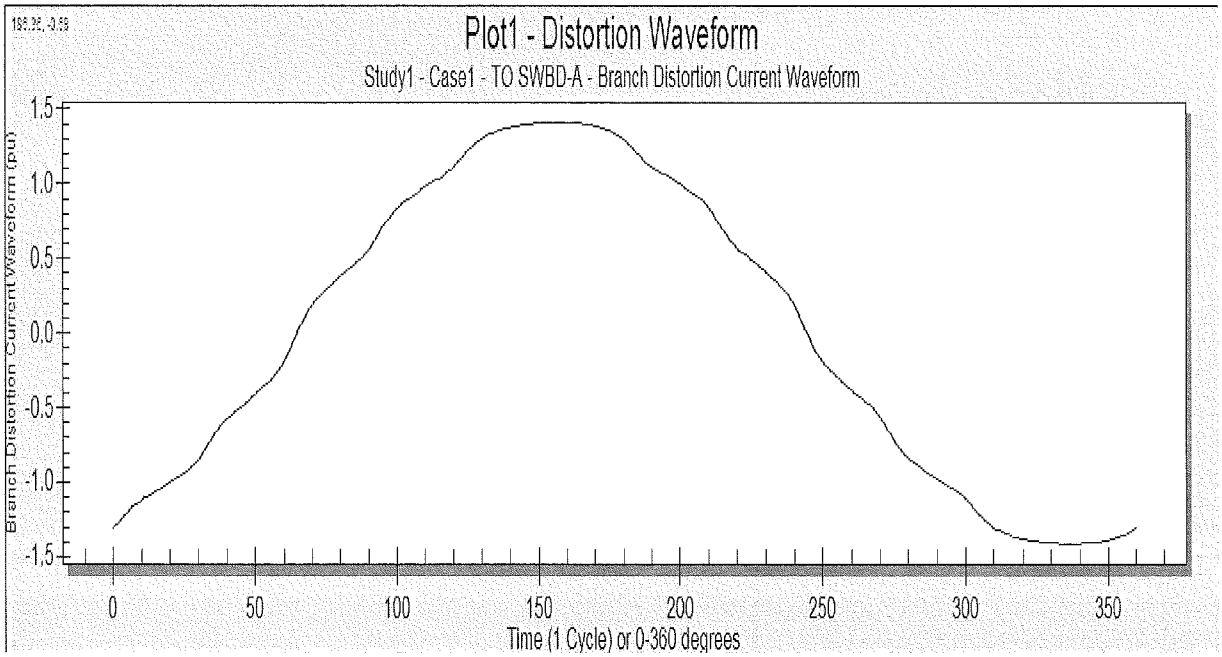


Figure 11: Scenario 2 SWBD A Current Distortion Waveform

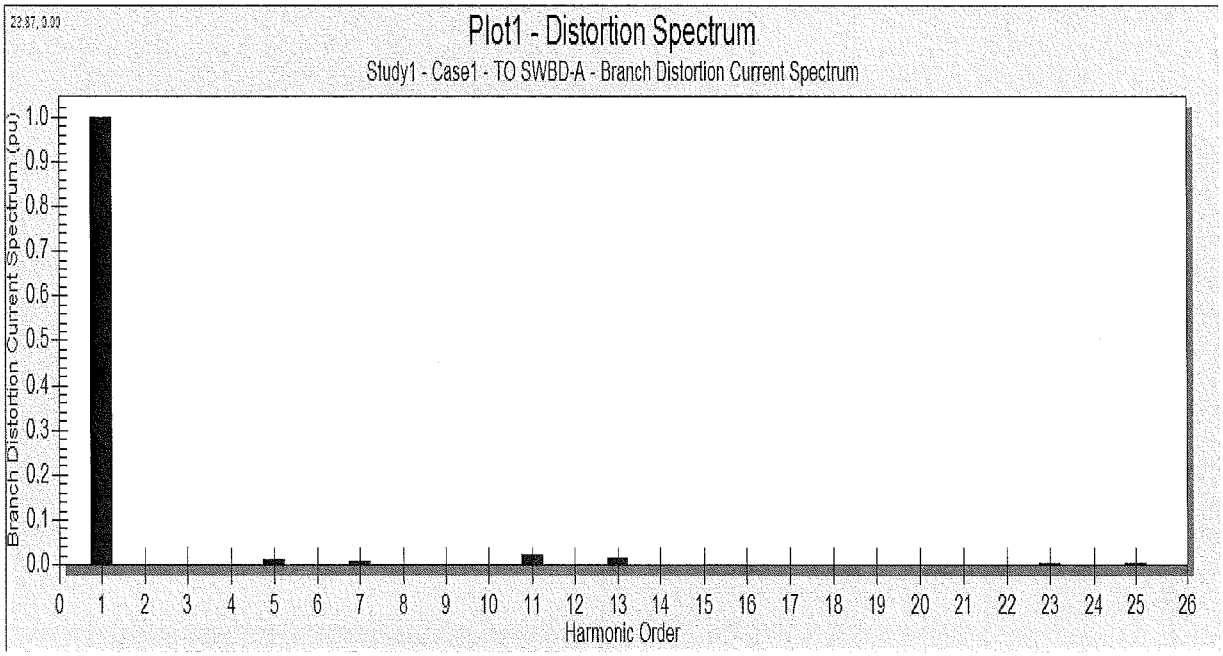


Figure 12: Scenario 1 SWBD A Current Distortion Spectrum

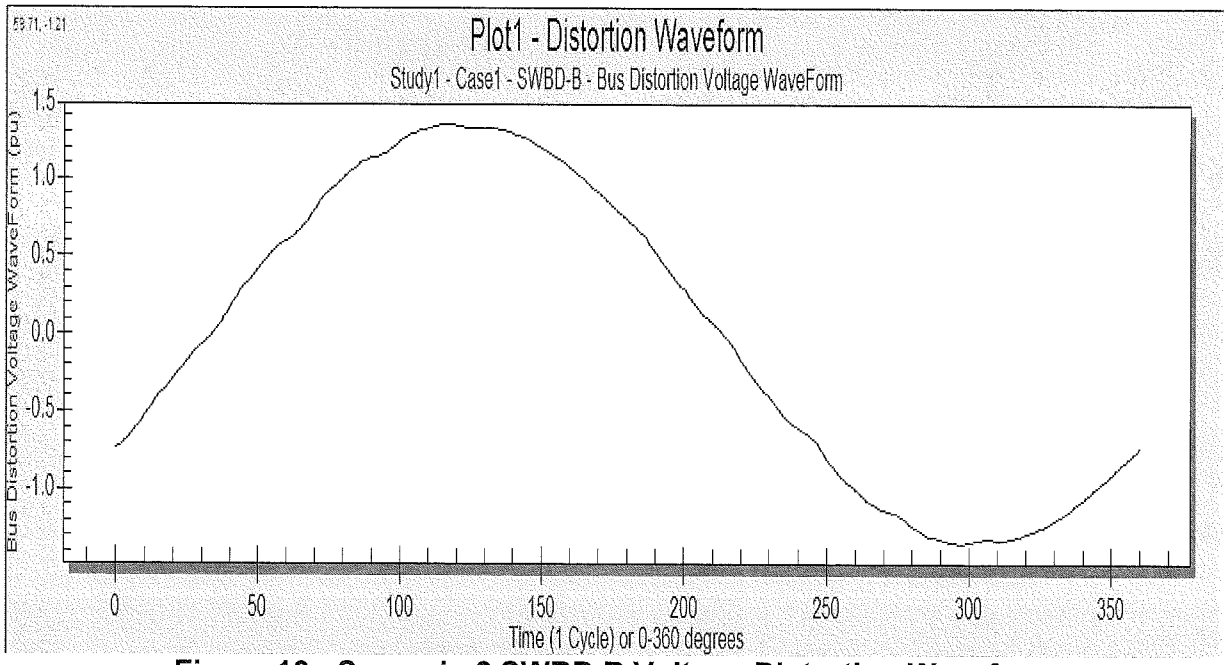


Figure 13: Scenario 2 SWBD B Voltage Distortion Waveform

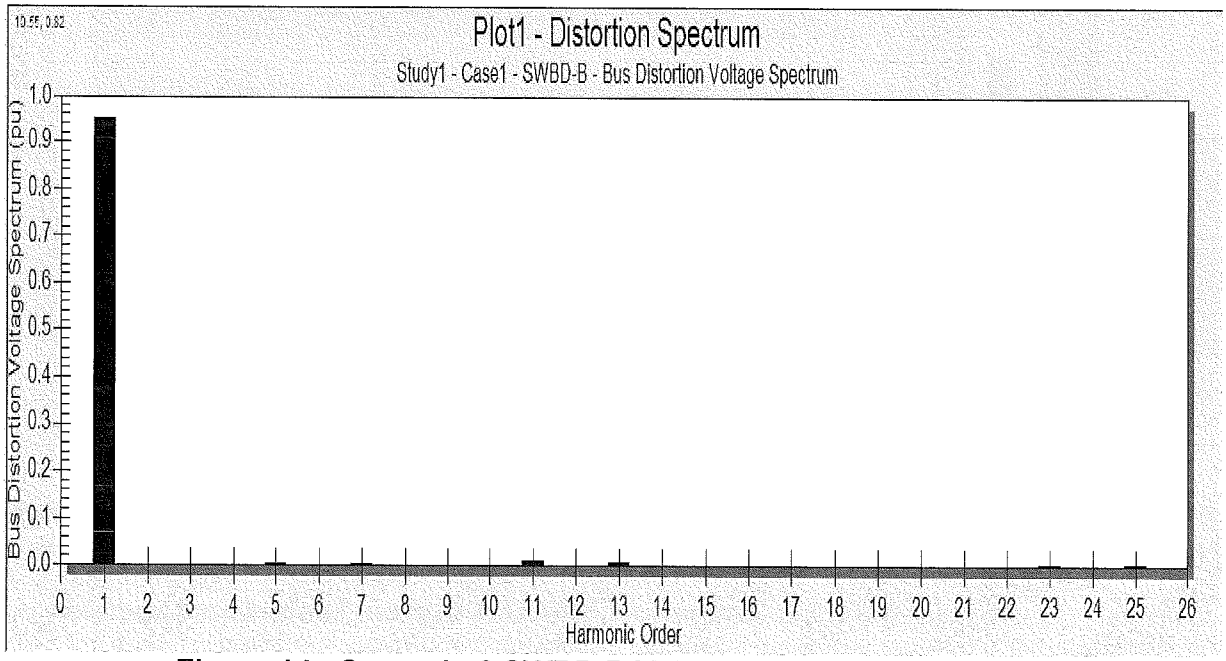


Figure 14: Scenario 2 SWBD B Voltage Distortion Spectrum

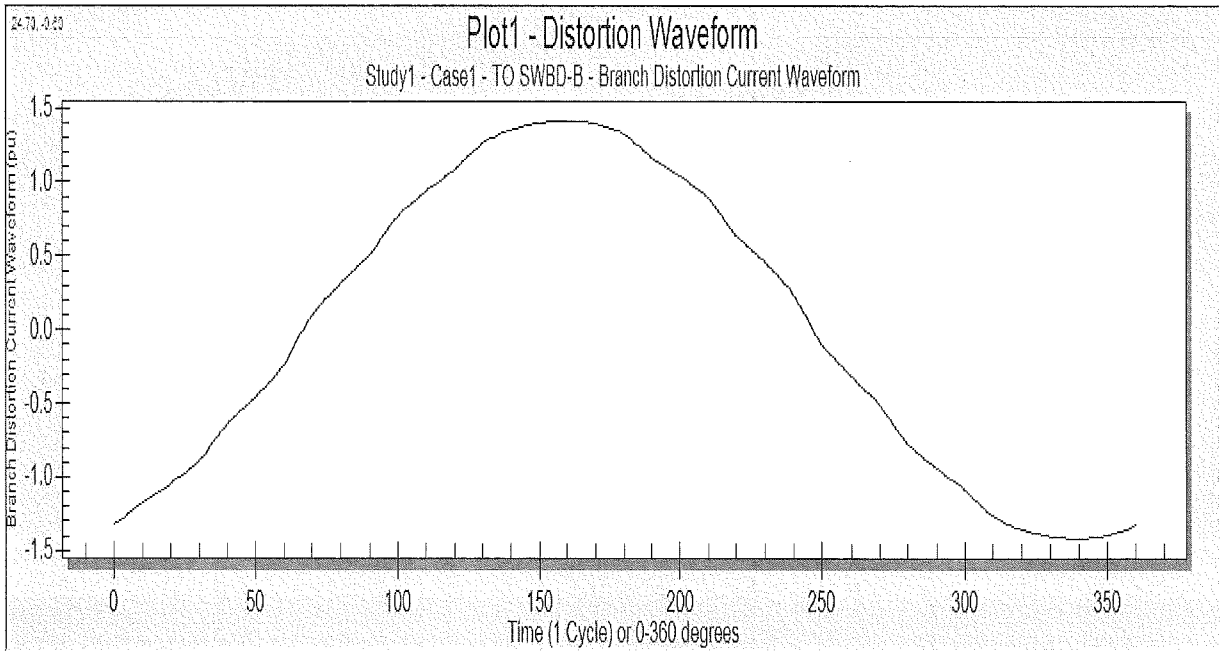


Figure 15: Scenario 2 SWBD B Current Distortion Waveform

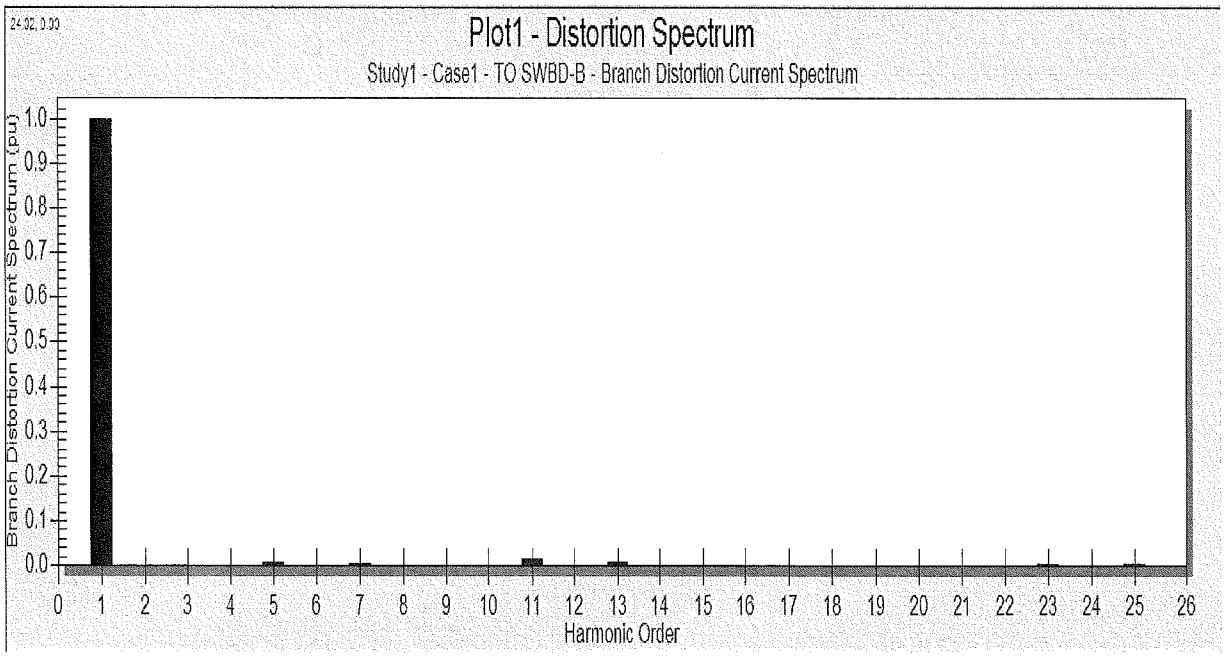
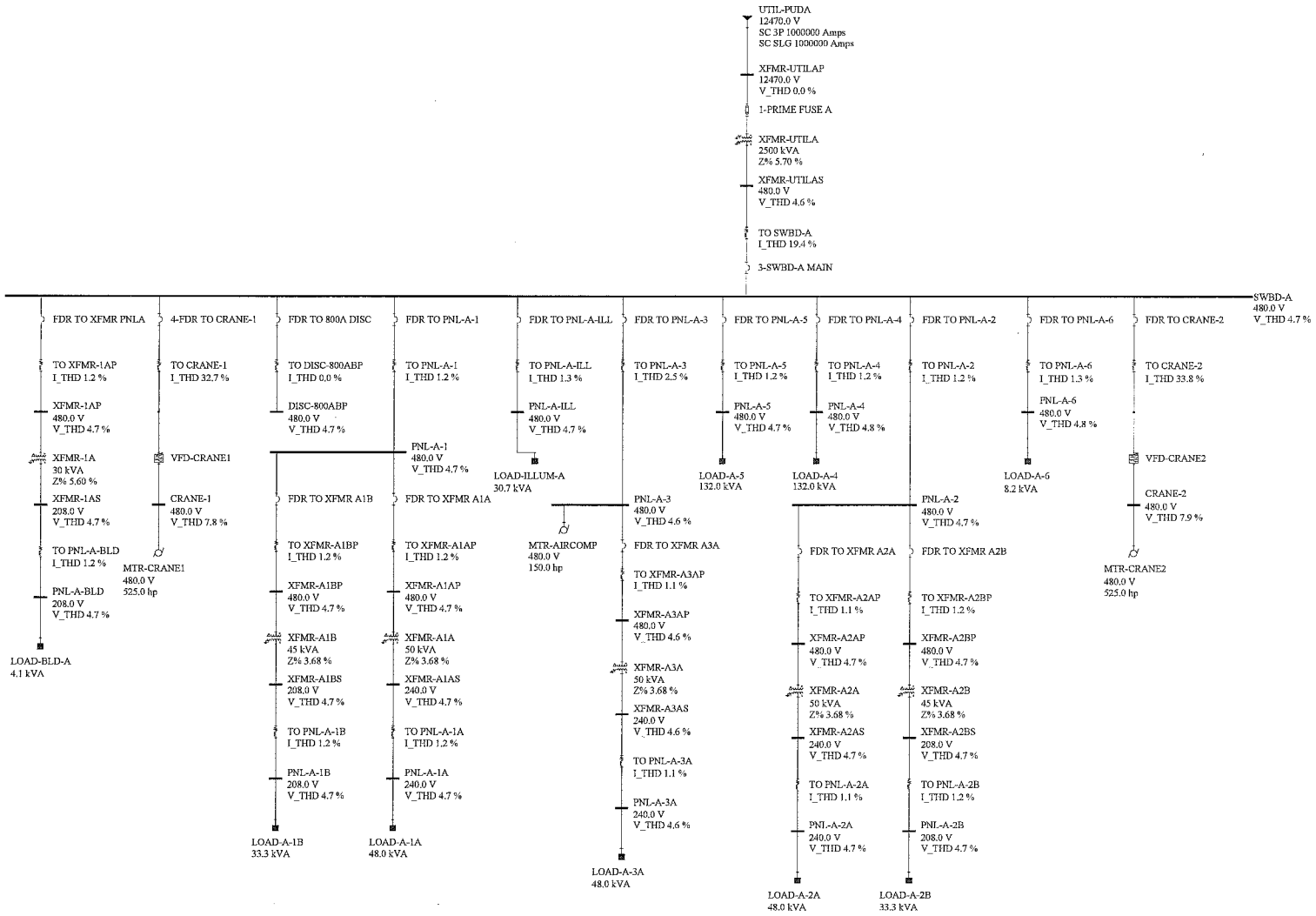


