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City of Oxnard

Public Works Integrated Master Plan

RECYCLED WATER

PROJECT MEMORANDUM 4.4
ARC FLASH ASSESSMENT

FINAL DRAFT
December 2015

Engineers...Working Wonders With Water™

2700 YGNACIO VALLEY ROAD • SUITE 300 • WALNUT CREEK, CALIFORNIA 94598 • (925) 932-1710 • FAX (925) 930-0208
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City of Oxnard

Public Works Integrated Master Plan

RECYCLED WATER

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ARC FLASH ASSESSMENT

1.0 INTRODUCTION

As part of the Public Works Integrated Master Plan (PWIMP), Power Studies.com was contracted to conduct assessments for short circuiting, protective device coordination, and arc flash potential for the Advanced Water Purification Facility (AWPF) and recycled water distribution system within the City of Oxnard (City). The summary report for all three of these studies is included in Appendix A.

1.1 PMs Used for Reference

The findings outlined in the Arc Flash Assessment were made in concert with recommendations and analyses from other related PMs:

- PM 4.1 – Recycled Water System - Background Summary.

2.0 FINDINGS

Below is a summary of the findings and recommendations for the City's recycled water infrastructure as it relates to the study noted above.

2.1 AWPF

- Arc Flash warning labels were provided for various locations to aid technicians in determining what PPE clothing should be worn.

2.2 Recycled Water Distribution System

- Revise, update and redraw the Distribution System One-Line Drawings 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.
- Verify that the device setting are set to the values shown in Appendix A, Tab 9.
- Test and inspect all electrical equipment periodically as outlined in applicable standards (as noted in report in Appendix A).

APPENDIX A – SHORT CIRCUIT, PROTECTION DEVICE COORDINATION AND ARC FLASH STUDIES

PowerStudies.com PS
16122 SE 266th Street ■ Covington, WA 98042

SHORT CIRCUIT, PROTECTIVE DEVICE COORDINATION & ARC FLASH STUDIES

Oxnard Advanced Water Purification
Oxnard, CA

Submitted By:
Tam Tran

Reviewed By:
Ann Holliday
& Robert Fuhr, P.E.

Customer P.O. # 6200-10100-1093
Job # 1104042-1
Date: 4/28/11
Revision 0

REGISTERED PROFESSIONAL ENGINEER
ROBERT E. FUHR
E 15265
EXP. 12/26/11
ELECTRICAL
STATE OF CALIFORNIA

P.E.

253.639.8535 Phone
253.639.8685 Fax
www.powerstudies.com

TAB 1

INTRODUCTION

In 2011, Doty Bros. Equipment Company was awarded a contract to provide the electrical distribution equipment for the Oxnard Advanced Water Purification. The facility is located in Oxnard, CA. The specifications for this project required a short circuit, protective device coordination, and arc flash 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 existing 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 can be found in Tab 7. The time current curves are located under Tab 8. The circuit breaker and relay setting sheets are located under Tab 9. Copies of the manufacturer's time current curves are found under Tab 10.

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 12. Paper copies of the Arc Flash labels located in Tab 13. (Note: Only 1 set of adhesive labels is included for this project.) These labels should be attached to each piece of equipment.

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 existing and 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. Southern California Edison supplied the available fault current and transformer information. (3) 2500 kVA transformer with 5.75% impedance was supplied by Southern California Edison. The available fault current used in the study is listed below.

			Available Fault Current	
Node ID#	**Node Name**	**Volts**	**3-Phase**	**Line to Grd**
05XFMR9001S	05XFMR9001 SEC	480	37,655 A	41,533 A
05XFMR9002S	05XFMR9002 SEC	480	37,655 A	41,533 A
05XFMR9004S	05XFMR9004 SEC	480	37,647 A	41,526 A

The study was performed on the existing and 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 following recommendations will correct code violations and equipment problems.

1. The engineer was informed the breaker currently feeding the 15kVA transformer on panel 40DP9202 is a 60A FD. This is a code violation as this is too high for a 15kVA transformer. Consider replacing this with a 30A FD breaker.

2. The engineer was informed the breaker currently feeding the 15kVA transformer on panel 30DP9201 is a 50A FD. This is a code violation as this is too high for a 15kVA transformer. Consider replacing this with a 30A FD breaker.

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.

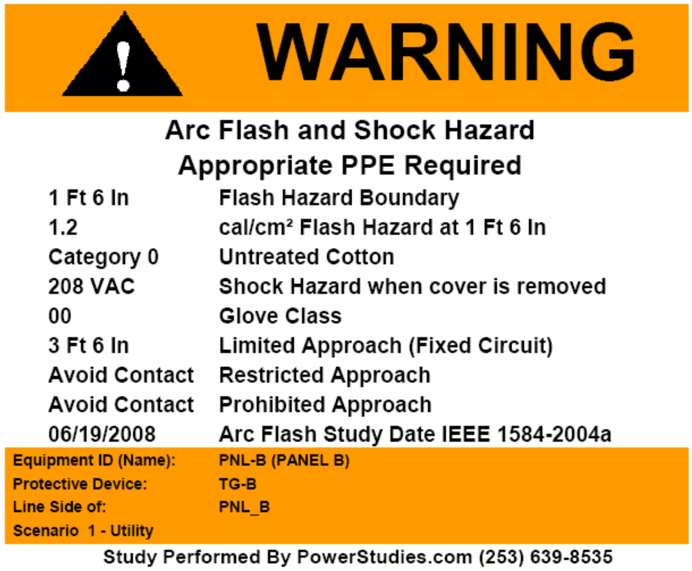


Figure 1 – Example Arc Flash Label

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 11.

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 Power

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
15SWGR9001 (15SWGR9001) (3-15SWGR9001 MN LineSide)	1	1-FDR TO 9001	480	28.65	28.13	15.82	2.00	0.000	Y	PNL	25	282	18	109.00	Dangerous! (*N9)
30SWBD9001 (30SWBD9001) (12-30SWBD9001 MN LineSide)	1	10-FDR TO 9002	480	30.59	30.51	17.00	2.00	0.000	Y	PNL	25	295	18	118.00	Dangerous! (*N9)
46SWGR9001 (46SWGR9001) (18-46SWGR9001 MN LineSide)	1	16-FDR TO 9004	480	35.43	35.30	19.25	2.00	0.000	Y	PNL	25	321	18	135.00	Dangerous! (*N9)

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 9.

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

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. Southern California Edison supplied the available fault current and transformer information. (3) 2500 kVA transformer with 5.75% impedance was supplied by Southern California Edison. The available fault current used in the study is listed below.

			Available Fault Current	
Node ID#	**Node Name**	**Volts**	**3-Phase**	**Line to Grd**
05XFMR9001S	05XFMR9001 SEC	480	37,655 A	41,533 A
05XFMR9002S	05XFMR9002 SEC	480	37,655 A	41,533 A
05XFMR9004S	05XFMR9004 SEC	480	37,647 A	41,526 A

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

3. All the motors on the MCCs without the VFDs 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 existing and 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^{o}C (167^{o}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	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	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																				
				Equip Rating (KA)													Equipment Underrated?			
Node ID	Node Name	Volts	Type of Device	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	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:																		