Figure 16: Scenario 2 SWBD B Current Distortion Spectrum



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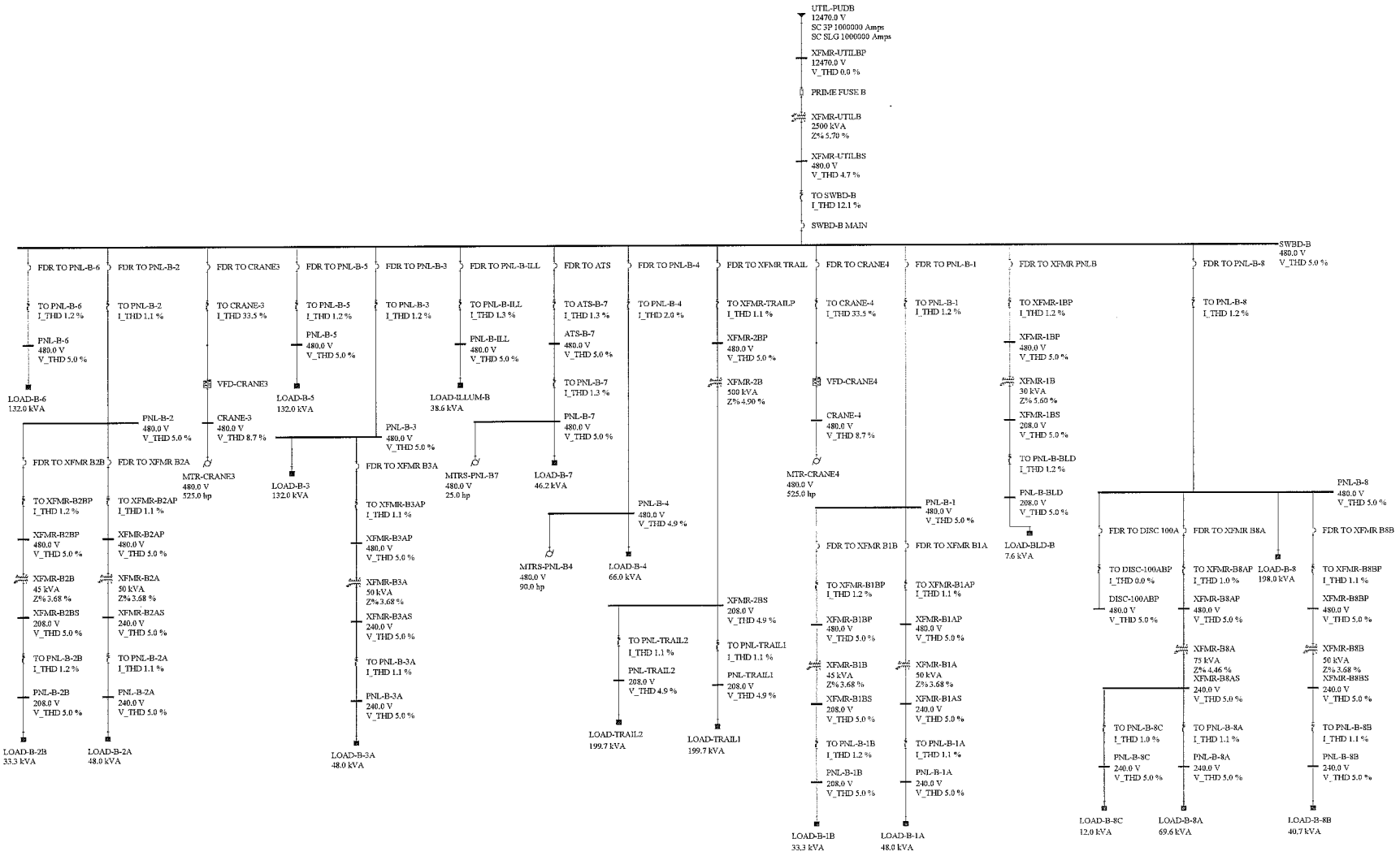
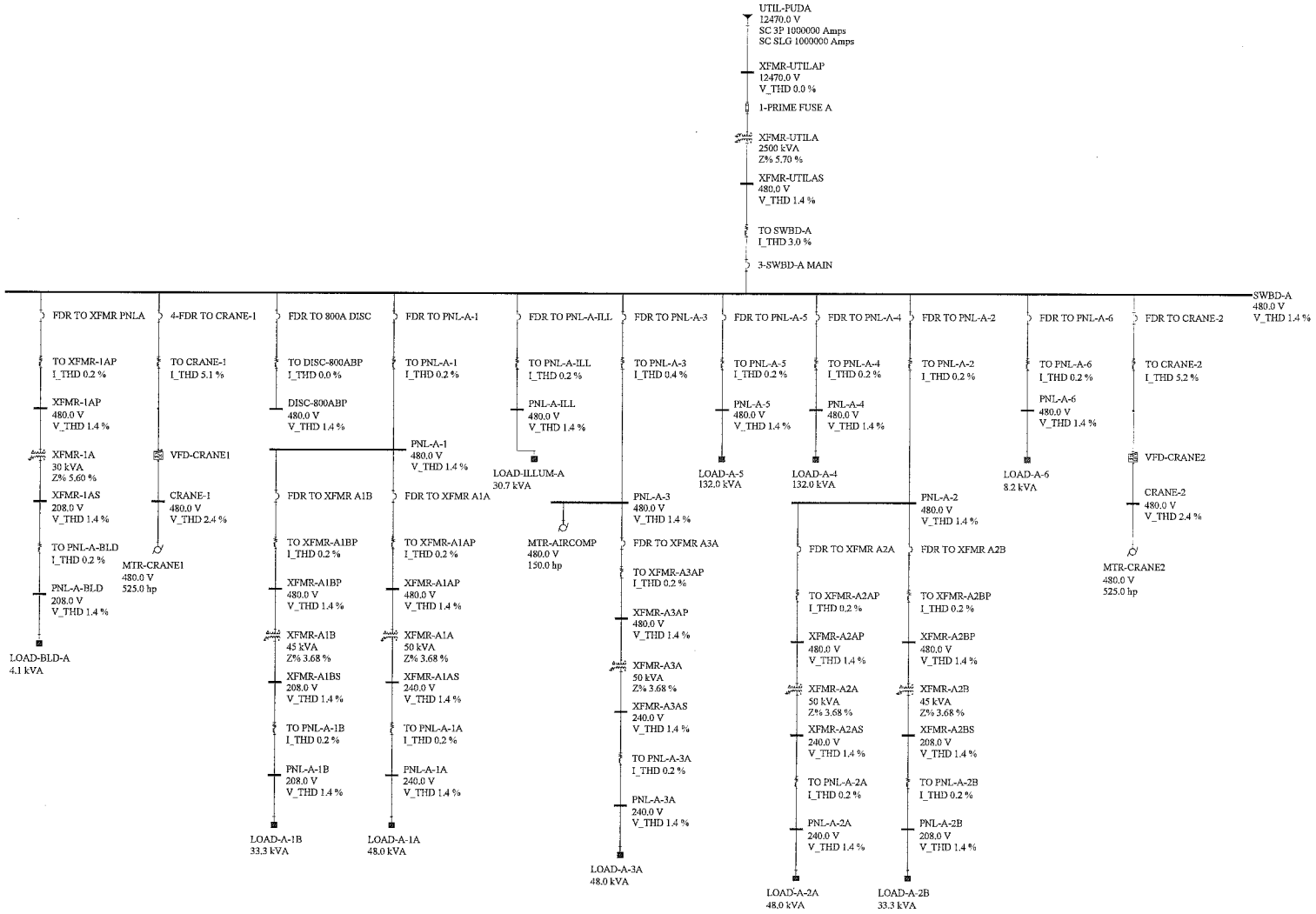
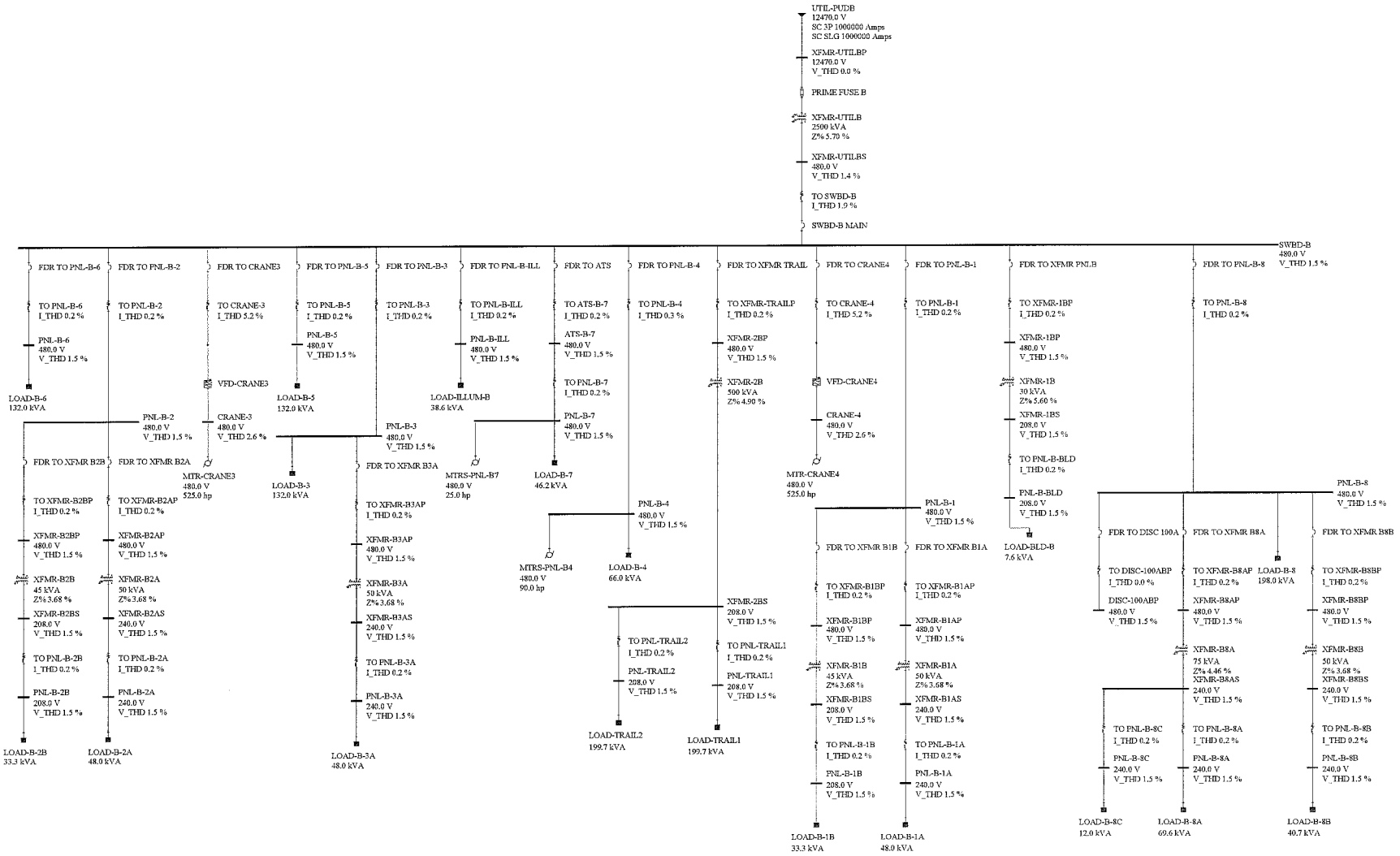
Revision 1						
				Checked By: Robert E. Fuhr P.E. 6/3/2011	Phone 253-639-8535 ■ Fax 253-639-8685 ■ 16122 SE 266th St, Covington, WA 98042	Scenario 1 Harmonic Diagram	1001055-3



				Drawn By: Tam Tran 6/3/2011	PowerStudies.com PS Phone 253-639-8535 ■ Fax 253-639-8685 ■ 16122 SE 266th St, Covington, WA 98042	SR 520 Pontoon Project	E4B
Revision 1				Checked By: Robert E. Fuhr P.E. 6/3/2011		Scenario 1 Harmonic Diagram	1001055-3



				Drawn By: Tam Tran 6/3/2011	PowerStudies.com PS Phone 253-639-8535 ■ Fax 253-639-8685 ■ 16122 SE 266th St, Covington, WA 98042	SR 520 Pontoon Project	E4C
Revision 1				Checked By: Robert E. Fuhr P.E. 6/3/2011		Scenario 2 Harmonic Diagram	1001055-3



				Drawn By: Tam Tran 6/3/2011	PowerStudies.com PS Phone 253-639-8535 ■ Fax 253-639-8685 ■ 16122 SE 266th St, Covington, WA 98042	SR 520 Pontoon Project	E4D
Revision 1				Checked By: Robert E. Fuhr P.E. 6/3/2011		Scenario 2 Harmonic Diagram	1001055-3

Harmonic Results – Scenario 1

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OUTPUT DATA REPORT
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STUDY CRITERIA

Studies Selected To Run:	
Load Flow:	Yes
Frequency Scan:	Yes
Harmonic Distortion:	Yes
Load Flow Study Setup Options	
Utility Impedance:	Yes
Transformer Phase Shift:	Yes
Solution Method:	Exact
Load Specification:	Connected Load
Generation Acceleration Factor:	1.00
Load Acceleration Factor:	1.00
Bus Voltage Drop:	5.00
Branch Voltage Drop:	3.00
HI_WAVE Study Setup Options	
Fundamental Frequency:	60 Hz
Max. Harmonic Order:	50
Include Triplet Harmonics Path (Static Load):	No
Include Triplet Harmonics Path (Ind. Motor):	No
Modify Motor Z by Load Factor (Ind. Motor):	Yes
Modify Load Z by Load Factor (Static Load):	Yes
HI_WAVE Study Setup Options for Frequency Scan	
Scan Impedance Option:	Scan Self Impedance
Use Positive Sequence Network:	Yes
Use Negative Sequence Network:	Yes
Use Zero Sequence Network:	No
Model Transformer Tap:	Yes
Model Transformer Phase Shift:	Yes
Report Bus Equivalent Impedance:	No
Number of Scan Steps Per Order:	1
HI_WAVE Study Setup Options for Distortion	
Use Positive Sequence Network:	Yes
Use Negative Sequence Network:	Yes
Use Zero Sequence Network:	Yes
Model Transformer Tap:	Yes
Model Transformer Phase Shift:	Yes
Fundamental Solution:	Use Load Flow Result
Report Option:	All Distortions and Violations
Current Limits:	IEEE 519-1996 Std, Current Distortion Limit Table 3.2

LOADS AND MOTORS WITH HARMONIC SOURCE MODELS				
Bus Name	Voltage	Component Name	LF Current	Harmonic Library
CRANE-1	480	VFD-CRANE1	635.4	Typical 6 Pulse
CRANE-2	480	VFD-CRANE2	635.4	Typical 6 Pulse
CRANE-3	480	VFD-CRANE3	651.6	Typical 6 Pulse
CRANE-4	480	VFD-CRANE4	651.6	Typical 6 Pulse

HARMONIC SOURCE		
Typical 6 Pulse		
Order	Magnitude (%)	Angle (Degrees)
1	100.000	-12.60
5	37.600	107.40
7	12.600	-126.90
11	7.000	-93.20
13	3.400	-50.20
17	2.900	15.90
19	1.700	45.00

HARMONIC SOURCE INDEX TABLE
HARMONIC SOURCES HAVE BEEN FOUND AND INJECTED FOR EACH OF THE FOLLOWING HARMONIC ORDERS
5 7 11 13 17 19

PASSIVE FILTER DATA												
Filter Name	Bus Name	Bus Voltage	Rated Voltage	Connect	Filter Type	Capacitor KVAR	Tuned Order	Q	M	R (Ω)	L (H)	C (μF)
NO FILTER												

ULTILITY, GENERATOR AND MOTOR DATA							
Component Name	Component Type	Bus Name	Bus Voltage	Base Voltage	Base KVA	R1(pu) R2 R0	X1(pu) X2 X0
UTIL-PUDA	UTILITY	XFMR-UTILAP	12470	12470	100000	0.0009 0.0009 0.0009	0.0045 0.0045 0.0045
UTIL-PUDB	UTILITY	XFMR-UTILBP	12470	12470	100000	0.0009 0.0009 0.0009	0.0045 0.0045 0.0045