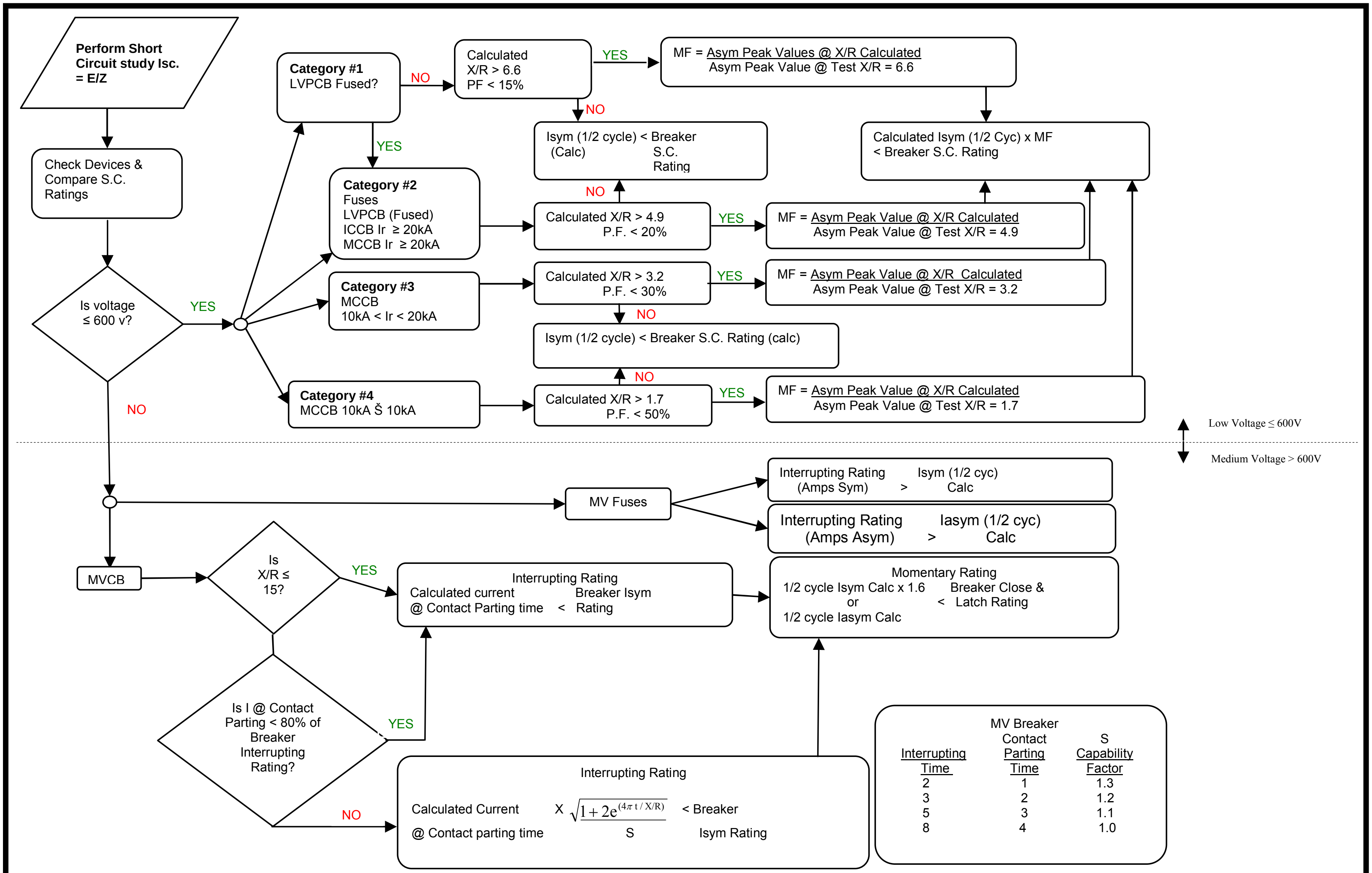
Table 2 - Medium Voltage Short Circuit Summary List

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.

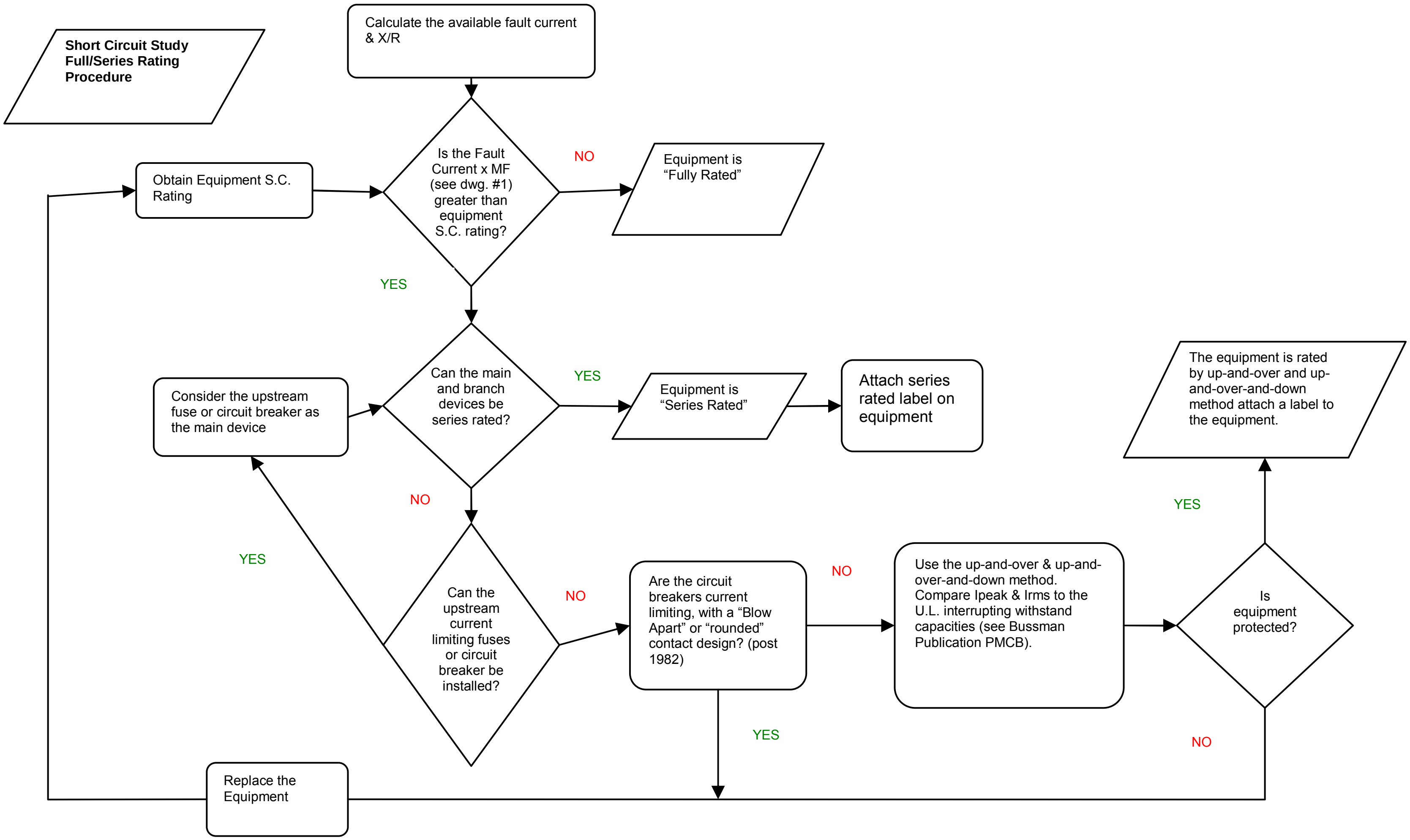
Oxnard Advanced Water Purification
Job Number #1104042-1
Revision #0 - Date: 4/28/11



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

Short Circuit Rating Flow Chart

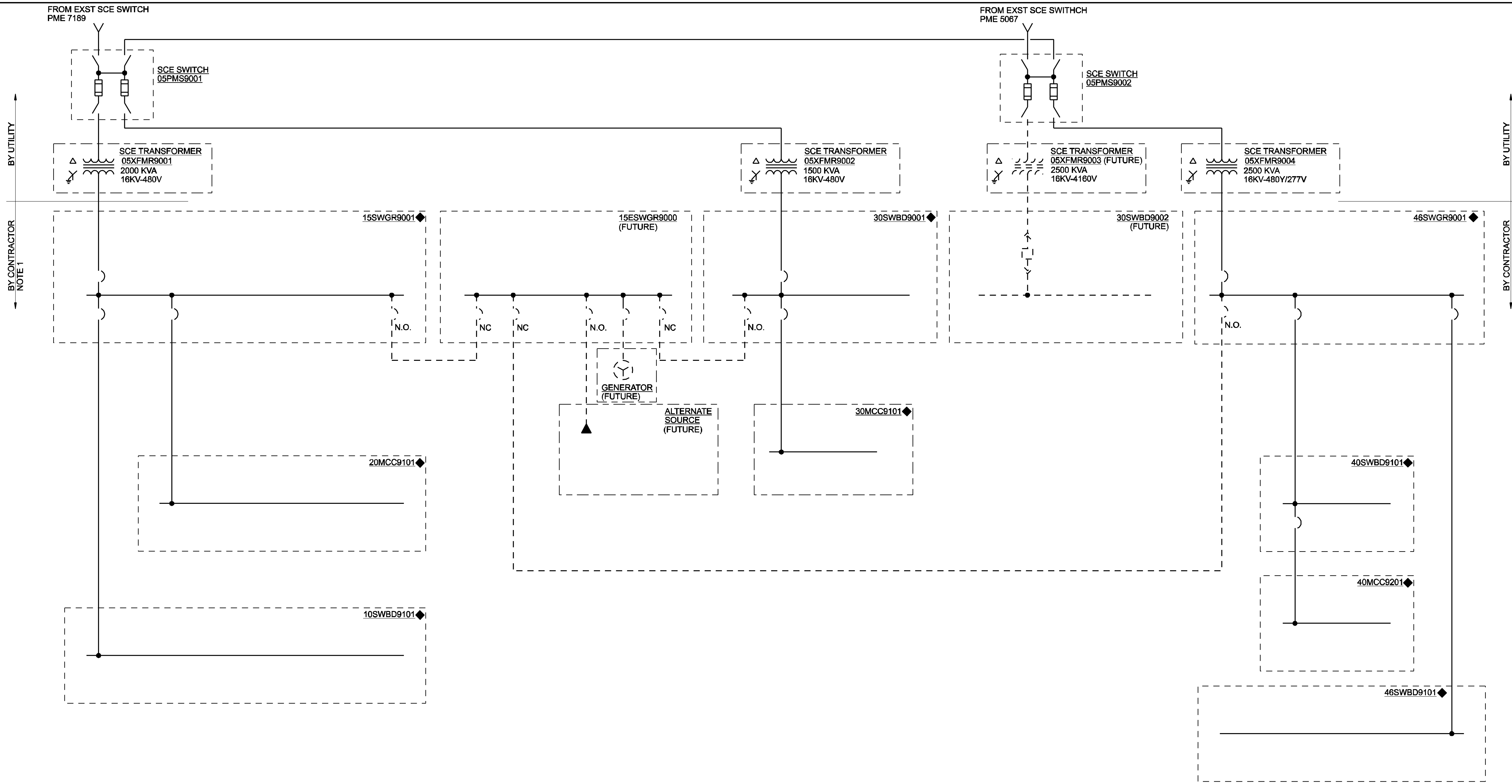
1



Short Circuit Study Full-Series Rating Flow Chart

2

TAB 4



FAULT CURRENT RATING TABLE

	AVAILABLE FAULT CURRENT	EQUIPMENT RATING
10SWBD9101	36KA	50KA
15SWGR9001	41KA	100KA
20MCC9101	34KA	65KA
30SWBD9001	29KA	50KA
30MCC9101	9KA	65KA
40MCC9201	9KA	65KA
40SWBD9101	34KA	50KA
46SWBD9101	36KA	50KA
46SWGR9001	40KA	100KA

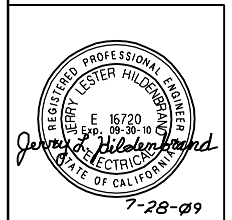
OVERALL ONE-LINE DIAGRAM

NOTES:

1. SCE TO PROVIDE INSTALL, AND CONNECT 16KV SWITCHES, HIGH VOLTAGE TRANSFORMERS, AND PRIMARY AND SECONDARY FEEDERS. CONTRACTOR TO PROVIDE TRANSFORMER PADS, MANHOLES, AND PRIMARY AND SECONDARY DUCT BANKS AND TRENCHES.

2. FOR ALL CONDUIT AND CONDUCTOR REQUIREMENTS SEE SITE PLAN AND CIRCUIT AND RACEWAY SCHEDULES.

THIS DRAWING IS PART OF THE I&C AND ELECTRICAL EQUIPMENT PRE-BID PACKAGE, AND HAS BEEN INCLUDED IN THESE CONTRACT FOR CONTRACTOR INFORMATION ONLY. FOR EQUIPMENT MARKED ◆, REFER TO EQUIPMENT SUBMITTAL'S AS PART OF PRE-BID PACKAGE FOR EXACT EQUIPMENT INFORMATION.



CH2MHILL
325 EAST HILLCREST DRIVE, SUITE 125
THOUSAND OAKS, CA 91360-5828
(805) 371-7817

REVISIONS

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NO	DATE	DESCRIPTION	APVR

REVIEWED BY:
APPROVED-BY: ML VORISSIS 7-28-09 DATE
CHECKED-BY: JL HILDENBRAND 7-28-09 DATE

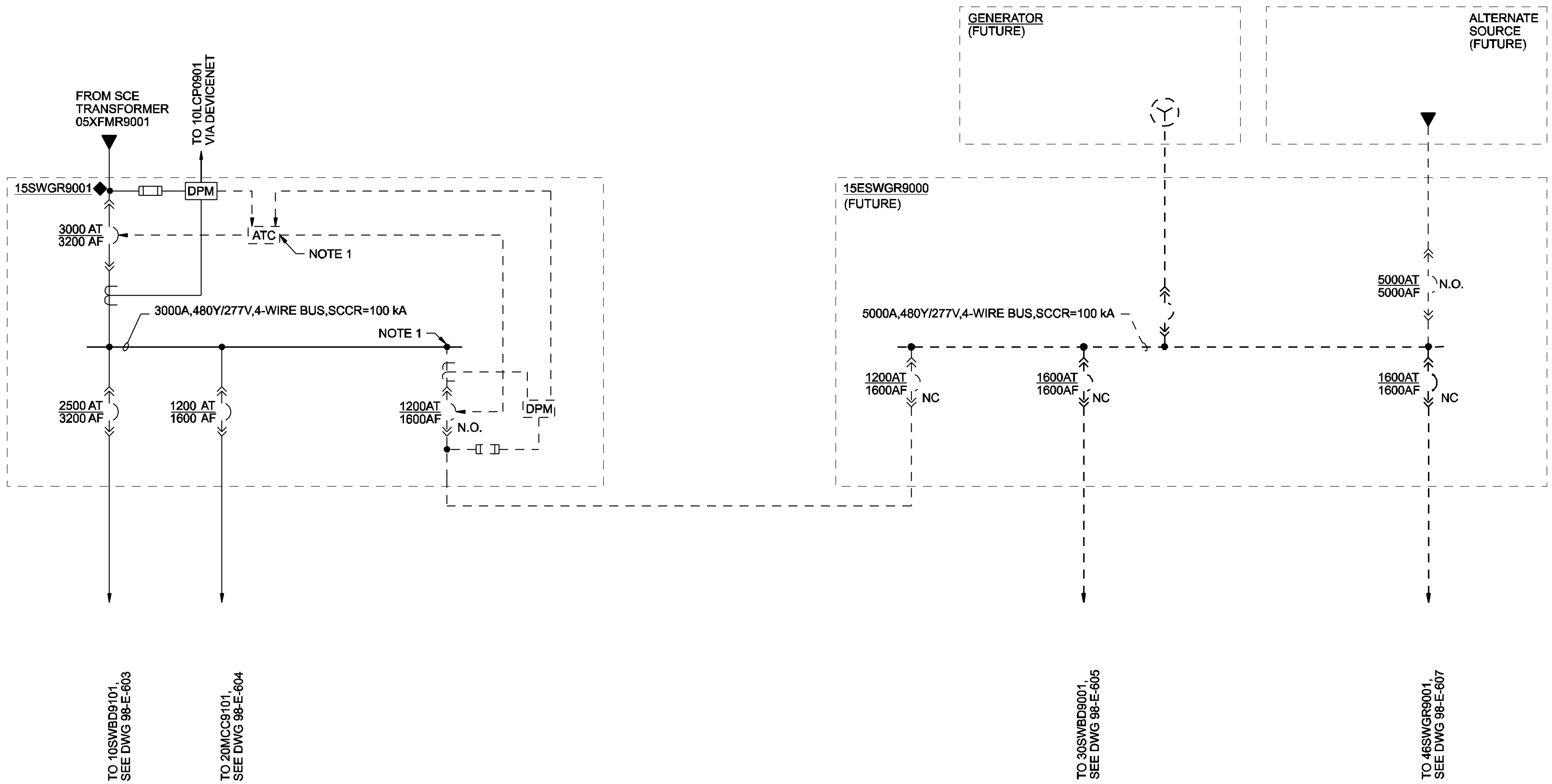
PUBLIC WORKS
CAPITAL PROJECTS MANAGEMENT DIVISION

ELECTRICAL
OVERALL ONE-LINE DIAGRAM

REVIEWED BY: Lucio Balderrama 7-28-09 DATE
City Engineer, Lucio Balderrama
R.C.E. 41743 Exp. 3-31-10

CITY OF OXNARD DRAWING NUMBER 09-06A
SHEET No: 465 OF 496
DRAWN BY: D CLARK
DESIGNED BY: M MACROSTIE
DRAWING NUMBER 98-E-601

PROJ NO.: 358064.DN
FILENAME: dn98e601_358064.dgn
PLOT DATE: 7/21/2009
PLOT TIME: 3:31:03 PM



NOTES:

1. PROVIDE FOR FUTURE IMPLEMENTATION OF AN AUTOMATIC TRANSFER CONTROLLER, AND STANDBY POWER SYSTEM CIRCUIT BREAKERS AS SHOWN.