TOTAL VOLTAGE DISTORTION					
Bus Name	Voltage	V_RMS(V)	V_TIF	V_THD(%)	IEEE-519
ATS-B-7	480	445.78	83.8589	5.0038	
BUS-0099	480	458.43	129.7965	7.7712	
BUS-0100	480	458.46	131.4890	7.8734	
BUS-0101	480	447.37	144.3220	8.6552	
BUS-0102	480	447.37	144.3220	8.6552	
CRANE-1	480	458.43	129.7967	7.7712	
CRANE-2	480	458.46	131.4892	7.8734	
CRANE-3	480	447.37	144.3222	8.6552	
CRANE-4	480	447.37	144.3222	8.6552	
DISC-100ABP	480	448.83	83.1845	4.9667	
DISC-800ABP	480	466.98	79.6340	4.7477	
PNL-A-1	480	465.91	79.5887	4.7452	
PNL-A-1A	240	223.49	79.5576	4.7426	
PNL-A-1B	208	195.33	79.6196	4.7461	
PNL-A-2	480	464.43	79.5299	4.7421	
PNL-A-2A	240	222.72	79.5213	4.7408	
PNL-A-2B	208	194.66	79.5784	4.7440	
PNL-A-3	480	458.26	77.0596	4.5940	
PNL-A-3A	240	219.50	77.1437	4.5983	
PNL-A-4	480	458.18	79.7287	4.7536	
PNL-A-5	480	456.41	79.4508	4.7383	
PNL-A-6	480	465.63	79.6896	4.7509	
PNL-A-BLD	208	200.68	79.6656	4.7489	
PNL-A-ILL	480	466.79	79.6547	4.7488	
PNL-B-1	480	454.65	83.5372	4.9858	
PNL-B-1A	240	217.61	83.6910	4.9942	
PNL-B-1B	208	190.27	83.7162	4.9954	
PNL-B-2	480	452.62	83.5983	4.9895	
PNL-B-2A	240	216.55	83.7874	5.0000	
PNL-B-2B	208	189.36	83.8051	5.0008	
PNL-B-3	480	446.78	83.0777	4.9610	
PNL-B-3A	240	213.48	83.3691	4.9776	
PNL-B-4	480	446.17	82.5199	4.9238	
PNL-B-5	480	450.31	83.5894	4.9890	
PNL-B-6	480	446.66	83.2097	4.9683	
PNL-B-7	480	445.40	83.9043	5.0065	
PNL-B-8	480	448.83	83.1845	4.9667	
PNL-B-8A	240	208.21	83.4515	4.9844	
PNL-B-8B	240	214.84	83.4847	4.9840	
PNL-B-8C	240	207.07	83.7342	5.0009	

TOTAL VOLTAGE DISTORTION					
Bus Name	Voltage	V_RMS(V)	V_TIF	V_THD(%)	IEEE-519
PNL-B-BLD	208	194.88	83.6086	4.9888	
PNL-B-ILL	480	456.88	83.5003	4.9834	
PNL-TRAIL1	208	191.12	81.1632	4.8531	
PNL-TRAIL2	208	191.12	81.1632	4.8531	
SWBD-A	480	466.98	79.6340	4.7477	
SWBD-B	480	457.12	83.4712	4.9818	
XFMR-1AP	480	466.96	79.6364	4.7478	
XFMR-1AS	208	200.70	79.6615	4.7487	
XFMR-1BP	480	457.09	83.4762	4.9820	
XFMR-1BS	208	194.91	83.5997	4.9883	
XFMR-2BP	480	456.87	83.4705	4.9817	
XFMR-2BS	208	191.35	81.1719	4.8537	
XFMR-A1AP	480	465.71	79.6043	4.7461	
XFMR-A1AS	240	223.78	79.5476	4.7421	
XFMR-A1BP	480	465.60	79.6269	4.7474	
XFMR-A1BS	208	195.75	79.5415	4.7417	
XFMR-A2AP	480	464.23	79.5456	4.7430	
XFMR-A2AS	240	223.00	79.5106	4.7403	
XFMR-A2BP	480	464.12	79.5684	4.7443	
XFMR-A2BS	208	195.08	79.4992	4.7396	
XFMR-A3AP	480	458.06	77.0758	4.5949	
XFMR-A3AS	240	219.79	77.1304	4.5976	
XFMR-B1AP	480	454.45	83.5554	4.9868	
XFMR-B1AS	240	217.90	83.6747	4.9933	
XFMR-B1BP	480	454.33	83.5802	4.9882	
XFMR-B1BS	208	190.70	83.6245	4.9903	
XFMR-B2AP	480	452.42	83.6169	4.9905	
XFMR-B2AS	240	216.84	83.7699	4.9990	
XFMR-B2BP	480	452.31	83.6419	4.9920	
XFMR-B2BS	208	189.80	83.7115	4.9956	
XFMR-B3AP	480	446.57	83.0972	4.9621	
XFMR-B3AS	240	213.78	83.3485	4.9765	
XFMR-B8AP	480	443.69	83.2641	4.9722	
XFMR-B8AS	240	208.61	83.4297	4.9832	
XFMR-B8BP	480	448.48	83.2173	4.9686	
XFMR-B8BS	240	216.23	83.3915	4.9784	
XFMR-UTILAP	12470	12469.26	0.5218	0.0089	5.0
XFMR-UTILAS	480	467.68	76.6485	4.5688	
XFMR-UTILBP	12470	12468.76	0.5219	0.0089	5.0
XFMR-UTILBS	480	459.07	78.2645	4.6695	

VOLTAGE DISTORTION SUMMARY					
Bus Name	Voltage	V_RMS(V)	V_TIF	V_THD(%)	IEEE-519

TOTAL CURRENT DISTORTION									
Device Name	Bus Name From/To	Voltage From/To	I_RMS(A)	kWLoss Tot/Harm	kVARLoss Tot/Harm	IT	K	I_THD(%)	IEEE-519
UTIL-PUDA	XFMR-UTILAP	12470 12470	82.75	0.001 0.001	0.029 0.029	11192.42	2.17	19.40	
UTIL-PUDB	XFMR-UTILBP	12470 12470	131.52	0.001 0.001	0.029 0.029	11219.75	1.46	12.11	
TO PNL-B-7	ATS-B-7 PNL-B-7	480 480	92.57	0.064 0.000	0.015 0.000	840.92	1.01	1.28	
VFD-CRANE1	BUS-0099 CRANE-1	480 480	668.49	0.000 0.000	0.000 0.000	147564.48	4.10	32.68	
VFD-CRANE2	BUS-0100 CRANE-2	480 480	670.79	0.000 0.000	0.000 0.000	152730.39	4.30	33.83	
VFD-CRANE3	BUS-0101 CRANE-3	480 480	687.23	0.000 0.000	0.000 0.000	155233.89	4.25	33.52	
VFD-CRANE4	BUS-0102 CRANE-4	480 480	687.23	0.000 0.000	0.000 0.000	155233.89	4.25	33.52	
TO XFMR-A1AP	PNL-A-1 XFMR-A1AP	480 480	62.07	0.021 0.000	0.008 0.000	520.30	1.00	1.15	
TO XFMR-A1BP	PNL-A-1 XFMR-A1BP	480 480	42.70	0.025 0.000	0.004 0.000	364.26	1.00	1.17	
TO XFMR-A2AP	PNL-A-2 XFMR-A2AP	480 480	62.29	0.021 0.000	0.008 0.000	518.27	1.00	1.14	
TO XFMR-A2BP	PNL-A-2 XFMR-A2BP	480 480	42.85	0.026 0.000	0.004 0.000	362.85	1.00	1.16	
TO XFMR-A3AP	PNL-A-3 XFMR-A3AP	480 480	63.20	0.022 0.000	0.008 0.000	495.62	1.00	1.08	
TO XFMR-B1AP	PNL-B-1 XFMR-B1AP	480 480	63.76	0.022 0.000	0.008 0.000	533.00	1.00	1.15	

TOTAL CURRENT DISTORTION									
Device Name	Bus Name From/To	Voltage From/To	I_RMS(A)	kWLoss Tot/Harm	kVARLoss Tot/Harm	IT	K	I_THD(%)	IEEE-519
TO XFMR-B1BP	PNL-B-1 XFMR-B1BP	480 480	43.84	0.027 0.000	0.004 0.000	373.16	1.00	1.17	
TO XFMR-B2AP	PNL-B-2 XFMR-B2AP	480 480	64.07	0.022 0.000	0.008 0.000	531.03	1.00	1.14	
TO XFMR-B2BP	PNL-B-2 XFMR-B2BP	480 480	44.05	0.027 0.000	0.004 0.000	371.78	1.00	1.16	
TO XFMR-B3AP	PNL-B-3 XFMR-B3AP	480 480	64.99	0.023 0.000	0.008 0.000	521.02	1.00	1.10	
TO DISC-100ABP	PNL-B-8 DISC-100ABP	480 480	0.00	0.000 0.000	0.000 0.000	0.00	0.00	0.00	
TO XFMR-B8AP	PNL-B-8 XFMR-B8AP	480 480	113.32	0.703 0.000	0.740 0.000	864.25	1.00	1.05	
TO XFMR-B8BP	PNL-B-8 XFMR-B8BP	480 480	54.78	0.032 0.000	0.012 0.000	445.40	1.00	1.12	
TO CRANE-1	SWBD-A BUS-0099	480 480	668.49	8.127 0.763	12.318 4.566	147564.48	4.10	32.68	
TO CRANE-2	SWBD-A BUS-0100	480 480	670.79	8.182 0.817	12.644 4.892	152730.39	4.30	33.83	
TO DISC-800ABP	SWBD-A DISC-800ABP	480 480	0.00	0.000 0.000	0.000 0.000	0.00	0.00	0.00	
TO PNL-A-1	SWBD-A PNL-A-1	480 480	104.78	0.116 0.000	0.167 0.000	884.56	1.00	1.16	
TO PNL-A-2	SWBD-A PNL-A-2	480 480	105.14	0.279 0.000	0.401 0.000	881.12	1.00	1.15	
TO PNL-A-3	SWBD-A PNL-A-3	480 480	244.33	2.257 0.001	3.257 0.011	4377.83	1.02	2.51	

TOTAL CURRENT DISTORTION									
Device Name	Bus Name From/To	Voltage From/To	I_RMS(A)	kWLoss Tot/Harm	kVARLoss Tot/Harm	IT	K	I_THD(%)	IEEE-519
TO PNL-A-4	SWBD-A PNL-A-4	480 480	166.53	1.994 0.000	1.570 0.001	1469.61	1.00	1.21	
TO PNL-A-5	SWBD-A PNL-A-5	480 480	167.18	2.135 0.000	2.249 0.002	1458.95	1.00	1.20	
TO PNL-A-6	SWBD-A PNL-A-6	480 480	10.18	0.021 0.000	0.011 0.000	92.72	1.01	1.25	
TO PNL-A-ILL	SWBD-A PNL-A-ILL	480 480	37.98	0.013 0.000	0.003 0.000	347.52	1.01	1.26	
TO XFMR-1AP	SWBD-A XFMR-1AP	480 480	5.12	0.000 0.000	0.000 0.000	46.10	1.00	1.24	
TO ATS-B-7	SWBD-B ATS-B-7	480 480	92.57	1.516 0.000	1.002 0.001	840.92	1.01	1.28	
TO CRANE-3	SWBD-B BUS-0101	480 480	687.23	9.658 0.946	14.854 5.683	155233.89	4.25	33.52	
TO CRANE-4	SWBD-B BUS-0102	480 480	687.23	9.658 0.946	14.854 5.683	155233.89	4.25	33.52	
TO PNL-B-1	SWBD-B PNL-B-1	480 480	107.60	0.362 0.000	0.285 0.000	906.15	1.00	1.16	
TO PNL-B-2	SWBD-B PNL-B-2	480 480	108.13	0.661 0.000	0.521 0.000	902.81	1.00	1.15	
TO PNL-B-3	SWBD-B PNL-B-3	480 480	235.79	2.531 0.000	3.645 0.003	2014.65	1.00	1.18	
TO PNL-B-4	SWBD-B PNL-B-4	480 480	202.98	3.027 0.001	2.386 0.005	2943.62	1.01	2.04	
TO PNL-B-5	SWBD-B PNL-B-5	480 480	169.46	1.571 0.000	1.237 0.001	1514.50	1.00	1.23	

TOTAL CURRENT DISTORTION									
Device Name	Bus Name From/To	Voltage From/To	I_RMS(A)	kWLoss Tot/Harm	kVARLoss Tot/Harm	IT	K	I_THD(%)	IEEE-519
TO PNL-B-6	SWBD-B PNL-B-6	480 480	170.85	2.023 0.000	2.453 0.002	1495.61	1.00	1.20	
TO PNL-B-8	SWBD-B PNL-B-8	480 480	423.12	3.639 0.000	5.240 0.004	3563.12	1.00	1.16	
TO PNL-B-ILL	SWBD-B PNL-B-ILL	480 480	48.79	0.022 0.000	0.004 0.000	448.35	1.01	1.26	
TO XFMR-1BP	SWBD-B XFMR-1BP	480 480	9.77	0.001 0.000	0.000 0.000	87.10	1.00	1.23	
TO XFMR-TRAILP	SWBD-B XFMR-2BP	480 480	523.48	0.156 0.000	0.165 0.000	4360.38	1.00	1.15	
XFMR-1A	XFMR-1AP XFMR-1AS	480 208	5.12	0.027 0.000	0.020 0.000	46.10	1.00	1.24	
TO PNL-A-BLD	XFMR-1AS PNL-A-BLD	208 208	11.81	0.000 0.000	0.000 0.000	106.38	1.00	1.24	
XFMR-1B	XFMR-1BP XFMR-1BS	480 208	9.77	0.099 0.000	0.073 0.000	87.10	1.00	1.23	
TO PNL-B-BLD	XFMR-1BS PNL-B-BLD	208 208	22.55	0.002 0.000	0.000 0.000	201.00	1.00	1.23	
XFMR-2B	XFMR-2BP XFMR-2BS	480 208	523.48	3.341 0.001	18.270 0.013	4360.38	1.00	1.15	
TO PNL-TRAIL1	XFMR-2BS PNL-TRAIL1	208 208	604.02	0.165 0.000	0.186 0.000	5031.21	1.00	1.15	
TO PNL-TRAIL2	XFMR-2BS PNL-TRAIL2	208 208	604.02	0.165 0.000	0.186 0.000	5031.21	1.00	1.15	
XFMR-A1A	XFMR-A1AP XFMR-A1AS	480 240	62.07	1.438 0.000	1.332 0.001	520.30	1.00	1.15	

TOTAL CURRENT DISTORTION									
Device Name	Bus Name From/To	Voltage From/To	I_RMS(A)	kWLoss Tot/Harm	kVARLoss Tot/Harm	IT	K	I_THD(%)	IEEE-519
TO PNL-A-1A	XFMR-A1AS PNL-A-1A	240 240	124.15	0.048 0.000	0.038 0.000	1040.59	1.00	1.15	
XFMR-A1B	XFMR-A1BP XFMR-A1BS	480 208	42.70	0.756 0.000	0.701 0.001	364.26	1.00	1.17	
TO PNL-A-1B	XFMR-A1BS PNL-A-1B	208 208	98.54	0.070 0.000	0.026 0.000	840.61	1.00	1.17	
XFMR-A2A	XFMR-A2AP XFMR-A2AS	480 240	62.29	1.448 0.000	1.342 0.001	518.27	1.00	1.14	
TO PNL-A-2A	XFMR-A2AS PNL-A-2A	240 240	124.58	0.049 0.000	0.038 0.000	1036.55	1.00	1.14	
XFMR-A2B	XFMR-A2BP XFMR-A2BS	480 208	42.85	0.762 0.000	0.705 0.001	362.85	1.00	1.16	
TO PNL-A-2B	XFMR-A2BS PNL-A-2B	208 208	98.88	0.071 0.000	0.026 0.000	837.34	1.00	1.16	
XFMR-A3A	XFMR-A3AP XFMR-A3AS	480 240	63.20	1.491 0.000	1.381 0.001	495.62	1.00	1.08	
TO PNL-A-3A	XFMR-A3AS PNL-A-3A	240 240	126.40	0.050 0.000	0.039 0.000	991.23	1.00	1.08	
XFMR-B1A	XFMR-B1AP XFMR-B1AS	480 240	63.76	1.518 0.000	1.406 0.001	533.00	1.00	1.15	
TO PNL-B-1A	XFMR-B1AS PNL-B-1A	240 240	127.52	0.051 0.000	0.040 0.000	1066.00	1.00	1.15	
XFMR-B1B	XFMR-B1BP XFMR-B1BS	480 208	43.84	0.797 0.000	0.739 0.001	373.16	1.00	1.17	
TO PNL-B-1B	XFMR-B1BS PNL-B-1B	208 208	101.18	0.074 0.000	0.027 0.000	861.13	1.00	1.17	

TOTAL CURRENT DISTORTION									
Device Name	Bus Name From/To	Voltage From/To	I_RMS(A)	kWLoss Tot/Harm	kVARLoss Tot/Harm	IT	K	I_THD(%)	IEEE-519
XFMR-B2A	XFMR-B2AP XFMR-B2AS	480 240	64.07	1.533 0.000	1.420 0.001	531.03	1.00	1.14	
TO PNL-B-2A	XFMR-B2AS PNL-B-2A	240 240	128.15	0.051 0.000	0.040 0.000	1062.06	1.00	1.14	
XFMR-B2B	XFMR-B2BP XFMR-B2BS	480 208	44.05	0.805 0.000	0.746 0.001	371.78	1.00	1.16	
TO PNL-B-2B	XFMR-B2BS PNL-B-2B	208 208	101.66	0.075 0.000	0.027 0.000	857.95	1.00	1.16	
XFMR-B3A	XFMR-B3AP XFMR-B3AS	480 240	64.99	1.577 0.000	1.461 0.001	521.02	1.00	1.10	
TO PNL-B-3A	XFMR-B3AS PNL-B-3A	240 240	129.98	0.053 0.000	0.042 0.000	1042.04	1.00	1.10	
XFMR-B8A	XFMR-B8AP XFMR-B8AS	480 240	113.32	3.551 0.001	3.907 0.002	864.25	1.00	1.05	
TO PNL-B-8A	XFMR-B8AS PNL-B-8A	240 240	193.13	0.099 0.000	0.092 0.000	1474.64	1.00	1.05	
TO PNL-B-8C	XFMR-B8AS PNL-B-8C	240 240	33.50	0.084 0.000	0.036 0.000	253.87	1.00	1.04	
XFMR-B8B	XFMR-B8BP XFMR-B8BS	480 240	54.78	1.120 0.000	1.038 0.001	445.40	1.00	1.12	
TO PNL-B-8B	XFMR-B8BS PNL-B-8B	240 240	109.57	0.206 0.000	0.163 0.000	890.81	1.00	1.12	
XFMR-UTILA	XFMR-UTILAP XFMR-UTILAS	12470 480	82.75	9.401 0.695	84.108 14.458	11192.42	2.17	19.40	20.0
TO SWBD-A	XFMR-UTILAS SWBD-A	480 480	2149.81	1.611 0.075	3.146 0.541	290769.63	2.17	19.40	