2. FOR ALL CONDUIT AND CONDUCTOR REQUIREMENTS, SEE SITE PLAN AND CIRCUIT AND RACEWAY SCHEDULES.

15SWGR9001 AND 15ESWGR9000 ONE-LINE DIAGRAMS

THIS DRAWING IS PART OF THE I&C AND ELECTRICAL EQUIPMENT PRE-BID PACKAGE, AND HAS BEEN INCLUDED IN THESE CONTRACT FOR CONTRACTOR INFORMATION ONLY. FOR EQUIPMENT MARKED ◆, REFER TO EQUIPMENT SUBMITTALS AS PART OF PRE-BID PACKAGE FOR EXACT EQUIPMENT INFORMATION.

REGISTERED PROFESSIONAL ENGINEER
JERRY LESTER HILDENBRAND
E 16720
Exp. 09-30-10
ELECTRICAL
STATE OF CALIFORNIA
7-28-09

CH2MHILL
325 EAST HILLCREST DRIVE, SUITE 125
THOUSAND OAKS, CA 91360-5828
(805) 371-7817

REVISIONS

MARK	DATE	DESCRIPTION	BY
NO	DATE	DESCRIPTION	APVR

REVIEWED BY:
APPROVED-BY: ML VORISSIS 7-28-09
CHECKED-BY: JL HILDENBRAND 7-28-09

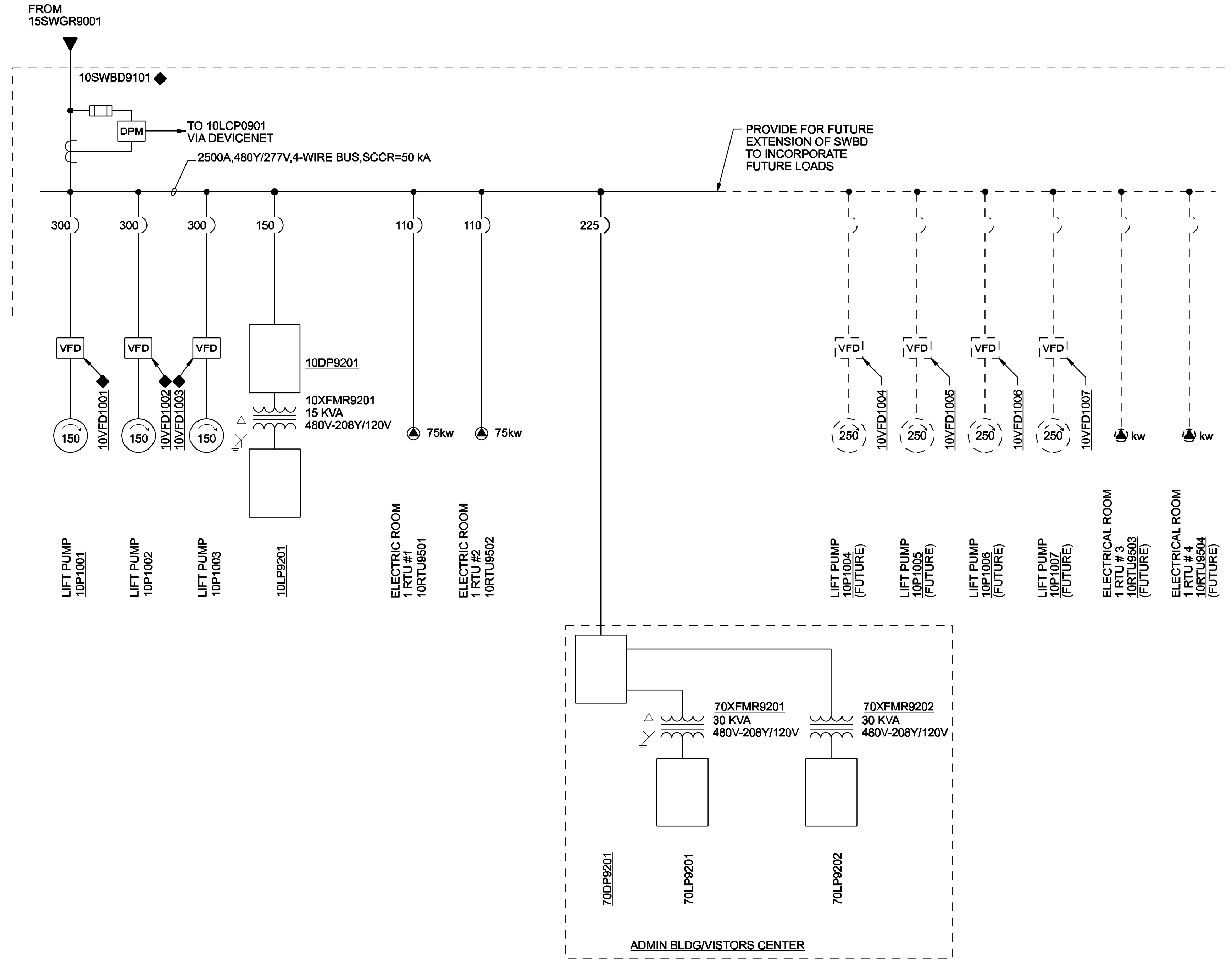
PUBLIC WORKS
CAPITAL PROJECTS MANAGEMENT DIVISION

ELECTRICAL
15SWGR9001 AND 15SWBD9000
ONE-LINE DIAGRAMS

REVIEWED BY: City Engineer Lucio Balderrama R.C.E. 41743 Exp. 3-31-10 — 7-28-09

CITY OF OXNARD DRAWING NUMBER 09-06A
SHEET No: 466 OF 496
DRAWN BY: D CLARK
DESIGNED BY: M MACROSTIE
DRAWING NUMBER 98-E-602

PROJ NO.: 358064.DN
FILENAME: dn98e602_358064.dgn
PLOT DATE: 7/21/2009
PLOT TIME: 3:31:19 PM



10SWBD9101 ONE-LINE DIAGRAM

NOTES:

1. FOR ALL CONDUIT AND CONDUCTOR REQUIREMENTS, SEE SITE PLAN AND CIRCUIT AND RACEWAY SCHEDULES.

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CH2MHILL

325 EAST HILLCREST DRIVE, SUITE 125
THOUSAND OAKS, CA 91360-5828
(805) 371-7817

REVISIONS

MARK	DATE	DESCRIPTION	BY
NO	DATE	DESCRIPTION	APVR

REVIEWED BY:
APPROVED-BY: ML VORISSIS 7-28-09 DATE
CHECKED-BY: JL HILDENBRAND 7-28-09 DATE

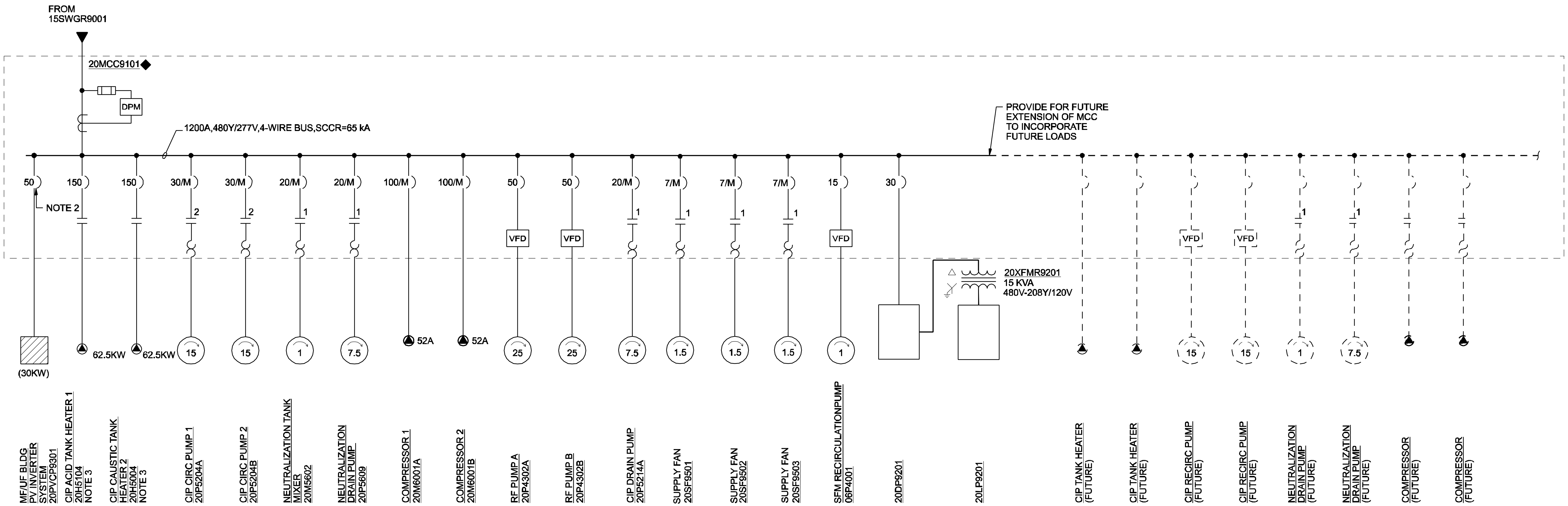
PUBLIC WORKS
CAPITAL PROJECTS MANAGEMENT DIVISION

ELECTRICAL
10SWBD9101 ONE-LINE DIAGRAM

REVIEWED BY: Lucio Balderrama 7-28-09 DATE
City Engineer: Lucio Balderrama R.C.E. 41743 Exp. 3-31-10

CITY OF OXNARD DRAWING NUMBER 09-06A
SHEET No: 467 OF 496
DRAWN BY: D CLARK
DESIGNED BY: M MACROSTIE
DRAWING NUMBER 98-E-603

PROJ NO.: 358064.DN
FILENAME: dn98e603_358064.dgn
PLOT DATE: 9/10/2009
PLOT TIME: 9:21:14 AM



NOTES:

1. FOR ALL CONDUIT AND CONDUCTOR REQUIREMENTS, SEE SITE PLAN AND CIRCUIT AND RACEWAY SCHEDULES.
2. FINAL BREAKER SIZE SHALL BE AS RECOMMENDED BY PV SYSTEM PROVIDER, AND COORDINATED WITH INVERTER SIZE.
3. COORDINATE CONTROL AND STARTER WITH MF/VF SYSTEM SUPPLIER.

20MCC9101 ONE-LINE DIAGRAM

THIS DRAWING IS PART OF THE I&C AND ELECTRICAL EQUIPMENT PRE-BID PACKAGE, AND HAS BEEN INCLUDED IN THESE CONTRACT FOR CONTRACTOR INFORMATION ONLY. FOR EQUIPMENT MARKED ◆, REFER TO EQUIPMENT SUBMITTALS AS PART OF PRE-BID PACKAGE FOR EXACT EQUIPMENT INFORMATION.

REGISTERED PROFESSIONAL ENGINEER JERRY LESTER HILDENBRAND E 16720 Exp. 09-30-10 ELECTRICAL STATE OF CALIFORNIA
7-28-09

CH2MHILL
325 EAST HILLCREST DRIVE, SUITE 125
THOUSAND OAKS, CA 91360-5828
(805) 371-7817

REVISIONS

MARK	DATE	DESCRIPTION	BY
NO	DATE	DESCRIPTION	APVR

REVIEWED BY:
APPROVED-BY: ML VORISSIS 7-28-09 DATE
CHECKED-BY: JL HILDENBRAND 7-28-09 DATE

PUBLIC WORKS
CAPITAL PROJECTS MANAGEMENT DIVISION

ELECTRICAL
20MCC9101 ONE-LINE DIAGRAM

REVIEWED BY: City Engineer, Lucio Balderrama R.C.E. 41743 Exp. 3-31-10 7-28-09 DATE

CITY OF OXNARD DRAWING NUMBER 09-06A
SHEET No: 468 OF 496
DRAWN BY: D CLARK
DESIGNED BY: M MACROSTIE
DRAWING NUMBER 98-E-604

PROJ NO.: 358064.DN
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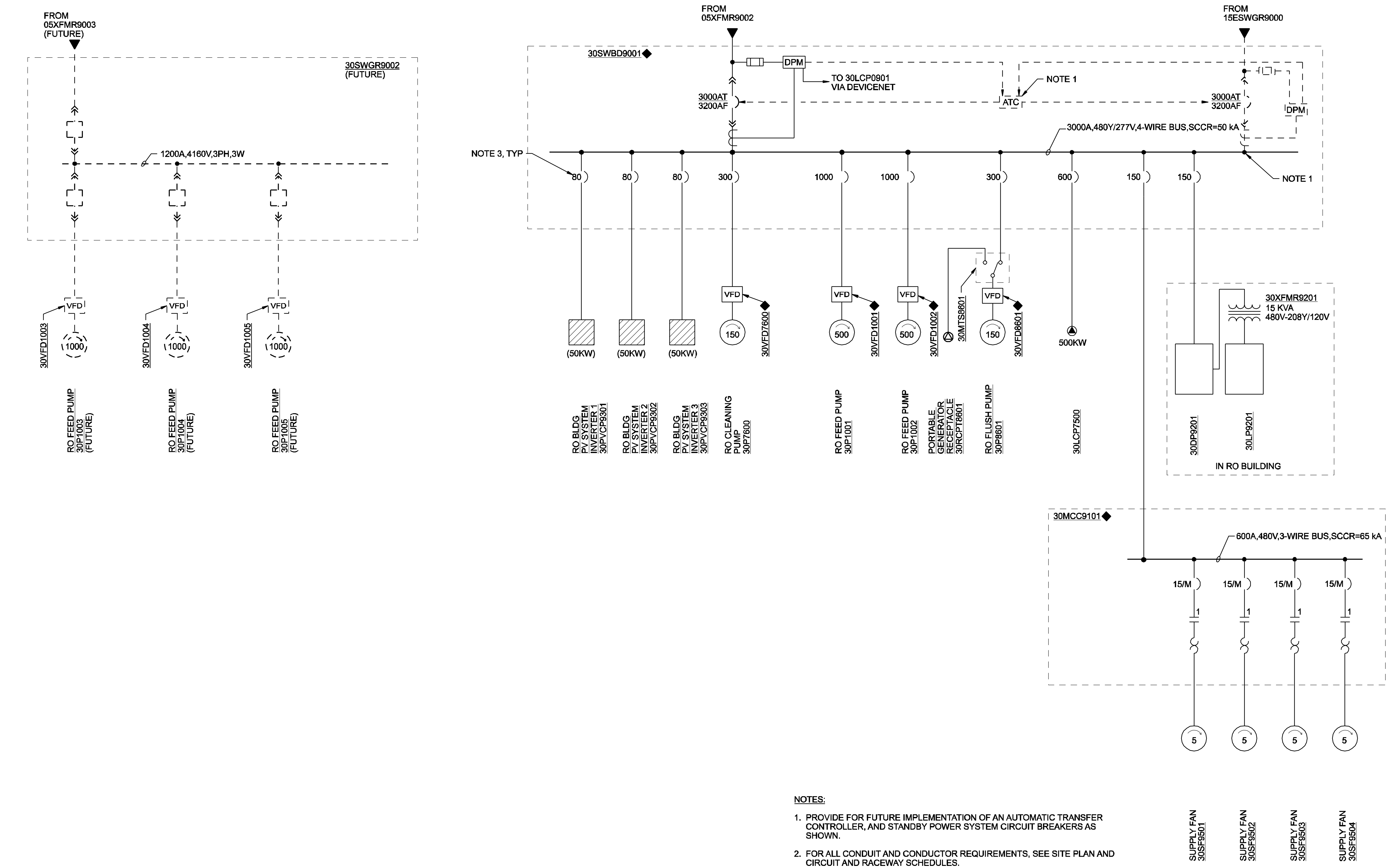
PLOT DATE: 7/21/2009
PLOT TIME: 3:31:49 PM



NOTES:

1. PROVIDE FOR FUTURE IMPLEMENTATION OF AN AUTOMATIC TRANSFER CONTROLLER, AND STANDBY POWER SYSTEM CIRCUIT BREAKERS AS SHOWN.

2. FOR ALL CONDUIT AND CONDUCTOR REQUIREMENTS, SEE SITE PLAN AND CIRCUIT AND RACEWAY SCHEDULES.

3. FINAL BREAKER SIZE SHALL BE AS RECOMMENDED BY PV SYSTEM PROVIDER, AND COORDINATED WITH INVERTER SIZE.

THIS DRAWING IS PART OF THE I&C AND ELECTRICAL EQUIPMENT PRE-BID PACKAGE, AND HAS BEEN INCLUDED IN THESE CONTRACT FOR CONTRACTOR INFORMATION ONLY. FOR EQUIPMENT MARKED ◆, REFER TO EQUIPMENT SUBMITTALS AS PART OF PRE-BID PACKAGE FOR EXACT EQUIPMENT INFORMATION.