TOTAL CURRENT DISTORTION

Device Name	Bus Name From/To	Voltage From/To	I_RMS(A)	kWLoss Tot/Harm	kVARLoss Tot/Harm	IT	K	I_THD(%)	IEEE-519
XFMR-UTILB	XFMR-UTILBP XFMR-UTILBS	12470 480	131.52	23.189 0.699	194.467 14.554	11219.75	1.46	12.11	20.0
TO SWBD-B	XFMR-UTILBS SWBD-B	480 480	3416.71	6.700 0.111	12.076 0.904	291479.69	1.46	12.11	

TOTAL SYSTEM POWER LOSSES

Harmonic Losses		Total RMS Losses	
P(kW)	Q(kVAR)	P(kW)	Q(kVAR)
15.02	58.82	131.42	416.92

CURRENT DISTORTION SUMMARY									
Device Name	Bus Name From/To	Voltage From/To	I_RMS(A)	kWLoss Tot/Harm	kVARLoss Tot/Harm	IT	K	I_THD(%)	IEEE-519
NO VIOLATION									

TOTAL SYSTEM POWER LOSSES

Harmonic Losses		Total RMS Losses	
P(kW)	Q(kVAR)	P(kW)	Q(kVAR)
15.02	58.82	131.42	416.92

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: SWBD-A (480V)

Harmonic Order	Harmonic Voltages	Phase Angle	Distortion Percent	IEEE-519 Limit
1	466.452	-31.78		
5	17.840	118.71	3.825	>
7	8.366	141.95	1.794	
11	7.303	-29.53	1.566	
13	4.192	-89.16	0.899	
17	4.676	131.67	1.003	
19	3.064	58.13	0.657	

Voltage: 480.0 V_RMS: 466.98 V_THD(%): 4.75
IEEE-519 LIMIT (THD%):

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: SWBD-B (480V)

Harmonic Order	Harmonic Voltages	Phase Angle	Distortion Percent	IEEE-519 Limit
1	456.556	-32.84		
5	18.330	112.78	4.015	>
7	8.589	133.93	1.881	
11	7.494	-41.85	1.641	
13	4.301	-103.66	0.942	
17	4.798	112.79	1.051	
19	3.144	37.05	0.689	

Voltage: 480.0 V_RMS: 457.12 V_THD(%): 4.98
IEEE-519 LIMIT (THD%):

HARMONIC CURRENT SPECTRUM REPORT

Device Name: TO SWBD-A
From: XFMR-UTILAS (480V)
To: SWBD-A (480V)
PCC does not exist.

Harmonic Order	Harmonic Amperes	Phase Angle	Distortion Percent	IEEE-519 Limit
1	2110.447	-65.44		
5	379.708	-148.33	17.992	
7	127.206	-125.26	6.027	
11	70.657	63.30	3.348	
13	34.318	3.75	1.626	
17	29.270	-135.23	1.387	
19	17.158	151.33	0.813	

Voltage: 480.0 I_RMS: 2149.81 I_THD(%): 19.40
kWLoss: 1.611 kVARLoss: 3.146
I_K: 2.17 IEEE-519 LIMIT (THD%):

HARMONIC CURRENT SPECTRUM REPORT

Device Name: TO SWBD-B
From: XFMR-UTILBS (480V)
To: SWBD-B (480V)
PCC does not exist.

Harmonic Order	Harmonic Amperes	Phase Angle	Distortion Percent	IEEE-519 Limit
1	3391.917	-68.08		
5	381.042	-154.18	11.234	
7	127.565	-133.24	3.761	
11	70.825	50.98	2.088	
13	34.397	-10.76	1.014	
17	29.335	-154.15	0.865	
19	17.196	130.21	0.507	

Voltage: 480.0 I_RMS: 3416.71 I_THD(%): 12.11
kWLoss: 6.700 kVARLoss: 12.076
I_K: 1.46 IEEE-519 LIMIT (THD%):

Harmonic Results – Scenario 2

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OUTPUT DATA REPORT
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STUDY CRITERIA

Studies Selected To Run:	
Load Flow:	Yes
Frequency Scan:	Yes
Harmonic Distortion:	Yes
Load Flow Study Setup Options	
Utility Impedance:	Yes
Transformer Phase Shift:	Yes
Solution Method:	Exact
Load Specification:	Connected Load
Generation Acceleration Factor:	1.00
Load Acceleration Factor:	1.00
Bus Voltage Drop:	5.00
Branch Voltage Drop:	3.00
HI_WAVE Study Setup Options	
Fundamental Frequency:	60 Hz
Max. Harmonic Order:	50
Include Triplet Harmonics Path (Static Load):	No
Include Triplet Harmonics Path (Ind. Motor):	No
Modify Motor Z by Load Factor (Ind. Motor):	Yes
Modify Load Z by Load Factor (Static Load):	Yes
HI_WAVE Study Setup Options for Frequency Scan	
Scan Impedance Option:	Scan Self Impedance
Use Positive Sequence Network:	Yes
Use Negative Sequence Network:	Yes
Use Zero Sequence Network:	No
Model Transformer Tap:	Yes
Model Transformer Phase Shift:	Yes
Report Bus Equivalent Impedance:	No
Number of Scan Steps Per Order:	1
HI_WAVE Study Setup Options for Distortion	
Use Positive Sequence Network:	Yes
Use Negative Sequence Network:	Yes
Use Zero Sequence Network:	Yes
Model Transformer Tap:	Yes
Model Transformer Phase Shift:	Yes
Fundamental Solution:	Use Load Flow Result
Report Option:	All Distortions and Violations
Current Limits:	IEEE 519-1996 Std, Current Distortion Limit Table 3.2

LOADS AND MOTORS WITH HARMONIC SOURCE MODELS				
Bus Name	Voltage	Component Name	LF Current	Harmonic Library
CRANE-1	480	VFD-CRANE1	635.4	Typical 12 Pulse
CRANE-2	480	VFD-CRANE2	635.4	Typical 12 Pulse
CRANE-3	480	VFD-CRANE3	651.6	Typical 12 Pulse
CRANE-4	480	VFD-CRANE4	651.6	Typical 12 Pulse

HARMONIC SOURCE		
Typical 12 Pulse		
Order	Magnitude (%)	Angle (Degrees)
1	100.000	0.00
5	2.600	0.00
7	1.600	0.00
11	4.500	0.00
13	2.900	0.00
17	0.200	0.00
19	0.100	0.00
23	0.900	0.00
25	0.800	0.00

HARMONIC SOURCE INDEX TABLE
HARMONIC SOURCES HAVE BEEN FOUND AND INJECTED FOR EACH OF THE FOLLOWING HARMONIC ORDERS
5 7 11 13 17 19 23 25

PASSIVE FILTER DATA												
Filter Name	Bus Name	Bus Voltage	Rated Voltage	Connect	Filter Type	Capacitor KVAR	Tuned Order	Q	M	R (Ω)	L (H)	C (μF)
NO FILTER												

ULTILITY, GENERATOR AND MOTOR DATA							
Component Name	Component Type	Bus Name	Bus Voltage	Base Voltage	Base KVA	R1(pu) R2 R0	X1(pu) X2 X0
UTIL-PUDA	UTILITY	XFMR-UTILAP	12470	12470	100000	0.0009 0.0009 0.0009	0.0045 0.0045 0.0045
UTIL-PUDB	UTILITY	XFMR-UTILBP	12470	12470	100000	0.0009 0.0009 0.0009	0.0045 0.0045 0.0045

TOTAL VOLTAGE DISTORTION					
Bus Name	Voltage	V_RMS(V)	V_TIF	V_THD(%)	IEEE-519
ATS-B-7	480	445.28	54.2965	1.5159	
BUS-0099	480	457.17	84.1562	2.3510	
BUS-0100	480	457.18	85.2595	2.3818	
BUS-0101	480	445.86	93.6300	2.6162	
BUS-0102	480	445.86	93.6300	2.6162	
CRANE-1	480	457.17	84.1564	2.3510	
CRANE-2	480	457.18	85.2597	2.3818	
CRANE-3	480	445.86	93.6301	2.6162	
CRANE-4	480	445.86	93.6301	2.6162	
DISC-100ABP	480	448.33	53.8571	1.5038	
DISC-800ABP	480	466.50	51.5577	1.4392	
PNL-A-1	480	465.44	51.5282	1.4384	
PNL-A-1A	240	223.27	51.5105	1.4378	
PNL-A-1B	208	195.13	51.5507	1.4389	
PNL-A-2	480	463.95	51.4898	1.4374	
PNL-A-2A	240	222.49	51.4867	1.4371	
PNL-A-2B	208	194.46	51.5237	1.4382	
PNL-A-3	480	457.82	49.8877	1.3926	
PNL-A-3A	240	219.29	49.9447	1.3941	
PNL-A-4	480	457.71	51.6190	1.4410	
PNL-A-5	480	455.94	51.4380	1.4360	
PNL-A-6	480	465.15	51.5939	1.4402	
PNL-A-BLD	208	200.47	51.5793	1.4398	
PNL-A-ILL	480	466.31	51.5712	1.4396	
PNL-B-1	480	454.14	54.0871	1.5101	
PNL-B-1A	240	217.36	54.1896	1.5128	
PNL-B-1B	208	190.06	54.2059	1.5133	
PNL-B-2	480	452.11	54.1267	1.5112	
PNL-B-2A	240	216.30	54.2520	1.5146	
PNL-B-2B	208	189.15	54.2635	1.5149	
PNL-B-3	480	446.28	53.7874	1.5019	
PNL-B-3A	240	213.24	53.9791	1.5071	
PNL-B-4	480	445.68	53.4276	1.4916	
PNL-B-5	480	449.80	54.1209	1.5111	
PNL-B-6	480	446.16	53.8734	1.5042	
PNL-B-7	480	444.89	54.3260	1.5167	
PNL-B-8	480	448.33	53.8571	1.5038	
PNL-B-8A	240	207.98	54.0316	1.5086	
PNL-B-8B	240	214.60	54.0543	1.5092	
PNL-B-8C	240	206.84	54.2154	1.5137	

TOTAL VOLTAGE DISTORTION					
Bus Name	Voltage	V_RMS(V)	V_TIF	V_THD(%)	IEEE-519
PNL-B-BLD	208	194.66	54.1354	1.5113	
PNL-B-ILL	480	456.37	54.0632	1.5094	
PNL-TRAIL1	208	190.92	52.5423	1.4674	
PNL-TRAIL2	208	190.92	52.5423	1.4674	
SWBD-A	480	466.50	51.5577	1.4392	
SWBD-B	480	456.61	54.0443	1.5089	
XFMR-1AP	480	466.48	51.5593	1.4393	
XFMR-1AS	208	200.49	51.5766	1.4397	
XFMR-1BP	480	456.57	54.0476	1.5090	
XFMR-1BS	208	194.69	54.1296	1.5112	
XFMR-2BP	480	456.36	54.0439	1.5089	
XFMR-2BS	208	191.15	52.5478	1.4675	
XFMR-A1AP	480	465.24	51.5384	1.4387	
XFMR-A1AS	240	223.55	51.5041	1.4376	
XFMR-A1BP	480	465.13	51.5530	1.4391	
XFMR-A1BS	208	195.55	51.4998	1.4375	
XFMR-A2AP	480	463.75	51.5001	1.4377	
XFMR-A2AS	240	222.78	51.4798	1.4369	
XFMR-A2BP	480	463.64	51.5149	1.4381	
XFMR-A2BS	208	194.88	51.4721	1.4368	
XFMR-A3AP	480	457.62	49.8983	1.3929	
XFMR-A3AS	240	219.58	49.9361	1.3938	
XFMR-B1AP	480	453.93	54.0990	1.5104	
XFMR-B1AS	240	217.65	54.1790	1.5125	
XFMR-B1BP	480	453.82	54.1151	1.5109	
XFMR-B1BS	208	190.49	54.1461	1.5116	
XFMR-B2AP	480	451.91	54.1389	1.5116	
XFMR-B2AS	240	216.59	54.2407	1.5143	
XFMR-B2BP	480	451.80	54.1551	1.5120	
XFMR-B2BS	208	189.58	54.2024	1.5132	
XFMR-B3AP	480	446.07	53.8001	1.5022	
XFMR-B3AS	240	213.54	53.9657	1.5067	
XFMR-B8AP	480	443.19	53.9083	1.5053	
XFMR-B8AS	240	208.38	54.0175	1.5082	
XFMR-B8BP	480	447.98	53.8785	1.5044	
XFMR-B8BS	240	215.99	53.9938	1.5075	
XFMR-UTILAP	12470	12469.26	0.5092	0.0027	5.0
XFMR-UTILAS	480	467.24	49.6220	1.3851	
XFMR-UTILBP	12470	12468.76	0.5093	0.0027	5.0
XFMR-UTILBS	480	458.62	50.6679	1.4145	

VOLTAGE DISTORTION SUMMARY					
Bus Name	Voltage	V_RMS(V)	V_TIF	V_THD(%)	IEEE-519
NO VIOLATION					

TOTAL CURRENT DISTORTION									
Device Name	Bus Name From/To	Voltage From/To	I_RMS(A)	kWLoss Tot/Harm	kVARLoss Tot/Harm	IT	K	I_THD(%)	IEEE-519
UTIL-PUDA	XFMR-UTILAP	12470 12470	81.27	0.000 0.000	0.001 0.001	6295.88	1.11	3.01	
UTIL-PUDB	XFMR-UTILBP	12470 12470	130.59	0.000 0.000	0.001 0.001	6310.54	1.04	1.87	
TO PNL-B-7	ATS-B-7 PNL-B-7	480 480	92.56	0.064 0.000	0.015 0.000	474.71	1.00	0.20	
VFD-CRANE1	BUS-0099 CRANE-1	480 480	636.24	0.000 0.000	0.000 0.000	83014.94	1.32	5.07	
VFD-CRANE2	BUS-0100 CRANE-2	480 480	636.29	0.000 0.000	0.000 0.000	85920.34	1.35	5.24	
VFD-CRANE3	BUS-0101 CRANE-3	480 480	652.47	0.000 0.000	0.000 0.000	87330.39	1.34	5.20	
VFD-CRANE4	BUS-0102 CRANE-4	480 480	652.47	0.000 0.000	0.000 0.000	87330.39	1.34	5.20	
TO XFMR-A1AP	PNL-A-1 XFMR-A1AP	480 480	62.07	0.021 0.000	0.008 0.000	294.73	1.00	0.18	
TO XFMR-A1BP	PNL-A-1 XFMR-A1BP	480 480	42.70	0.025 0.000	0.004 0.000	206.32	1.00	0.19	
TO XFMR-A2AP	PNL-A-2 XFMR-A2AP	480 480	62.29	0.021 0.000	0.008 0.000	293.60	1.00	0.18	
TO XFMR-A2BP	PNL-A-2 XFMR-A2BP	480 480	42.85	0.026 0.000	0.004 0.000	205.53	1.00	0.18	
TO XFMR-A3AP	PNL-A-3 XFMR-A3AP	480 480	63.19	0.022 0.000	0.008 0.000	280.91	1.00	0.17	
TO XFMR-B1AP	PNL-B-1 XFMR-B1AP	480 480	63.76	0.022 0.000	0.008 0.000	301.90	1.00	0.18	

TOTAL CURRENT DISTORTION									
Device Name	Bus Name From/To	Voltage From/To	I_RMS(A)	kWLoss Tot/Harm	kVARLoss Tot/Harm	IT	K	I_THD(%)	IEEE-519
TO XFMR-B1BP	PNL-B-1 XFMR-B1BP	480 480	43.84	0.027 0.000	0.004 0.000	211.33	1.00	0.18	
TO XFMR-B2AP	PNL-B-2 XFMR-B2AP	480 480	64.07	0.022 0.000	0.008 0.000	300.80	1.00	0.18	
TO XFMR-B2BP	PNL-B-2 XFMR-B2BP	480 480	44.05	0.027 0.000	0.004 0.000	210.56	1.00	0.18	
TO XFMR-B3AP	PNL-B-3 XFMR-B3AP	480 480	64.99	0.023 0.000	0.008 0.000	295.19	1.00	0.17	
TO DISC-100ABP	PNL-B-8 DISC-100ABP	480 480	0.00	0.000 0.000	0.000 0.000	0.00	0.00	0.00	
TO XFMR-B8AP	PNL-B-8 XFMR-B8AP	480 480	113.31	0.703 0.000	0.740 0.000	489.83	1.00	0.17	
TO XFMR-B8BP	PNL-B-8 XFMR-B8BP	480 480	54.78	0.032 0.000	0.012 0.000	252.32	1.00	0.18	
TO CRANE-1	SWBD-A BUS-0099	480 480	636.24	7.383 0.019	7.963 0.211	83014.94	1.32	5.07	
TO CRANE-2	SWBD-A BUS-0100	480 480	636.29	7.385 0.020	7.979 0.226	85920.34	1.35	5.24	
TO DISC-800ABP	SWBD-A DISC-800ABP	480 480	0.00	0.000 0.000	0.000 0.000	0.00	0.00	0.00	
TO PNL-A-1	SWBD-A PNL-A-1	480 480	104.77	0.116 0.000	0.167 0.000	501.05	1.00	0.18	
TO PNL-A-2	SWBD-A PNL-A-2	480 480	105.13	0.279 0.000	0.401 0.000	499.13	1.00	0.18	
TO PNL-A-3	SWBD-A PNL-A-3	480 480	244.25	2.255 0.000	3.246 0.001	2466.31	1.00	0.39	