REGISTERED PROFESSIONAL ENGINEER
JERRY LESTER HILDENBRAND
E 16720
Exp. 09-30-10
ELECTRICAL
STATE OF CALIFORNIA
7-28-09

30SWBD9001, 30SWBD9002 (FUTURE) ONE-LINE DIAGRAMS

CH2MHILL
325 EAST HILLCREST DRIVE, SUITE 125
THOUSAND OAKS, CA 91360-5828
(805) 371-7817

REVISIONS			
NO	DATE	DESCRIPTION	APVR

REVIEWED BY:
APPROVED-BY: ML VORISSIS 7-28-09
CHECKED-BY: JL HILDENBRAND 7-28-09

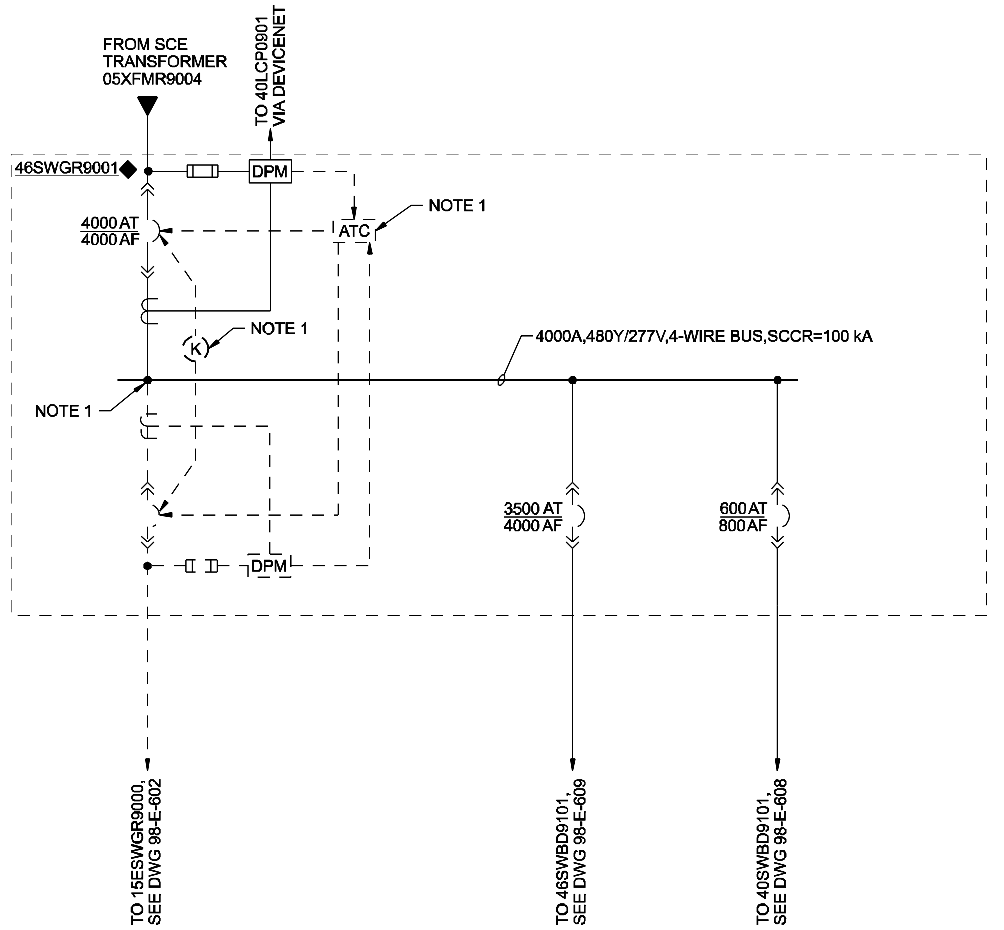
PUBLIC WORKS
CAPITAL PROJECTS MANAGEMENT DIVISION

ELECTRICAL
30SWBD9001, 30SWBD9002 (FUTURE)
ONE-LINE DIAGRAMS

REVIEWED BY: City Engineer Lucio Baldemera R.C.E. 41743 Exp. 3-31-10 7-28-09

CITY OF OXNARD DRAWING NUMBER 09-06A
SHEET No: 469 OF 496
DRAWN BY: D CLARK
DESIGNED BY: M MACROSTIE
DRAWING NUMBER 98-E-605

PROJ NO.: 358064.DN
FILENAME: dn98e605_358064.dgn
PLOT DATE: 7/21/2009
PLOT TIME: 3:32:05 PM



NOTES:

1. PROVIDE FOR FUTURE IMPLEMENTATION OF AN AUTOMATIC TRANSFER CONTROLLER, AND STANDBY POWER SYSTEM CIRCUIT BREAKERS AS SHOWN.

2. FOR ALL CONDUIT AND CONDUCTOR REQUIREMENTS, SEE SITE PLAN AND CIRCUIT AND RACEWAY SCHEDULES.

46SWGR9001 ONE-LINE DIAGRAM

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REGISTERED PROFESSIONAL ENGINEER JERRY LESTER HILDENBRAND E 16720 EXP. 09-30-10 ELECTRICAL STATE OF CALIFORNIA
7-28-09

CH2MHILL
325 EAST HILLCREST DRIVE, SUITE 125
THOUSAND OAKS, CA 91360-5828
(805) 371-7817

REVISIONS			
MARK	DATE	DESCRIPTION	BY
NO	DATE	DESCRIPTION	APVR

REVIEWED BY:
APPROVED-BY: ML VORISSIS 7-28-09 DATE
CHECKED-BY: JL HILDENBRAND 7-28-09 DATE

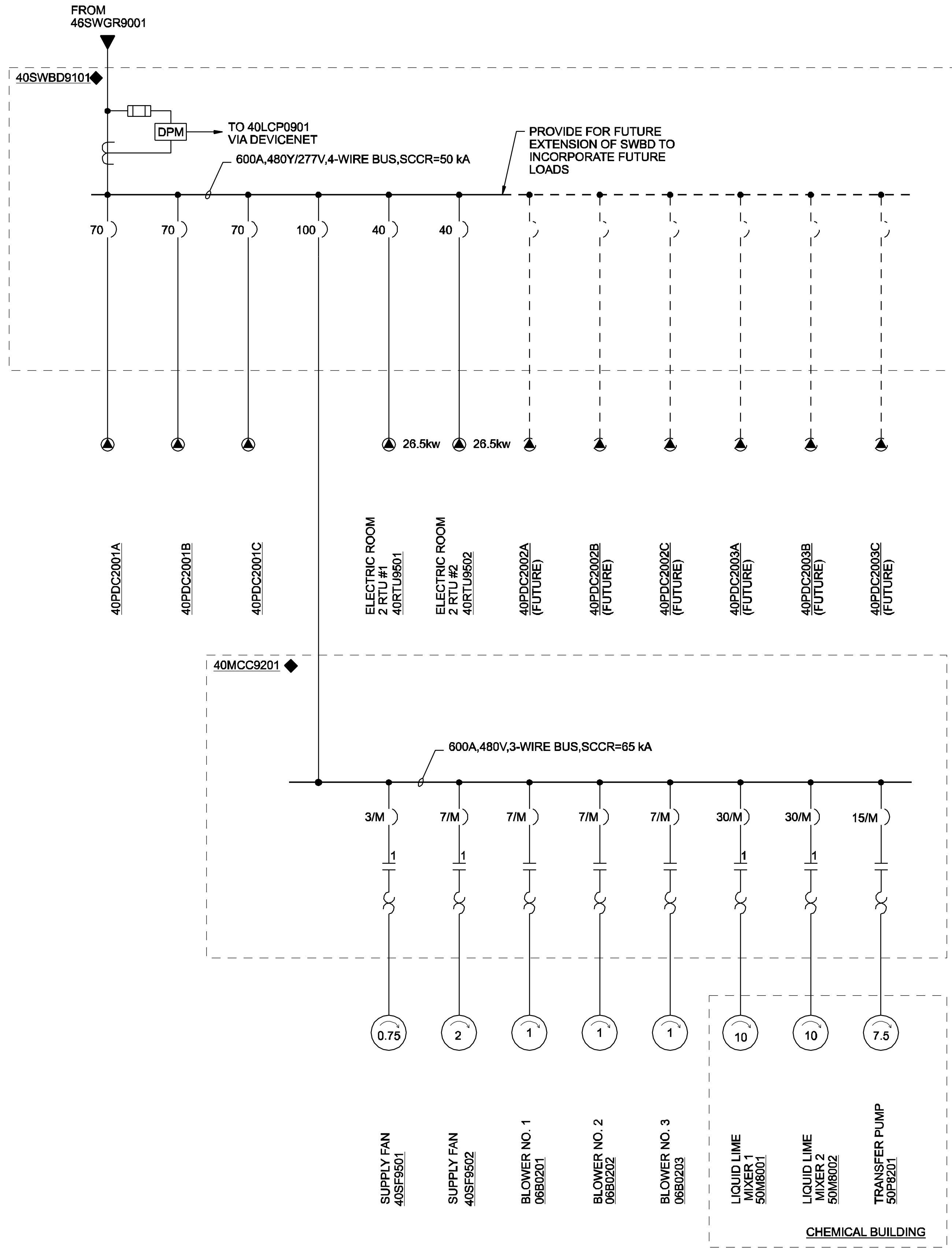
PUBLIC WORKS
CAPITAL PROJECTS MANAGEMENT DIVISION

ELECTRICAL
46SWGR9001 ONE-LINE DIAGRAM

REVIEWED BY: City Engineer Lucio Balderrama R.C.E. 41743 Exp. 3-31-10 7-28-09 DATE