TOTAL CURRENT DISTORTION									
Device Name	Bus Name From/To	Voltage From/To	I_RMS(A)	kWLoss Tot/Harm	kVARLoss Tot/Harm	IT	K	I_THD(%)	IEEE-519
TO PNL-A-4	SWBD-A PNL-A-4	480 480	166.52	1.994 0.000	1.569 0.000	832.17	1.00	0.19	
TO PNL-A-5	SWBD-A PNL-A-5	480 480	167.17	2.134 0.000	2.247 0.000	826.16	1.00	0.19	
TO PNL-A-6	SWBD-A PNL-A-6	480 480	10.18	0.021 0.000	0.011 0.000	52.49	1.00	0.20	
TO PNL-A-ILL	SWBD-A PNL-A-ILL	480 480	37.98	0.013 0.000	0.003 0.000	196.74	1.00	0.20	
TO XFMR-1AP	SWBD-A XFMR-1AP	480 480	5.12	0.000 0.000	0.000 0.000	26.10	1.00	0.20	
TO ATS-B-7	SWBD-B ATS-B-7	480 480	92.56	1.516 0.000	1.001 0.000	474.71	1.00	0.20	
TO CRANE-3	SWBD-B BUS-0101	480 480	652.47	8.736 0.023	9.434 0.263	87330.39	1.34	5.20	
TO CRANE-4	SWBD-B BUS-0102	480 480	652.47	8.736 0.023	9.434 0.263	87330.39	1.34	5.20	
TO PNL-B-1	SWBD-B PNL-B-1	480 480	107.60	0.362 0.000	0.285 0.000	513.23	1.00	0.18	
TO PNL-B-2	SWBD-B PNL-B-2	480 480	108.12	0.661 0.000	0.521 0.000	511.36	1.00	0.18	
TO PNL-B-3	SWBD-B PNL-B-3	480 480	235.77	2.531 0.000	3.642 0.000	1140.82	1.00	0.19	
TO PNL-B-4	SWBD-B PNL-B-4	480 480	202.94	3.025 0.000	2.381 0.000	1657.97	1.00	0.32	
TO PNL-B-5	SWBD-B PNL-B-5	480 480	169.45	1.571 0.000	1.236 0.000	857.39	1.00	0.19	

TOTAL CURRENT DISTORTION									
Device Name	Bus Name From/To	Voltage From/To	I_RMS(A)	kWLoss Tot/Harm	kVARLoss Tot/Harm	IT	K	I_THD(%)	IEEE-519
TO PNL-B-6	SWBD-B PNL-B-6	480 480	170.83	2.022 0.000	2.452 0.000	846.77	1.00	0.19	
TO PNL-B-8	SWBD-B PNL-B-8	480 480	423.10	3.638 0.000	5.236 0.000	2017.88	1.00	0.18	
TO PNL-B-ILL	SWBD-B PNL-B-ILL	480 480	48.79	0.022 0.000	0.004 0.000	253.78	1.00	0.20	
TO XFMR-1BP	SWBD-B XFMR-1BP	480 480	9.77	0.001 0.000	0.000 0.000	49.31	1.00	0.19	
TO XFMR-TRAILP	SWBD-B XFMR-2BP	480 480	523.45	0.156 0.000	0.164 0.000	2469.09	1.00	0.18	
XFMR-1A	XFMR-1AP XFMR-1AS	480 208	5.12	0.027 0.000	0.020 0.000	26.10	1.00	0.20	
TO PNL-A-BLD	XFMR-1AS PNL-A-BLD	208 208	11.81	0.000 0.000	0.000 0.000	60.23	1.00	0.20	
XFMR-1B	XFMR-1BP XFMR-1BS	480 208	9.77	0.099 0.000	0.073 0.000	49.31	1.00	0.19	
TO PNL-B-BLD	XFMR-1BS PNL-B-BLD	208 208	22.54	0.002 0.000	0.000 0.000	113.80	1.00	0.19	
XFMR-2B	XFMR-2BP XFMR-2BS	480 208	523.45	3.340 0.000	18.258 0.001	2469.09	1.00	0.18	
TO PNL-TRAIL1	XFMR-2BS PNL-TRAIL1	208 208	603.98	0.165 0.000	0.186 0.000	2848.95	1.00	0.18	
TO PNL-TRAIL2	XFMR-2BS PNL-TRAIL2	208 208	603.98	0.165 0.000	0.186 0.000	2848.95	1.00	0.18	
XFMR-A1A	XFMR-A1AP XFMR-A1AS	480 240	62.07	1.438 0.000	1.331 0.000	294.73	1.00	0.18	

TOTAL CURRENT DISTORTION									
Device Name	Bus Name From/To	Voltage From/To	I_RMS(A)	kWLoss Tot/Harm	kVARLoss Tot/Harm	IT	K	I_THD(%)	IEEE-519
TO PNL-A-1A	XFMR-A1AS PNL-A-1A	240 240	124.14	0.048 0.000	0.038 0.000	589.47	1.00	0.18	
XFMR-A1B	XFMR-A1BP XFMR-A1BS	480 208	42.70	0.756 0.000	0.700 0.000	206.32	1.00	0.19	
TO PNL-A-1B	XFMR-A1BS PNL-A-1B	208 208	98.54	0.070 0.000	0.026 0.000	476.12	1.00	0.19	
XFMR-A2A	XFMR-A2AP XFMR-A2AS	480 240	62.29	1.448 0.000	1.341 0.000	293.60	1.00	0.18	
TO PNL-A-2A	XFMR-A2AS PNL-A-2A	240 240	124.57	0.049 0.000	0.038 0.000	587.20	1.00	0.18	
XFMR-A2B	XFMR-A2BP XFMR-A2BS	480 208	42.85	0.761 0.000	0.705 0.000	205.53	1.00	0.18	
TO PNL-A-2B	XFMR-A2BS PNL-A-2B	208 208	98.88	0.071 0.000	0.026 0.000	474.29	1.00	0.18	
XFMR-A3A	XFMR-A3AP XFMR-A3AS	480 240	63.19	1.491 0.000	1.380 0.000	280.91	1.00	0.17	
TO PNL-A-3A	XFMR-A3AS PNL-A-3A	240 240	126.39	0.050 0.000	0.039 0.000	561.81	1.00	0.17	
XFMR-B1A	XFMR-B1AP XFMR-B1AS	480 240	63.76	1.517 0.000	1.405 0.000	301.90	1.00	0.18	
TO PNL-B-1A	XFMR-B1AS PNL-B-1A	240 240	127.51	0.051 0.000	0.040 0.000	603.79	1.00	0.18	
XFMR-B1B	XFMR-B1BP XFMR-B1BS	480 208	43.84	0.797 0.000	0.738 0.000	211.33	1.00	0.18	
TO PNL-B-1B	XFMR-B1BS PNL-B-1B	208 208	101.17	0.074 0.000	0.027 0.000	487.69	1.00	0.18	

TOTAL CURRENT DISTORTION									
Device Name	Bus Name From/To	Voltage From/To	I_RMS(A)	kWLoss Tot/Harm	kVARLoss Tot/Harm	IT	K	I_THD(%)	IEEE-519
XFMR-B2A	XFMR-B2AP XFMR-B2AS	480 240	64.07	1.532 0.000	1.419 0.000	300.80	1.00	0.18	
TO PNL-B-2A	XFMR-B2AS PNL-B-2A	240 240	128.14	0.051 0.000	0.040 0.000	601.60	1.00	0.18	
XFMR-B2B	XFMR-B2BP XFMR-B2BS	480 208	44.05	0.805 0.000	0.745 0.000	210.56	1.00	0.18	
TO PNL-B-2B	XFMR-B2BS PNL-B-2B	208 208	101.65	0.075 0.000	0.027 0.000	485.92	1.00	0.18	
XFMR-B3A	XFMR-B3AP XFMR-B3AS	480 240	64.99	1.576 0.000	1.460 0.000	295.19	1.00	0.17	
TO PNL-B-3A	XFMR-B3AS PNL-B-3A	240 240	129.97	0.053 0.000	0.042 0.000	590.37	1.00	0.17	
XFMR-B8A	XFMR-B8AP XFMR-B8AS	480 240	113.31	3.550 0.000	3.905 0.000	489.83	1.00	0.17	
TO PNL-B-8A	XFMR-B8AS PNL-B-8A	240 240	193.12	0.099 0.000	0.092 0.000	835.77	1.00	0.17	
TO PNL-B-8C	XFMR-B8AS PNL-B-8C	240 240	33.50	0.084 0.000	0.036 0.000	143.89	1.00	0.16	
XFMR-B8B	XFMR-B8BP XFMR-B8BS	480 240	54.78	1.120 0.000	1.037 0.000	252.32	1.00	0.18	
TO PNL-B-8B	XFMR-B8BS PNL-B-8B	240 240	109.56	0.206 0.000	0.162 0.000	504.64	1.00	0.18	
XFMR-UTILA	XFMR-UTILAP XFMR-UTILAS	12470 480	81.27	8.739 0.033	70.318 0.668	6295.88	1.11	3.01	20.0
TO SWBD-A	XFMR-UTILAS SWBD-A	480 480	2111.40	1.539 0.002	2.631 0.025	163561.80	1.11	3.01	

TOTAL CURRENT DISTORTION									
Device Name	Bus Name From/To	Voltage From/To	I_RMS(A)	kWLoss Tot/Harm	kVARLoss Tot/Harm	IT	K	I_THD(%)	IEEE-519
XFMR-UTILB	XFMR-UTILBP XFMR-UTILBS	12470 480	130.59	22.522 0.033	180.585 0.671	6310.54	1.04	1.87	20.0
TO SWBD-B	XFMR-UTILBS SWBD-B	480 480	3392.51	6.592 0.003	11.214 0.042	163942.66	1.04	1.87	

TOTAL SYSTEM POWER LOSSES			
Harmonic Losses		Total RMS Losses	
P(kW)	Q(kVAR)	P(kW)	Q(kVAR)
0.47	2.81	116.86	360.91

CURRENT DISTORTION SUMMARY									
Device Name	Bus Name From/To	Voltage From/To	I_RMS(A)	kWLoss Tot/Harm	kVARLoss Tot/Harm	IT	K	I_THD(%)	IEEE-519
NO VIOLATION									

TOTAL SYSTEM POWER LOSSES			
Harmonic Losses		Total RMS Losses	
P(kW)	Q(kVAR)	P(kW)	Q(kVAR)
0.47	2.81	116.86	360.91

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: SWBD-A (480V)

Harmonic Order	Harmonic Voltages	Phase Angle	Distortion Percent	IEEE-519 Limit
1	466.452	-31.78		
5	1.234	-51.69	0.264	
7	1.062	-179.35	0.228	
11	4.695	-74.93	1.006	
13	3.576	157.24	0.767	
17	0.323	-98.43	0.069	
19	0.180	133.73	0.039	
23	1.964	-121.95	0.421	
25	1.898	110.22	0.407	

Voltage: 480.0 V_RMS: 466.50 V_THD(%): 1.44
IEEE-519 LIMIT (THD%):

HARMONIC CURRENT SPECTRUM REPORT

Device Name: TO SWBD-A
From: XFMR-UTILAS (480V)
To: SWBD-A (480V)
PCC does not exist.

Harmonic Order	Harmonic Amperes	Phase Angle	Distortion Percent	IEEE-519 Limit
1	2110.447	-65.44		
5	26.256	41.27	1.244	
7	16.153	-86.56	0.765	
11	45.422	17.90	2.152	
13	29.271	-109.85	1.387	
17	2.019	-5.33	0.096	
19	1.009	-133.07	0.048	
23	9.084	-28.54	0.430	
25	8.074	-156.28	0.383	

Voltage: 480.0 I_RMS: 2111.40 I_THD(%): 3.01
kWLoss: 1.539 kVARLoss: 2.631
I_K: 1.11 IEEE-519 LIMIT (THD%):

HARMONIC VOLTAGE SPECTRUM REPORT

Bus: SWBD-B (480V)

Harmonic Order	Harmonic Voltages	Phase Angle	Distortion Percent	IEEE-519 Limit
1	456.556	-32.84		
5	1.267	-57.62	0.278	
7	1.091	172.63	0.239	
11	4.817	-87.25	1.055	
13	3.669	142.74	0.804	
17	0.331	-117.31	0.072	
19	0.185	112.65	0.041	
23	2.015	-147.43	0.441	
25	1.947	82.53	0.426	

Voltage: 480.0 V_RMS: 456.61 V_THD(%): 1.51
IEEE-519 LIMIT (THD%):

HARMONIC CURRENT SPECTRUM REPORT

Device Name: TO SWBD-B
From: XFMR-UTILBS (480V)
To: SWBD-B (480V)
PCC does not exist.

Harmonic Order	Harmonic Amperes	Phase Angle	Distortion Percent	IEEE-519 Limit
1	3391.917	-68.08		
5	26.349	35.42	0.777	
7	16.199	-94.54	0.478	
11	45.530	5.58	1.342	
13	29.338	-124.36	0.865	
17	2.023	-24.25	0.060	
19	1.012	-154.19	0.030	
23	9.103	-54.07	0.268	
25	8.092	175.98	0.239	

Voltage: 480.0 I_RMS: 3392.51 I_THD(%): 1.87
kWLoss: 6.592 kVARLoss: 11.214
I_K: 1.04 IEEE-519 LIMIT (THD%):

TAB 15

LOAD FLOW STUDY

The purpose of the load flow study was to determine the power factor, voltage drops, kW, kVAR and current flows. Performing this study required the field technicians to develop an as-built one-line of the distribution system, model the distribution system in the computer, record loads at some of the major panelboards and switchboards, and input this data into the computer.

The load flow study was conducted using SKM Powertools program. The study engineer used NEC recommendation for voltage drop as the design criteria. NEC recommends a maximum of 3% voltage drop across a cable and 5% at the equipment. The load flow study was performed to investigate the system loading condition for normal power operations condition. The following assumptions were made:

- Both cranes are operating at the same time at each switchboard.
- The linear demand loads are taken from the panel schedules
- Linear loads are taken from the panel schedules and have a 0.8 pf
- All loads have 80% load factor

❖ In Scenario 1, the engineer ran the calculation with the utility transformers' tap setting at 5.0 %.

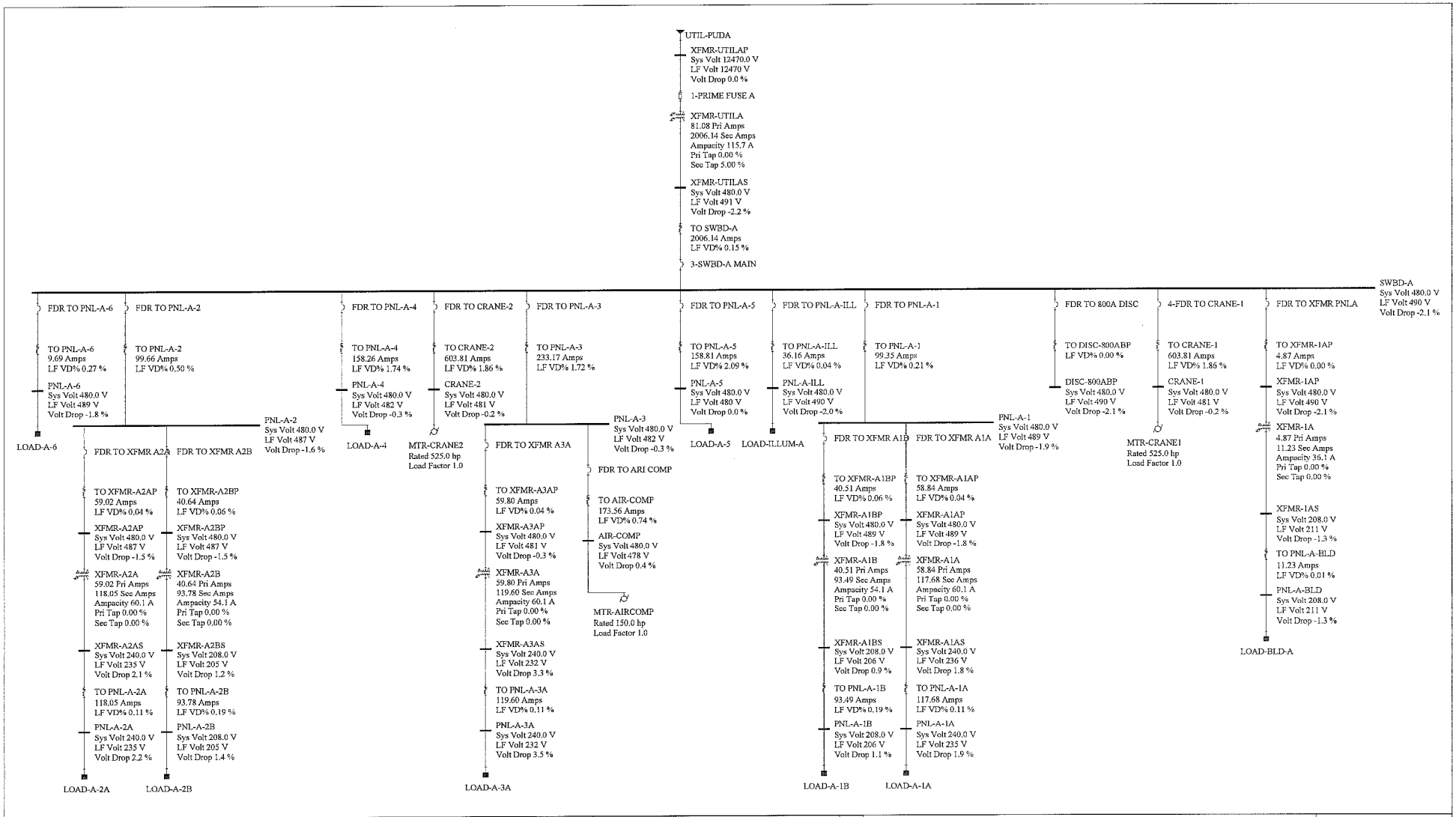
❖ In Scenario 2, the engineer ran the calculation with the utility transformers' tap setting at 5.0 %, transformer B3A at 2.5%, transformer B8A at 5.0%, and transformer B8B at 2.5%.

In Scenario 1, the result from the load flow study shows the voltage drop across each cable is within the 3% recommendations by NEC. The total voltage drop at each bus is above the 5% recommendation by NEC.

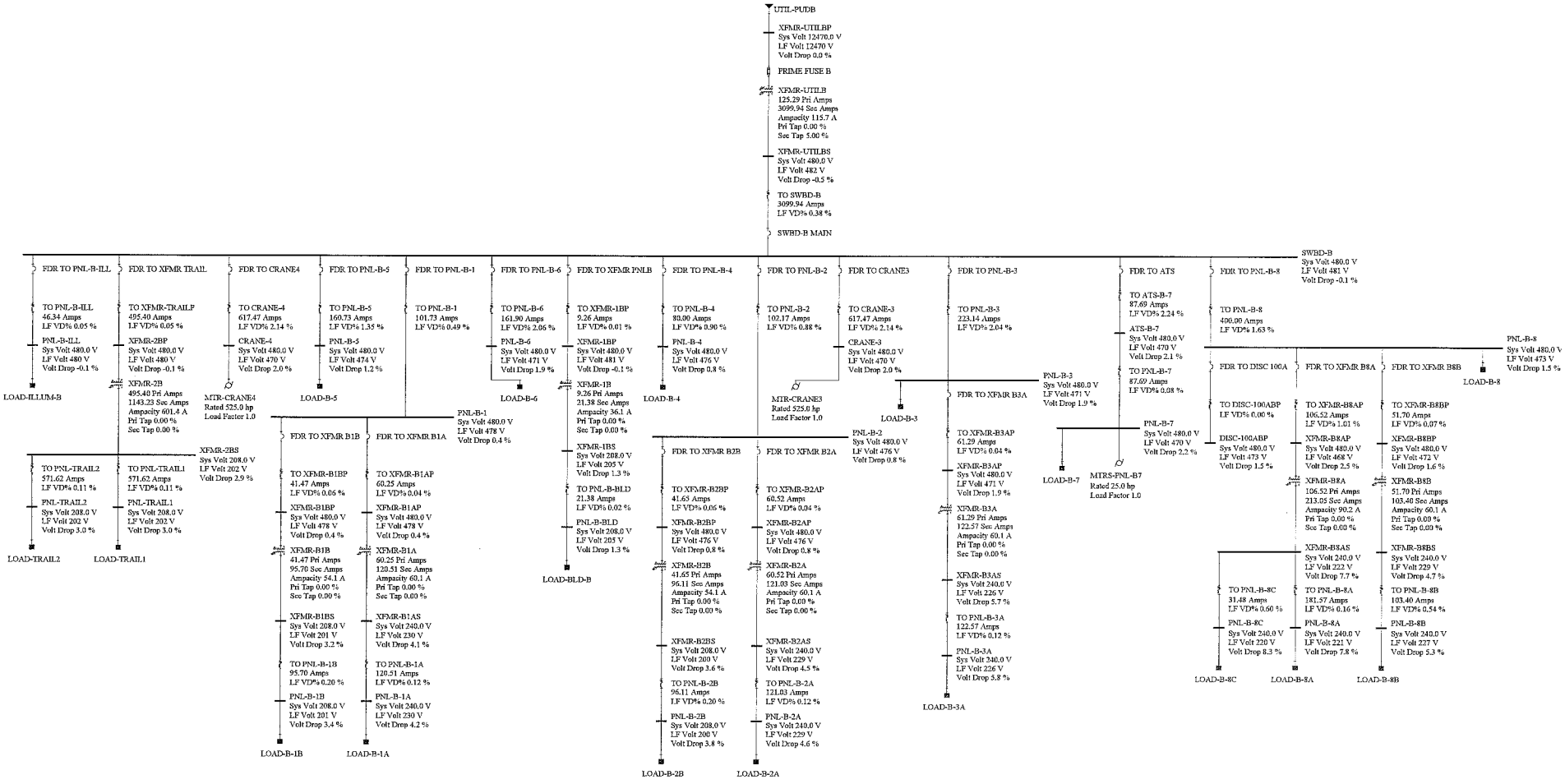
In Scenario 2, the result from the load flow study shows the voltage drop across each cable is within the 3% recommendations by NEC. The total voltage drop at each bus is within the 5% recommendation by NEC.

The engineer recommends setting the both utility transformer's tap setting at 5.0%, transformer B3A at 2.5%, transformer B8A at 5.0%, and transformer B8B at 2.5%.

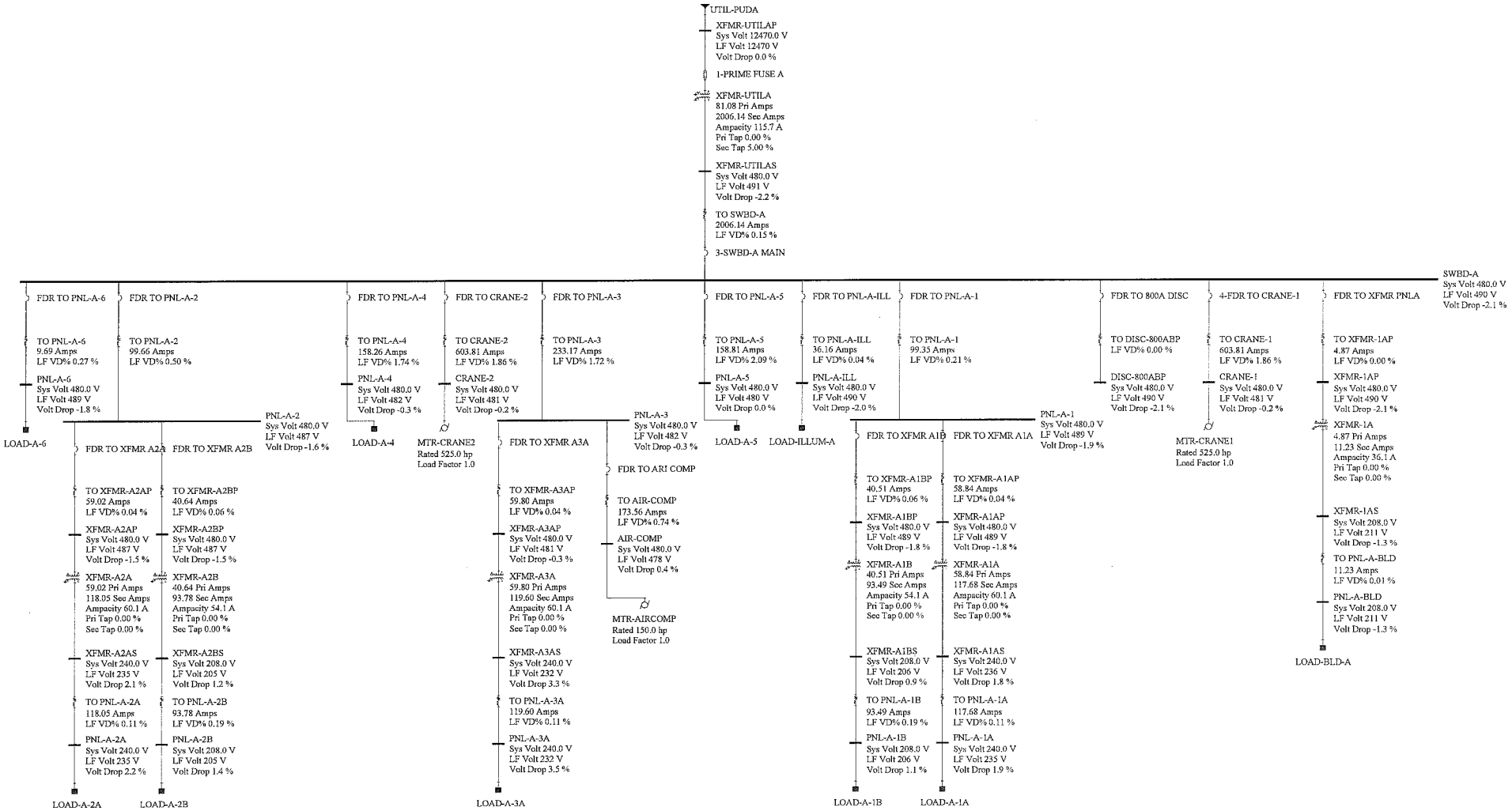
The computer printouts for the load flow study and the load flow diagram is located under tab 15.



				Drawn By: Tam Tran 6/9/2011	PowerStudies.com PS	SR 520 Pontoon Project	E4F
				Checked By: Robert E. Fuhr P.E. 6/9/2011	Phone 253-639-8535 ■ Fax 253-639-8685 ■ 16122 SE 266th St, Covington, WA 98042	Scenario 1 Load Flow Diagram	1001055-3



				Drawn By: Tam Tran 6/9/2011	PowerStudies.com PS	SR 520 Pontoon Project	E4G
				Checked By: Robert E. Fuhr P.E. 6/9/2011	Phone 253-639-8535 ■ Fax 253-639-8685 ■ 16122 SE 266th St, Covington, WA 98042	Scenario 1 Load Flow Diagram	1001055-3



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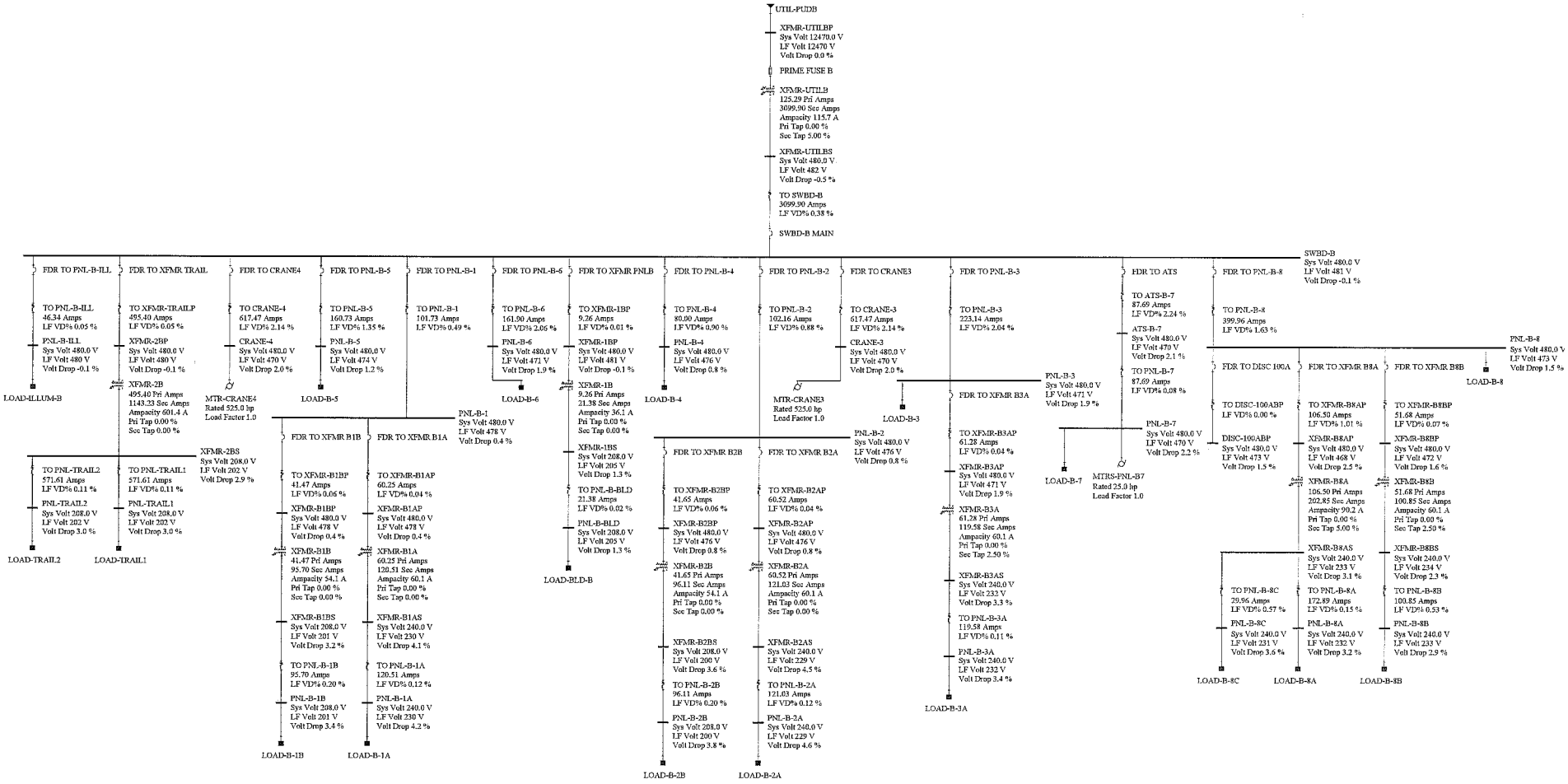
				Checked By: Robert E. Fuhr P.E. 6/9/2011	Phone 253-639-8535 ■ Fax 253-639-8685 ■ 16122 SE 266th St, Covington, WA 98042	Scenario 2 Load Flow Diagram	1001055-3



				Drawn By: Tam Tran 6/9/2011	PowerStudies.com PS Phone 253-639-8535 ■ Fax 253-639-8685 ■ 16122 SE 266th St, Covington, WA 98042	SR 520 Pontoon Project	E4I
				Checked By: Robert E. Fuhr P.E. 6/9/2011		Scenario 2 Load Flow Diagram	1001055-3

Project: 1001055 Scenario1

Load Flow Summary Report

Load Flow Study Settings

Include Source Impedance	No	**Load Acceleration Factor**	1.00
Solution Method	Exact (Iterative)	**Bus Voltage Drop %**	5.00
Load Specification	Connected Load	**Branch Voltage Drop %**	3.00
Generation Acceleration Factor	1.00		

Swing Generators

Source	In/Out Service	Vpu	Angle	kW	kvar	VD%	Utility Impedance
UTIL-PUDA	In	1.00	0.00	1,427.5	1,014.5	0.00	0.00 +*j* 0.00
UTIL-PUDB	In	1.00	0.00	2,132.3	1,666.3	0.00	0.00 +*j* 0.00

Buses

Bus Name	In/Out Service	Design Volts	LF Volts	Angle Degree	PU Volts	%VD
AIR-COMP	In	480	478	-2.16	1.00	0.40
ATS-B-7	In	480	470	-2.67	0.98	2.11
CRANE-1	In	480	481	-2.05	1.00	-0.20
CRANE-2	In	480	481	-2.05	1.00	-0.20
CRANE-3	In	480	470	-3.03	0.98	2.01
CRANE-4	In	480	470	-3.03	0.98	2.01
DISC-100ABP	In	480	473	-3.01	0.98	1.50
DISC-800ABP	In	480	490	-1.77	1.02	-2.07
PNL-A-1	In	480	489	-1.81	1.02	-1.85
PNL-A-1A	In	240	235	-2.02	0.98	1.88
PNL-A-1B	In	208	206	-1.92	0.99	1.14
PNL-A-2	In	480	487	-1.86	1.02	-1.56
PNL-A-2A	In	240	235	-2.07	0.98	2.18

Bus Name	In/Out Service	Design Volts	LF Volts	Angle Degree	PU Volts	%VD
PNL-A-2B	In	208	205	-1.98	0.99	1.44
PNL-A-3	In	480	482	-2.16	1.00	-0.34
PNL-A-3A	In	240	232	-2.37	0.97	3.45
PNL-A-4	In	480	482	-1.79	1.00	-0.32
PNL-A-5	In	480	480	-1.97	1.00	0.02
PNL-A-6	In	480	489	-1.75	1.02	-1.80
PNL-A-BLD	In	208	211	-1.77	1.01	-1.30
PNL-A-ILL	In	480	490	-1.76	1.02	-2.03
PNL-B-1	In	480	478	-2.71	1.00	0.36
PNL-B-1A	In	240	230	-2.92	0.96	4.18
PNL-B-1B	In	208	201	-2.82	0.97	3.42
PNL-B-2	In	480	476	-2.71	0.99	0.76
PNL-B-2A	In	240	229	-2.93	0.95	4.60
PNL-B-2B	In	208	200	-2.83	0.96	3.83
PNL-B-3	In	480	471	-3.09	0.98	1.91
PNL-B-3A	In	240	226	-3.31	0.94	5.80
PNL-B-4	In	480	476	-2.72	0.99	0.77
PNL-B-5	In	480	474	-2.72	0.99	1.22
PNL-B-6	In	480	471	-2.99	0.98	1.93
PNL-B-7	In	480	470	-2.65	0.98	2.18
PNL-B-8	In	480	473	-3.01	0.98	1.50
PNL-B-8A	In	240	221	-3.70	0.92	7.84
PNL-B-8B	In	240	227	-3.19	0.95	5.26
PNL-B-8C	In	240	220	-3.59	0.92	8.29
PNL-B-BLD	In	208	205	-2.69	0.99	1.33
PNL-B-ILL	In	480	480	-2.69	1.00	-0.08
PNL-TRAIL1	In	208	202	-4.29	0.97	3.03
PNL-TRAIL2	In	208	202	-4.29	0.97	3.03
SWBD-A	In	480	490	-1.77	1.02	-2.07
SWBD-B	In	480	481	-2.70	1.00	-0.13
XFMR-1AP	In	480	490	-1.77	1.02	-2.06
XFMR-1AS	In	208	211	-1.77	1.01	-1.31
XFMR-1BP	In	480	481	-2.70	1.00	-0.12
XFMR-1BS	In	208	205	-2.70	0.99	1.32
XFMR-2BP	In	480	480	-2.71	1.00	-0.08
XFMR-2BS	In	208	202	-4.28	0.97	2.92
XFMR-A1AP	In	480	489	-1.80	1.02	-1.82
XFMR-A1AS	In	240	236	-2.01	0.98	1.77
XFMR-A1BP	In	480	489	-1.79	1.02	-1.79
XFMR-A1BS	In	208	206	-1.95	0.99	0.95
XFMR-A2AP	In	480	487	-1.86	1.02	-1.52
XFMR-A2AS	In	240	235	-2.07	0.98	2.07