CITY OF OXNARD DRAWING NUMBER 09-06A
SHEET No: 470 OF 496
DRAWN BY: D CLARK
DESIGNED BY: M MACROSTIE
DRAWING NUMBER 98-E-607

PROJ NO.: 358064.DN
FILENAME: dn98e607_358064.dgn
PLOT DATE: 7/21/2009
PLOT TIME: 3:32:18 PM



NOTES:

1. FOR ALL CONDUIT AND CONDUCTOR REQUIREMENTS, SEE SITE PLAN AND CIRCUIT AND RACEWAY SCHEDULES.

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40SWBD9101, 40MCC9201 ONE-LINE DIAGRAMS

REGISTERED PROFESSIONAL ENGINEER JERRY LESTER HILDENBRAND E 16720 EXP. 09-30-10 ELECTRICAL STATE OF CALIFORNIA
7-28-09

CH2MHILL
325 EAST HILLCREST DRIVE, SUITE 125
THOUSAND OAKS, CA 91360-5828
(805) 371-7817

REVISIONS

NO	DATE	DESCRIPTION	APVR

REVIEWED BY:
APPROVED-BY: ML VORISSIS 7-28-09
CHECKED-BY: JL HILDENBRAND 7-28-09

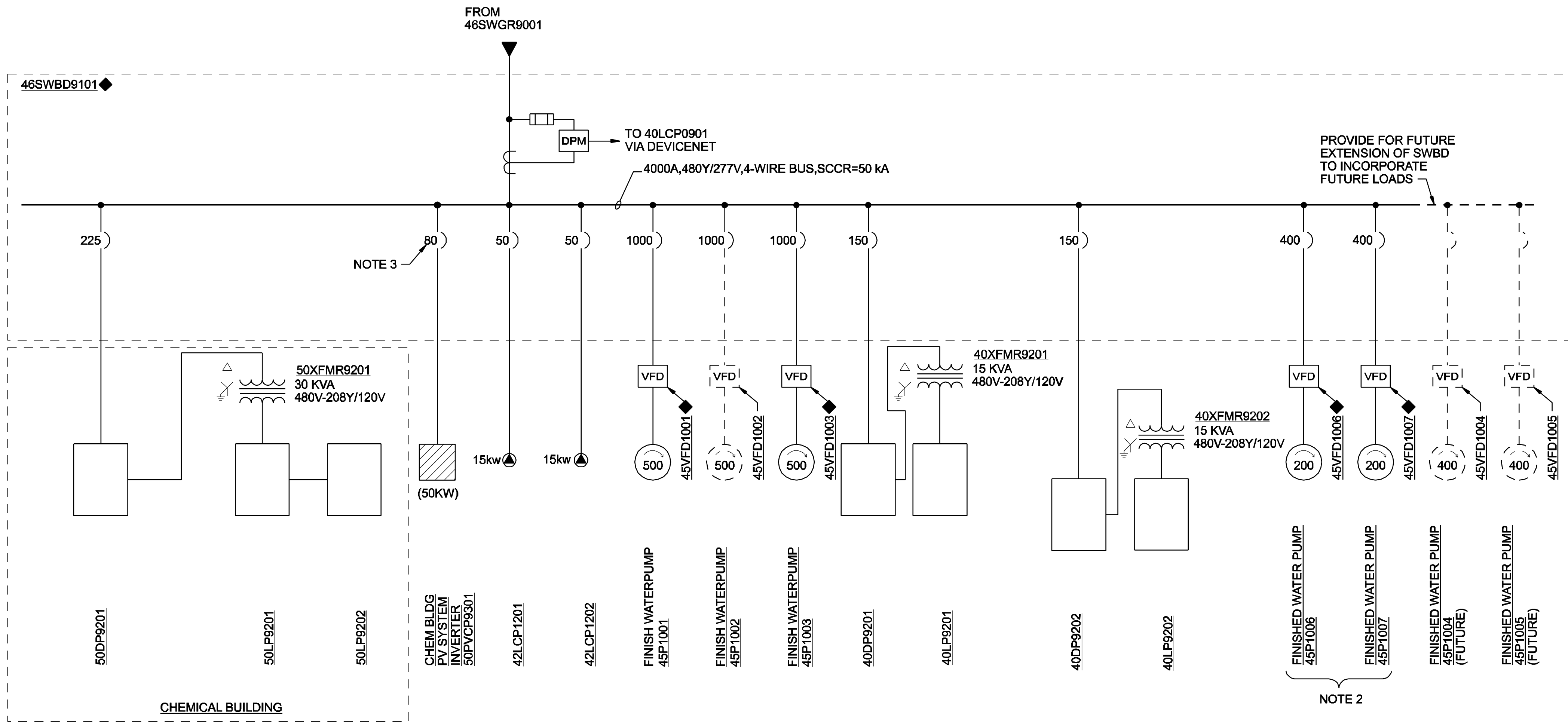
PUBLIC WORKS
CAPITAL PROJECTS MANAGEMENT DIVISION

ELECTRICAL
40SWBD9101, 40MCC9201 ONE-LINE DIAGRAM

REVIEWED BY: City Engineer Lucio Baldarrama R.C.E. 41743 Exp. 3-31-10 7-28-09

CITY OF OXNARD DRAWING NUMBER 09-06A
SHEET No. 471 OF 496
DRAWN BY: D CLARK
DESIGNED BY: M MACROSTIE
DRAWING NUMBER 98-E-608

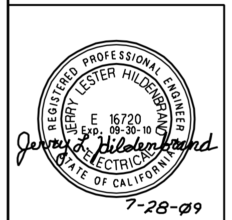
PROJ NO.: 358064.DN
FILENAME: dn98e608_358064.dgn
PLOT DATE: 7/21/2009
PLOT TIME: 3:32:32 PM



NOTES:

1. FOR ALL CONDUIT AND CONDUCTOR REQUIREMENTS, SEE SITE PLAN AND CIRCUIT AND RACEWAY SCHEDULES.
2. 200HP PUMPS WILL BE REPLACED BY 400HP PUMPS IN THE NEXT PHASE OF EXPANSION.
3. FINAL BREAKER SIZE SHALL BE AS RECOMMENDED BY PV SYSTEM PROVIDER, AND COORDINATED WITH INVERTER SIZE.

46SWBD9101 ONE-LINE DIAGRAM



THIS DRAWING IS PART OF THE I&C AND ELECTRICAL EQUIPMENT PRE-BID PACKAGE, AND HAS BEEN INCLUDED IN THESE CONTRACT FOR CONTRACTOR INFORMATION ONLY. FOR EQUIPMENT MARKED ◆, REFER TO EQUIPMENT SUBMITTALS AS PART OF PRE-BID PACKAGE FOR EXACT EQUIPMENT INFORMATION.