Bus Name	In/Out Service	Design Volts	LF Volts	Angle Degree	PU Volts	%VD
XFMR-A2BP	In	480	487	-1.85	1.02	-1.50
XFMR-A2BS	In	208	205	-2.01	0.99	1.25
XFMR-A3AP	In	480	481	-2.16	1.00	-0.30
XFMR-A3AS	In	240	232	-2.37	0.97	3.34
XFMR-B1AP	In	480	478	-2.70	1.00	0.40
XFMR-B1AS	In	240	230	-2.92	0.96	4.07
XFMR-B1BP	In	480	478	-2.69	1.00	0.42
XFMR-B1BS	In	208	201	-2.86	0.97	3.22
XFMR-B2AP	In	480	476	-2.71	0.99	0.80
XFMR-B2AS	In	240	229	-2.93	0.96	4.48
XFMR-B2BP	In	480	476	-2.70	0.99	0.82
XFMR-B2BS	In	208	200	-2.87	0.96	3.63
XFMR-B3AP	In	480	471	-3.08	0.98	1.95
XFMR-B3AS	In	240	226	-3.31	0.94	5.68
XFMR-B8AP	In	480	468	-3.10	0.97	2.51
XFMR-B8AS	In	240	222	-3.69	0.92	7.68
XFMR-B8BP	In	480	472	-3.00	0.98	1.57
XFMR-B8BS	In	240	229	-3.19	0.95	4.72
XFMR-UTILAP	In	12,470	12,470	0.00	1.00	0.00
XFMR-UTILAS	In	480	491	-1.73	1.02	-2.21
XFMR-UTILBP	In	12,470	12,470	0.00	1.00	0.00
XFMR-UTILBS	In	480	482	-2.61	1.01	-0.51

Cables

From Bus To Bus	Component Name	In/Out Service	%VD	kW Loss	kvar Loss	kVA Loss	LF Amps Rating %	PF
ATS-B-7	TO PNL-B-7	In	0.08	58.4	41.0	71.4	87.7	0.82
PNL-B-7				0.1	0.0	0.1	0.0	
PNL-A-1	TO XFMR-A1AP	In	0.04	39.8	30.0	49.8	58.8	0.80
XFMR-A1AP				0.0	0.0	0.0	0.0	
PNL-A-1	TO XFMR-A1BP	In	0.06	27.4	20.6	34.3	40.5	0.80
XFMR-A1BP				0.0	0.0	0.0	0.0	
PNL-A-2	TO XFMR-A2AP	In	0.04	39.8	30.0	49.8	59.0	0.80
XFMR-A2AP				0.0	0.0	0.0	0.0	
PNL-A-2	TO XFMR-A2BP	In	0.06	27.4	20.6	34.3	40.6	0.80
XFMR-A2BP				0.0	0.0	0.0	0.0	
PNL-A-3	TO AIR-COMP	In	0.74	123.1	76.3	144.8	173.6	0.85
AIR-COMP				0.9	0.6	1.1	0.0	

From Bus To Bus	Component Name	In/Out Service	%VD	kW Loss	kvar Loss	kVA Loss	LF Amps Rating %	PF
PNL-A-3 XFMR-A3AP	TO XFMR-A3AP	In	0.04	39.8 0.0	30.1 0.0	49.9 0.0	59.8 0.0	0.80
PNL-B-1 XFMR-B1AP	TO XFMR-B1AP	In	0.04	39.8 0.0	30.1 0.0	49.9 0.0	60.3 0.0	0.80
PNL-B-1 XFMR-B1BP	TO XFMR-B1BP	In	0.06	27.4 0.0	20.7 0.0	34.4 0.0	41.5 0.0	0.80
PNL-B-2 XFMR-B2AP	TO XFMR-B2AP	In	0.04	39.8 0.0	30.1 0.0	49.9 0.0	60.5 0.0	0.80
PNL-B-2 XFMR-B2BP	TO XFMR-B2BP	In	0.06	27.5 0.0	20.7 0.0	34.4 0.0	41.6 0.0	0.80
PNL-B-3 XFMR-B3AP	TO XFMR-B3AP	In	0.04	39.9 0.0	30.1 0.0	50.0 0.0	61.3 0.0	0.80
PNL-B-8 DISC-100ABP	TO DISC-100ABP	In	0.00	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.00
PNL-B-8 XFMR-B8AP	TO XFMR-B8AP	In	1.01	69.2 0.6	53.2 0.7	87.2 0.9	106.5 0.0	0.79
PNL-B-8 XFMR-B8BP	TO XFMR-B8BP	In	0.07	33.8 0.0	25.5 0.0	42.3 0.0	51.7 0.0	0.80
SWBD-A CRANE-1	TO CRANE-1	In	1.86	434.2 6.7	272.0 7.0	512.4 9.7	603.8 0.0	0.85
SWBD-A CRANE-2	TO CRANE-2	In	1.86	434.2 6.7	272.0 7.0	512.4 9.7	603.8 0.0	0.85
SWBD-A DISC-800ABP	TO DISC-800ABP	In	0.00	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.00
SWBD-A PNL-A-1	TO PNL-A-1	In	0.21	67.3 0.1	50.8 0.2	84.3 0.2	99.4 0.0	0.80
SWBD-A PNL-A-2	TO PNL-A-2	In	0.50	67.4 0.3	51.0 0.4	84.6 0.4	99.7 0.0	0.80
SWBD-A PNL-A-3	TO PNL-A-3	In	1.72	164.9 2.1	109.3 3.0	197.9 3.6	233.2 0.0	0.83
SWBD-A PNL-A-4	TO PNL-A-4	In	1.74	107.4 1.8	80.6 1.4	134.3 2.3	158.3 0.0	0.80
SWBD-A PNL-A-5	TO PNL-A-5	In	2.09	107.5 1.9	81.2 2.0	134.8 2.8	158.8 0.0	0.80
SWBD-A PNL-A-6	TO PNL-A-6	In	0.27	6.6 0.0	4.9 0.0	8.2 0.0	9.7 0.0	0.80

From Bus To Bus	Component Name	In/Out Service	%VD	kW Loss	kvar Loss	kVA Loss	LF Amps Rating %	PF
SWBD-A PNL-A-ILL	TO PNL-A-ILL	In	0.04	24.5 0.0	18.4 0.0	30.7 0.0	36.2 0.0	0.80
SWBD-A XFMR-1AP	TO XFMR-1AP	In	0.00	3.3 0.0	2.5 0.0	4.1 0.0	4.9 0.0	0.80
SWBD-B ATS-B-7	TO ATS-B-7	In	2.24	59.8 1.4	41.9 0.9	73.0 1.6	87.7 0.0	0.82
SWBD-B CRANE-3	TO CRANE-3	In	2.14	435.4 7.8	273.2 8.2	514.0 11.4	617.5 0.0	0.85
SWBD-B CRANE-4	TO CRANE-4	In	2.14	435.4 7.8	273.2 8.2	514.0 11.4	617.5 0.0	0.85
SWBD-B PNL-B-1	TO PNL-B-1	In	0.49	67.6 0.3	51.0 0.3	84.7 0.4	101.7 0.0	0.80
SWBD-B PNL-B-2	TO PNL-B-2	In	0.88	67.9 0.6	51.2 0.5	85.0 0.8	102.2 0.0	0.80
SWBD-B PNL-B-3	TO PNL-B-3	In	2.04	147.7 2.3	112.6 3.3	185.8 4.0	223.1 0.0	0.80
SWBD-B PNL-B-4	TO PNL-B-4	In	0.90	53.3 0.5	40.0 0.4	66.6 0.6	80.0 0.0	0.80
SWBD-B PNL-B-5	TO PNL-B-5	In	1.35	107.0 1.4	80.3 1.1	133.8 1.8	160.7 0.0	0.80
SWBD-B PNL-B-6	TO PNL-B-6	In	2.06	107.4 1.8	81.4 2.2	134.8 2.9	161.9 0.0	0.80
SWBD-B PNL-B-8	TO PNL-B-8	In	1.63	264.6 3.3	202.1 4.7	333.0 5.7	400.0 0.0	0.79
SWBD-B PNL-B-ILL	TO PNL-B-ILL	In	0.05	30.9 0.0	23.1 0.0	38.6 0.0	46.3 0.0	0.80
SWBD-B XFMR-1BP	TO XFMR-1BP	In	0.01	6.2 0.0	4.6 0.0	7.7 0.0	9.3 0.0	0.80
SWBD-B XFMR-2BP	TO XFMR-TRAIL	In	0.05	322.9 0.1	256.5 0.1	412.4 0.2	495.4 0.0	0.78
XFMR-1AS PNL-A-BLD	TO PNL-A-BLD	In	0.01	3.3 0.0	2.5 0.0	4.1 0.0	11.2 0.0	0.80
XFMR-1BS PNL-B-BLD	TO PNL-B-BLD	In	0.02	6.1 0.0	4.6 0.0	7.6 0.0	21.4 0.0	0.80
XFMR-2BS PNL-TRAIL1	TO PNL-TRAIL1	In	0.11	159.9 0.1	120.0 0.2	199.9 0.2	571.6 0.0	0.80
XFMR-2BS PNL-TRAIL2	TO PNL-TRAIL2	In	0.11	159.9 0.1	120.0 0.2	199.9 0.2	571.6 0.0	0.80

From Bus To Bus	Component Name	In/Out Service	%VD	kW Loss	kvar Loss	kVA Loss	LF Amps Rating %	PF
XFMR-A1AS PNL-A-1A	TO PNL-A-1A	In	0.11	38.4 0.0	28.8 0.0	48.1 0.1	117.7 0.0	0.80
XFMR-A1BS PNL-A-1B	TO PNL-A-1B	In	0.19	26.7 0.1	20.0 0.0	33.4 0.1	93.5 0.0	0.80
XFMR-A2AS PNL-A-2A	TO PNL-A-2A	In	0.11	38.4 0.0	28.8 0.0	48.1 0.1	118.0 0.0	0.80
XFMR-A2BS PNL-A-2B	TO PNL-A-2B	In	0.19	26.7 0.1	20.0 0.0	33.4 0.1	93.8 0.0	0.80
XFMR-A3AS PNL-A-3A	TO PNL-A-3A	In	0.11	38.4 0.0	28.8 0.0	48.1 0.1	119.6 0.0	0.80
XFMR-B1AS PNL-B-1A	TO PNL-B-1A	In	0.12	38.4 0.0	28.8 0.0	48.1 0.1	120.5 0.0	0.80
XFMR-B1BS PNL-B-1B	TO PNL-B-1B	In	0.20	26.7 0.1	20.0 0.0	33.4 0.1	95.7 0.0	0.80
XFMR-B2AS PNL-B-2A	TO PNL-B-2A	In	0.12	38.4 0.0	28.8 0.0	48.1 0.1	121.0 0.0	0.80
XFMR-B2BS PNL-B-2B	TO PNL-B-2B	In	0.20	26.7 0.1	20.0 0.0	33.4 0.1	96.1 0.0	0.80
XFMR-B3AS PNL-B-3A	TO PNL-B-3A	In	0.12	38.4 0.0	28.8 0.0	48.1 0.1	122.6 0.0	0.80
XFMR-B8AS PNL-B-8A	TO PNL-B-8A	In	0.16	55.7 0.1	41.8 0.1	69.7 0.1	181.6 0.0	0.80
XFMR-B8AS PNL-B-8C	TO PNL-B-8C	In	0.60	9.7 0.1	7.2 0.0	12.1 0.1	31.5 0.0	0.80
XFMR-B8BS PNL-B-8B	TO PNL-B-8B	In	0.54	32.8 0.2	24.6 0.1	41.0 0.2	103.4 0.0	0.80
XFMR-UTILAS SWBD-A	TO SWBD-A	In	0.15	1,418.8 1.4	945.1 2.4	1,704.8 2.7	2,006.1 0.0	0.83
XFMR-UTILBS SWBD-B	TO SWBD-B	In	0.38	2,111.6 5.5	1,500.6 9.3	2,590.5 10.8	3,099.9 0.0	0.82

2-Winding Transformers

From Bus To Bus	Component Name	In/Out Service	%VD	kW Loss	kvar Loss	kVA Loss	LF Amps Rating %	PF
XFMR-1AP XFMR-1AS	XFMR-1A	In	0.76	3.3 0.0	2.5 0.0	4.1 0.0	5.0 13.5	0.80

From Bus To Bus	Component Name	In/Out Service	%VD	kW Loss	kvar Loss	kVA Loss	LF Amps Rating %	PF
XFMR-1BP	XFMR-1B	In	1.44	6.2	4.6	7.7	9.0	0.80
XFMR-1BS				0.1	0.1	0.1	25.7	
XFMR-2BP	XFMR-2B	In	3.00	322.8	256.3	412.2	495.0	0.78
XFMR-2BS				3.0	16.4	16.6	82.4	
XFMR-A1AP	XFMR-A1A	In	3.58	39.7	30.0	49.8	59.0	0.80
XFMR-A1AS				1.3	1.2	1.8	97.8	
XFMR-A1BP	XFMR-A1B	In	2.74	27.4	20.6	34.3	41.0	0.80
XFMR-A1BS				0.7	0.6	0.9	74.9	
XFMR-A2AP	XFMR-A2A	In	3.59	39.7	30.0	49.8	59.0	0.80
XFMR-A2AS				1.3	1.2	1.8	98.1	
XFMR-A2BP	XFMR-A2B	In	2.75	27.4	20.6	34.3	41.0	0.80
XFMR-A2BS				0.7	0.6	0.9	75.1	
XFMR-A3AP	XFMR-A3A	In	3.64	39.8	30.1	49.9	60.0	0.80
XFMR-A3AS				1.3	1.2	1.8	99.4	
XFMR-B1AP	XFMR-B1A	In	3.67	39.8	30.1	49.9	60.0	0.80
XFMR-B1AS				1.4	1.3	1.8	100.2	
XFMR-B1BP	XFMR-B1B	In	2.80	27.4	20.7	34.3	41.0	0.80
XFMR-B1BS				0.7	0.7	1.0	76.6	
XFMR-B2AP	XFMR-B2A	In	3.68	39.8	30.1	49.9	61.0	0.80
XFMR-B2AS				1.4	1.3	1.9	100.6	
XFMR-B2BP	XFMR-B2B	In	2.82	27.4	20.7	34.3	42.0	0.80
XFMR-B2BS				0.7	0.7	1.0	76.9	
XFMR-B3AP	XFMR-B3A	In	3.73	39.8	30.1	50.0	61.0	0.80
XFMR-B3AS				1.4	1.3	1.9	101.9	
XFMR-B8AP	XFMR-B8A	In	5.18	68.5	52.5	86.3	107.0	0.79
XFMR-B8AS				3.1	3.5	4.7	118.1	
XFMR-B8BP	XFMR-B8B	In	3.15	33.8	25.5	42.3	52.0	0.80
XFMR-B8BS				1.0	0.9	1.4	86.0	
XFMR-UTILA	XFMR-UTILA	In	-2.21	1,427.5	1,014.5	1,751.3	81.0	0.82
XFMR-UTILA				8.7	69.4	69.9	70.1	
XFMR-UTILB	XFMR-UTILB	In	-0.51	2,132.3	1,666.3	2,706.1	125.0	0.79
XFMR-UTILBS				20.7	165.7	167.0	108.2	

Project: 1001055 Scenario 2

Load Flow Summary Report

Load Flow Study Settings

Include Source Impedance	No	**Load Acceleration Factor**	1.00
Solution Method	Exact (Iterative)	**Bus Voltage Drop %**	5.00
Load Specification	Connected Load	**Branch Voltage Drop %**	3.00
Generation Acceleration Factor	1.00		

Swing Generators

Source	In/Out Service	Vpu	Angle	kW	kvar	VD%	Utility Impedance
UTIL-PUDA	In	1.00	0.00	1,427.5	1,014.5	0.00	0.00 +*j* 0.00
UTIL-PUDB	In	1.00	0.00	2,132.2	1,666.2	0.00	0.00 +*j* 0.00

Buses

Bus Name	In/Out Service	Design Volts	LF Volts	Angle Degree	PU Volts	%VD
AIR-COMP	In	480	478	-2.16	1.00	0.40
ATS-B-7	In	480	470	-2.67	0.98	2.11
CRANE-1	In	480	481	-2.05	1.00	-0.20
CRANE-2	In	480	481	-2.05	1.00	-0.20
CRANE-3	In	480	470	-3.03	0.98	2.01
CRANE-4	In	480	470	-3.03	0.98	2.01
DISC-100ABP	In	480	473	-3.01	0.98	1.50
DISC-800ABP	In	480	490	-1.77	1.02	-2.07
PNL-A-1	In	480	489	-1.81	1.02	-1.85
PNL-A-1A	In	240	235	-2.02	0.98	1.88
PNL-A-1B	In	208	206	-1.92	0.99	1.14
PNL-A-2	In	480	487	-1.86	1.02	-1.56
PNL-A-2A	In	240	235	-2.07	0.98	2.18

Bus Name	In/Out Service	Design Volts	LF Volts	Angle Degree	PU Volts	%VD
PNL-A-2B	In	208	205	-1.98	0.99	1.44
PNL-A-3	In	480	482	-2.16	1.00	-0.34
PNL-A-3A	In	240	232	-2.37	0.97	3.45
PNL-A-4	In	480	482	-1.79	1.00	-0.32
PNL-A-5	In	480	480	-1.97	1.00	0.02
PNL-A-6	In	480	489	-1.75	1.02	-1.80
PNL-A-BLD	In	208	211	-1.77	1.01	-1.30
PNL-A-ILL	In	480	490	-1.76	1.02	-2.03
PNL-B-1	In	480	478	-2.71	1.00	0.36
PNL-B-1A	In	240	230	-2.92	0.96	4.18
PNL-B-1B	In	208	201	-2.82	0.97	3.42
PNL-B-2	In	480	476	-2.71	0.99	0.76
PNL-B-2A	In	240	229	-2.93	0.95	4.60
PNL-B-2B	In	208	200	-2.83	0.96	3.83
PNL-B-3	In	480	471	-3.09	0.98	1.91
PNL-B-3A	In	240	232	-3.31	0.97	3.43
PNL-B-4	In	480	476	-2.72	0.99	0.77
PNL-B-5	In	480	474	-2.72	0.99	1.22
PNL-B-6	In	480	471	-2.99	0.98	1.93
PNL-B-7	In	480	470	-2.65	0.98	2.18
PNL-B-8	In	480	473	-3.01	0.98	1.50
PNL-B-8A	In	240	232	-3.69	0.97	3.22
PNL-B-8B	In	240	233	-3.19	0.97	2.86
PNL-B-8C	In	240	231	-3.60	0.96	3.64
PNL-B-BLD	In	208	205	-2.69	0.99	1.33
PNL-B-ILL	In	480	480	-2.69	1.00	-0.08
PNL-TRAIL1	In	208	202	-4.29	0.97	3.03
PNL-TRAIL2	In	208	202	-4.29	0.97	3.03
SWBD-A	In	480	490	-1.77	1.02	-2.07
SWBD-B	In	480	481	-2.70	1.00	-0.13
XFMR-1AP	In	480	490	-1.77	1.02	-2.06
XFMR-1AS	In	208	211	-1.77	1.01	-1.31
XFMR-1BP	In	480	481	-2.70	1.00	-0.12
XFMR-1BS	In	208	205	-2.70	0.99	1.32
XFMR-2BP	In	480	480	-2.71	1.00	-0.08
XFMR-2BS	In	208	202	-4.28	0.97	2.92
XFMR-A1AP	In	480	489	-1.80	1.02	-1.82
XFMR-A1AS	In	240	236	-2.01	0.98	1.77
XFMR-A1BP	In	480	489	-1.79	1.02	-1.79
XFMR-A1BS	In	208	206	-1.95	0.99	0.95
XFMR-A2AP	In	480	487	-1.86	1.02	-1.52
XFMR-A2AS	In	240	235	-2.07	0.98	2.07

Bus Name	In/Out Service	Design Volts	LF Volts	Angle Degree	PU Volts	%VD
XFMR-A2BP	In	480	487	-1.85	1.02	-1.50
XFMR-A2BS	In	208	205	-2.01	0.99	1.25
XFMR-A3AP	In	480	481	-2.16	1.00	-0.30
XFMR-A3AS	In	240	232	-2.37	0.97	3.34
XFMR-B1AP	In	480	478	-2.70	1.00	0.40
XFMR-B1AS	In	240	230	-2.92	0.96	4.07
XFMR-B1BP	In	480	478	-2.69	1.00	0.42
XFMR-B1BS	In	208	201	-2.86	0.97	3.22
XFMR-B2AP	In	480	476	-2.71	0.99	0.80
XFMR-B2AS	In	240	229	-2.93	0.96	4.48
XFMR-B2BP	In	480	476	-2.70	0.99	0.82
XFMR-B2BS	In	208	200	-2.87	0.96	3.63
XFMR-B3AP	In	480	471	-3.08	0.98	1.95
XFMR-B3AS	In	240	232	-3.31	0.97	3.32
XFMR-B8AP	In	480	468	-3.10	0.97	2.51
XFMR-B8AS	In	240	233	-3.69	0.97	3.07
XFMR-B8BP	In	480	472	-3.00	0.98	1.57
XFMR-B8BS	In	240	234	-3.19	0.98	2.33
XFMR-UTILAP	In	12,470	12,470	0.00	1.00	0.00
XFMR-UTILAS	In	480	491	-1.73	1.02	-2.21
XFMR-UTILBP	In	12,470	12,470	0.00	1.00	0.00
XFMR-UTILBS	In	480	482	-2.61	1.01	-0.51

Cables

From Bus To Bus	Component Name	In/Out Service	%VD	kW Loss	kvar Loss	kVA Loss	LF Amps Rating %	PF
ATS-B-7 PNL-B-7	TO PNL-B-7	In	0.08	58.4 0.1	41.0 0.0	71.4 0.1	87.7 0.0	0.82
PNL-A-1 XFMR-A1AP	TO XFMR-A1AP	In	0.04	39.8 0.0	30.0 0.0	49.8 0.0	58.8 0.0	0.80
PNL-A-1 XFMR-A1BP	TO XFMR-A1BP	In	0.06	27.4 0.0	20.6 0.0	34.3 0.0	40.5 0.0	0.80
PNL-A-2 XFMR-A2AP	TO XFMR-A2AP	In	0.04	39.8 0.0	30.0 0.0	49.8 0.0	59.0 0.0	0.80
PNL-A-2 XFMR-A2BP	TO XFMR-A2BP	In	0.06	27.4 0.0	20.6 0.0	34.3 0.0	40.6 0.0	0.80
PNL-A-3 AIR-COMP	TO AIR-COMP	In	0.74	123.1 0.9	76.3 0.6	144.8 1.1	173.6 0.0	0.85

From Bus To Bus	Component Name	In/Out Service	%VD	kW Loss	kvar Loss	kVA Loss	LF Amps Rating %	PF
PNL-A-3	TO XFMR-A3AP	In	0.04	39.8	30.1	49.9	59.8	0.80
XFMR-A3AP				0.0	0.0	0.0	0.0	
PNL-B-1	TO XFMR-B1AP	In	0.04	39.8	30.1	49.9	60.3	0.80
XFMR-B1AP				0.0	0.0	0.0	0.0	
PNL-B-1	TO XFMR-B1BP	In	0.06	27.4	20.7	34.4	41.5	0.80
XFMR-B1BP				0.0	0.0	0.0	0.0	
PNL-B-2	TO XFMR-B2AP	In	0.04	39.8	30.1	49.9	60.5	0.80
XFMR-B2AP				0.0	0.0	0.0	0.0	
PNL-B-2	TO XFMR-B2BP	In	0.06	27.5	20.7	34.4	41.6	0.80
XFMR-B2BP				0.0	0.0	0.0	0.0	
PNL-B-3	TO XFMR-B3AP	In	0.04	39.9	30.1	50.0	61.3	0.80
XFMR-B3AP				0.0	0.0	0.0	0.0	
PNL-B-8	TO DISC-100ABP	In	0.00	0.0	0.0	0.0	0.0	0.00
DISC-100ABP				0.0	0.0	0.0	0.0	
PNL-B-8	TO XFMR-B8AP	In	1.01	69.2	53.1	87.2	106.5	0.79
XFMR-B8AP				0.6	0.7	0.9	0.0	
PNL-B-8	TO XFMR-B8BP	In	0.07	33.8	25.5	42.3	51.7	0.80
XFMR-B8BP				0.0	0.0	0.0	0.0	
SWBD-A	TO CRANE-1	In	1.86	434.2	272.0	512.4	603.8	0.85
CRANE-1				6.7	7.0	9.7	0.0	
SWBD-A	TO CRANE-2	In	1.86	434.2	272.0	512.4	603.8	0.85
CRANE-2				6.7	7.0	9.7	0.0	
SWBD-A	TO DISC-800ABP	In	0.00	0.0	0.0	0.0	0.0	0.00
DISC-800ABP				0.0	0.0	0.0	0.0	
SWBD-A	TO PNL-A-1	In	0.21	67.3	50.8	84.3	99.4	0.80
PNL-A-1				0.1	0.2	0.2	0.0	
SWBD-A	TO PNL-A-2	In	0.50	67.4	51.0	84.6	99.7	0.80
PNL-A-2				0.3	0.4	0.4	0.0	
SWBD-A	TO PNL-A-3	In	1.72	164.9	109.3	197.9	233.2	0.83
PNL-A-3				2.1	3.0	3.6	0.0	
SWBD-A	TO PNL-A-4	In	1.74	107.4	80.6	134.3	158.3	0.80
PNL-A-4				1.8	1.4	2.3	0.0	
SWBD-A	TO PNL-A-5	In	2.09	107.5	81.2	134.8	158.8	0.80
PNL-A-5				1.9	2.0	2.8	0.0	
SWBD-A	TO PNL-A-6	In	0.27	6.6	4.9	8.2	9.7	0.80
PNL-A-6				0.0	0.0	0.0	0.0	

From Bus To Bus	Component Name	In/Out Service	%VD	kW Loss	kvar Loss	kVA Loss	LF Amps Rating %	PF
SWBD-A PNL-A-ILL	TO PNL-A-ILL	In	0.04	24.5 0.0	18.4 0.0	30.7 0.0	36.2 0.0	0.80
SWBD-A XFMR-1AP	TO XFMR-1AP	In	0.00	3.3 0.0	2.5 0.0	4.1 0.0	4.9 0.0	0.80
SWBD-B ATS-B-7	TO ATS-B-7	In	2.24	59.8 1.4	41.9 0.9	73.0 1.6	87.7 0.0	0.82
SWBD-B CRANE-3	TO CRANE-3	In	2.14	435.4 7.8	273.2 8.2	514.0 11.4	617.5 0.0	0.85
SWBD-B CRANE-4	TO CRANE-4	In	2.14	435.4 7.8	273.2 8.2	514.0 11.4	617.5 0.0	0.85
SWBD-B PNL-B-1	TO PNL-B-1	In	0.49	67.6 0.3	51.0 0.3	84.7 0.4	101.7 0.0	0.80
SWBD-B PNL-B-2	TO PNL-B-2	In	0.88	67.9 0.6	51.2 0.5	85.0 0.8	102.2 0.0	0.80
SWBD-B PNL-B-3	TO PNL-B-3	In	2.04	147.7 2.3	112.6 3.3	185.8 4.0	223.1 0.0	0.80
SWBD-B PNL-B-4	TO PNL-B-4	In	0.90	53.3 0.5	40.0 0.4	66.6 0.6	80.0 0.0	0.80
SWBD-B PNL-B-5	TO PNL-B-5	In	1.35	107.0 1.4	80.3 1.1	133.8 1.8	160.7 0.0	0.80
SWBD-B PNL-B-6	TO PNL-B-6	In	2.06	107.4 1.8	81.4 2.2	134.8 2.9	161.9 0.0	0.80
SWBD-B PNL-B-8	TO PNL-B-8	In	1.63	264.6 3.3	202.1 4.7	333.0 5.7	400.0 0.0	0.79
SWBD-B PNL-B-ILL	TO PNL-B-ILL	In	0.05	30.9 0.0	23.1 0.0	38.6 0.0	46.3 0.0	0.80
SWBD-B XFMR-1BP	TO XFMR-1BP	In	0.01	6.2 0.0	4.6 0.0	7.7 0.0	9.3 0.0	0.80
SWBD-B XFMR-2BP	TO XFMR-TRAIL	In	0.05	322.9 0.1	256.5 0.1	412.4 0.2	495.4 0.0	0.78
XFMR-1AS PNL-A-BLD	TO PNL-A-BLD	In	0.01	3.3 0.0	2.5 0.0	4.1 0.0	11.2 0.0	0.80
XFMR-1BS PNL-B-BLD	TO PNL-B-BLD	In	0.02	6.1 0.0	4.6 0.0	7.6 0.0	21.4 0.0	0.80
XFMR-2BS PNL-TRAIL1	TO PNL-TRAIL1	In	0.11	159.9 0.1	120.0 0.2	199.9 0.2	571.6 0.0	0.80
XFMR-2BS PNL-TRAIL2	TO PNL-TRAIL2	In	0.11	159.9 0.1	120.0 0.2	199.9 0.2	571.6 0.0	0.80

From Bus To Bus	Component Name	In/Out Service	%VD	kW Loss	kvar Loss	kVA Loss	LF Amps Rating %	PF
XFMR-A1AS PNL-A-1A	TO PNL-A-1A	In	0.11	38.4 0.0	28.8 0.0	48.1 0.1	117.7 0.0	0.80
XFMR-A1BS PNL-A-1B	TO PNL-A-1B	In	0.19	26.7 0.1	20.0 0.0	33.4 0.1	93.5 0.0	0.80
XFMR-A2AS PNL-A-2A	TO PNL-A-2A	In	0.11	38.4 0.0	28.8 0.0	48.1 0.1	118.0 0.0	0.80
XFMR-A2BS PNL-A-2B	TO PNL-A-2B	In	0.19	26.7 0.1	20.0 0.0	33.4 0.1	93.8 0.0	0.80
XFMR-A3AS PNL-A-3A	TO PNL-A-3A	In	0.11	38.4 0.0	28.8 0.0	48.1 0.1	119.6 0.0	0.80
XFMR-B1AS PNL-B-1A	TO PNL-B-1A	In	0.12	38.4 0.0	28.8 0.0	48.1 0.1	120.5 0.0	0.80
XFMR-B1BS PNL-B-1B	TO PNL-B-1B	In	0.20	26.7 0.1	20.0 0.0	33.4 0.1	95.7 0.0	0.80
XFMR-B2AS PNL-B-2A	TO PNL-B-2A	In	0.12	38.4 0.0	28.8 0.0	48.1 0.1	121.0 0.0	0.80
XFMR-B2BS PNL-B-2B	TO PNL-B-2B	In	0.20	26.7 0.1	20.0 0.0	33.4 0.1	96.1 0.0	0.80
XFMR-B3AS PNL-B-3A	TO PNL-B-3A	In	0.11	38.4 0.0	28.8 0.0	48.1 0.1	119.6 0.0	0.80
XFMR-B8AS PNL-B-8A	TO PNL-B-8A	In	0.15	55.7 0.1	41.8 0.1	69.7 0.1	172.9 0.0	0.80
XFMR-B8AS PNL-B-8C	TO PNL-B-8C	In	0.57	9.7 0.1	7.2 0.0	12.1 0.1	30.0 0.0	0.80
XFMR-B8BS PNL-B-8B	TO PNL-B-8B	In	0.53	32.8 0.2	24.6 0.1	40.9 0.2	100.8 0.0	0.80
XFMR-UTILAS SWBD-A	TO SWBD-A	In	0.15	1,418.8 1.4	945.1 2.4	1,704.8 2.7	2,006.1 0.0	0.83
XFMR-UTILBS SWBD-B	TO SWBD-B	In	0.38	2,111.5 5.5	1,500.6 9.3	2,590.4 10.8	3,099.9 0.0	0.82

2-Winding Transformers

From Bus To Bus	Component Name	In/Out Service	%VD	kW Loss	kvar Loss	kVA Loss	LF Amps Rating %	PF
XFMR-1AP XFMR-1AS	XFMR-1A	In	0.76	3.3 0.0	2.5 0.0	4.1 0.0	5.0 13.5	0.80

From Bus To Bus	Component Name	In/Out Service	%VD	kW Loss	kvar Loss	kVA Loss	LF Amps Rating %	PF
XFMR-1BP XFMR-1BS	XFMR-1B	In	1.44	6.2 0.1	4.6 0.1	7.7 0.1	9.0 25.7	0.80
XFMR-2BP XFMR-2BS	XFMR-2B	In	3.00	322.8 3.0	256.3 16.4	412.2 16.6	495.0 82.4	0.78
XFMR-A1AP XFMR-A1AS	XFMR-A1A	In	3.58	39.7 1.3	30.0 1.2	49.8 1.8	59.0 97.8	0.80
XFMR-A1BP XFMR-A1BS	XFMR-A1B	In	2.74	27.4 0.7	20.6 0.6	34.3 0.9	41.0 74.9	0.80
XFMR-A2AP XFMR-A2AS	XFMR-A2A	In	3.59	39.7 1.3	30.0 1.2	49.8 1.8	59.0 98.1	0.80
XFMR-A2BP XFMR-A2BS	XFMR-A2B	In	2.75	27.4 0.7	20.6 0.6	34.3 0.9	41.0 75.1	0.80
XFMR-A3AP XFMR-A3AS	XFMR-A3A	In	3.64	39.8 1.3	30.1 1.2	49.9 1.8	60.0 99.4	0.80
XFMR-B1AP XFMR-B1AS	XFMR-B1A	In	3.67	39.8 1.4	30.1 1.3	49.9 1.8	60.0 100.2	0.80
XFMR-B1BP XFMR-B1BS	XFMR-B1B	In	2.80	27.4 0.7	20.7 0.7	34.3 1.0	41.0 76.6	0.80
XFMR-B2AP XFMR-B2AS	XFMR-B2A	In	3.68	39.8 1.4	30.1 1.3	49.9 1.9	61.0 100.6	0.80
XFMR-B2BP XFMR-B2BS	XFMR-B2B	In	2.82	27.4 0.7	20.7 0.7	34.3 1.0	42.0 76.9	0.80
XFMR-B3AP XFMR-B3AS	XFMR-B3A	In	1.37	39.8 1.4	30.1 1.3	50.0 1.9	61.0 101.9	0.80
XFMR-B8AP XFMR-B8AS	XFMR-B8A	In	0.56	68.5 3.1	52.5 3.4	86.3 4.7	106.0 118.1	0.79
XFMR-B8BP XFMR-B8BS	XFMR-B8B	In	0.76	33.7 1.0	25.5 0.9	42.3 1.4	52.0 85.9	0.80
XFMR-UTILA XFMR-UTILA	XFMR-UTILA	In	-2.21	1,427.5 8.7	1,014.5 69.4	1,751.3 69.9	81.0 70.1	0.82
XFMR-UTILB XFMR-UTILBS	XFMR-UTILB	In	-0.51	2,132.2 20.7	1,666.2 165.7	2,706.1 167.0	125.0 108.2	0.79