CH2MHILL
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THOUSAND OAKS, CA 91360-5828
(805) 371-7817

REVISIONS

MARK	DATE	DESCRIPTION	BY
NO	DATE	DESCRIPTION	APVR

REVIEWED BY:
APPROVED-BY: ML VORISSIS 7-28-09 DATE
CHECKED-BY: JL HILDENBRAND 7-28-09 DATE

PUBLIC WORKS
CAPITAL PROJECTS MANAGEMENT DIVISION

ELECTRICAL
46SWBD9101 ONE-LINE DIAGRAM

REVIEWED BY: Lucio Baldenama 7-28-09 DATE
City Engineer Lucio Baldenama R.C.E. 41743 Exp. 3-31-10

CITY OF OXNARD DRAWING NUMBER 09-06A
SHEET No. 472 OF 496
DRAWN BY: D CLARK
DESIGNED BY: M MACROSTIE
DRAWING NUMBER 98-E-609

PROJ NO.: 358064.DN
FILENAME: dn98e609_358064.dgn
PLOT DATE: 7/21/2009
PLOT TIME: 3:32:46 PM

TAB 5

Project: 1104042-1

DAPPER Fault Analysis Input Report (English)

Utilities

Contribution From Name	Bus Name	In/Out Service	Nominal Voltage	-------- Contribution Data --------				PU (100 MVA Base		
					Duty	Units	X/R		R PU	X PU
PME-5067	05PMS9002	In	16,000	3P:	4,070	Amps	5.00	Pos:	0.174	0.869
				SLG:	4,070	Amps	5.00	Zero:	0.174	0.869
PME-7189	05PMS9001	In	16,000	3P:	4,100	Amps	5.00	Pos:	0.173	0.863
				SLG:	4,100	Amps	5.00	Zero:	0.173	0.863

Motors

Contribution From Name	# of Motors	Bus Name	In/Out Service	Nominal Voltage	--------- Contribution Data --------			PU (100 MVA Base)	
					Base kVA	Xd"	X/R	R PU	X PU
M-20MCC9101	1	20MCC9101	In	480	97.25	0.2405	9.00	25.236	227.121
M-30MCC9101	1	30MCC9101	In	480	20.18	0.3347	9.00	169.284	1,523.555
M-40MCC9201	1	40MCC9201	In	480	33.54	0.3347	9.00	101.825	916.424
MTR-10P1001	1	10VFD1001	Out	480	143.72	0.2405	9.00	0.000	0.000
MTR-10P1002	1	10VFD1002	Out	480	143.72	0.2405	9.00	0.000	0.000
MTR-10P1003	1	10VFD1003	Out	480	143.72	0.2405	9.00	0.000	0.000
MTR-30P1001	1	30VFD1001	Out	480	479.07	0.2004	9.00	0.000	0.000
MTR-30P1002	1	30VFD1002	Out	480	479.07	0.2004	9.00	0.000	0.000
MTR-30P7600	1	30VFD7600	Out	480	143.72	0.2405	9.00	0.000	0.000
MTR-30P8601	1	30VFD8601	Out	480	143.72	0.2405	9.00	0.000	0.000
MTR-45P1001	1	45VFD1001	Out	480	479.07	0.2004	9.00	0.000	0.000
MTR-45P1003	1	45VFD1003	Out	480	479.07	0.2004	9.00	0.000	0.000
MTR-45P1006	1	45VFD1006	Out	480	191.63	0.2004	9.00	0.000	0.000
MTR-45P1007	1	45VFD1007	Out	480	191.63	0.2004	9.00	0.000	0.000

Cables

Cable Name	From Bus To Bus	In/Out Service	Qty /Ph	Length Feet	------ Cable Description ------				Per Unit (100 MVA Base)		
					Size	Cond. Type	Duct Type	Insul		R pu	jX pu
TO 05XFMR9001P	05PMS9001	In	1	525	1-0	Copper	Magnetic		Pos:	0.0250	0.0114
	05XFMR9001P								Zero:	0.0382	0.0231

Cable Name	From Bus To Bus	In/Out Service	Qty /Ph	Length Feet	Size	Cond. Type	Duct Type	Insul		R pu	jX pu
TO 05XFMR9002P	05PMS9001 05XFMR9002P	In	1	525	1-0	Copper	Magnetic		Pos: Zero:	0.0250 0.0382	0.0114 0.0231
TO 05XFMR9004P	05PMS9002 05XFMR9004P	In	1	325	1-0	Copper	Magnetic		Pos: Zero:	0.0155 0.0237	0.0070 0.0143
TO 10DP9201	10SWBD9101 10DP9201	In	1	20	1-0	Copper	Magnetic		Pos: Zero:	1.0434 1.6172	0.4774 1.1250
TO 10LP9201	10XFMR9201S 10LP9201	In	1	5	6	Copper	Magnetic		Pos: Zero:	5.6733 6.3979	0.7396 2.0814
TO 10SWBD9101	15SWGR9001 10SWBD9101	In	3	70	500	Copper	Non-Magnetic		Pos: Zero:	0.2745 0.9206	0.3950 0.6451
TO 10VFD1001	10SWBD9101 10VFD1001	In	1	15	350	Copper	Non-Magnetic		Pos: Zero:	0.2474 0.6621	0.2604 0.4961
TO 10VFD1002	10SWBD9101 10VFD1002	In	1	15	350	Copper	Non-Magnetic		Pos: Zero:	0.2474 0.6621	0.2604 0.4961
TO 10VFD1003	10SWBD9101 10VFD1003	In	1	15	350	Copper	Non-Magnetic		Pos: Zero:	0.2474 0.6621	0.2604 0.4961
TO 10XFMR9201P	10DP9201 10XFMR9201P	In	1	5	10	Copper	Magnetic		Pos: Zero:	2.6089 2.7750	0.1367 0.4881
TO 15SWGR9001	05XFMR9001S 15SWGR9001	In	3	182	750	Copper	Non-Magnetic		Pos: Zero:	0.5029 2.1723	1.0006 1.3876
TO 20DP9201	20MCC9101 20DP9201	In	1	35	3	Copper	Magnetic		Pos: Zero:	3.8053 4.6955	0.8963 2.3409
TO 20LP9201	20XFMR9201S 20LP9201	In	1	5	6	Copper	Magnetic		Pos: Zero:	5.6733 6.3979	0.7396 2.0814
TO 20MCC9101	15SWGR9001 20MCC9101	In	2	50	350	Copper	Non-Magnetic		Pos: Zero:	0.4123 1.1035	0.4340 0.8268
TO 20XFMR9201P	20DP9201 20XFMR9201P	In	1	5	10	Copper	Magnetic		Pos: Zero:	2.6089 2.7750	0.1367 0.4881
TO 30DP9201	30SWBD9001 30DP9201	In	1	110	1-0	Copper	Magnetic		Pos: Zero:	5.7387 8.8945	2.6259 6.1875
TO 30LP9201	30XFMR9201S 30LP9201	In	1	5	6	Copper	Magnetic		Pos: Zero:	5.6733 6.3979	0.7396 2.0814
TO 30MCC9101	30SWBD9001 30MCC9101	In	1	20	1-0	Copper	Non-Magnetic		Pos: Zero:	1.0434 1.6172	0.3819 0.9375
TO 30MTS8601	30SWBD9001 30MTS8601	In	1	15	300	Copper	Non-Magnetic		Pos: Zero:	0.2871 0.7018	0.2669 0.5339
TO 30SWBD9001	05XFMR9002S 30SWBD9001	In	4	169	750	Copper	Non-Magnetic		Pos: Zero:	0.3502 1.5129	0.6968 0.9664
TO 30VFD1001	30SWBD9001 30VFD1001	In	3	26	500	Copper	Non-Magnetic		Pos: Zero:	0.1019 0.3419	0.1467 0.2396
TO 30VFD1002	30SWBD9001 30VFD1002	In	3	26	500	Copper	Non-Magnetic		Pos: Zero:	0.1019 0.3419	0.1467 0.2396

Column group headings: "------ Cable Description ------" (Size, Cond. Type, Duct Type, Insul); "Per Unit (100 MVA Base)" (R pu, jX pu).

Cable Name	From Bus / To Bus	In/Out Service	Qty /Ph	Length Feet	Size	Cond. Type	Duct Type	Insul		Per Unit (100 MVA Base) R pu	jX pu
TO 30VFD7600	30SWBD9001	In	1	15	300	Copper	Non-Magnetic		Pos:	0.2871	0.2669
	30VFD7600								Zero:	0.7018	0.5339
TO 30VFD8601	30MTS8601	In	1	20	300	Copper	Non-Magnetic		Pos:	0.3828	0.3559
	30VFD8601								Zero:	0.9358	0.7118
TO 30XFMR9201P	30DP9201	In	1	5	10	Copper	Magnetic		Pos:	2.6089	0.1367
	30XFMR9201P								Zero:	2.7750	0.4881
TO 40DP9201	46SWBD9101	In	1	25	1-0	Copper	Magnetic		Pos:	1.3043	0.5968
	40DP9201								Zero:	2.0215	1.4063
TO 40DP9202	46SWBD9101	In	1	140	1-0	Copper	Magnetic		Pos:	7.3038	3.3420
	40DP9202								Zero:	11.3203	7.8750
TO 40LP9201	40XFMR9201S	In	1	5	6	Copper	Magnetic		Pos:	5.6733	0.7396
	40LP9201								Zero:	6.3979	2.0814
TO 40LP9202	40XFMR9202S	In	1	5	6	Copper	Magnetic		Pos:	5.6733	0.7396
	40LP9202								Zero:	6.3979	2.0814
TO 40MCC9201	40SWBD9101	In	1	35	2	Copper	Non-Magnetic		Pos:	2.8924	0.6836
	40MCC9201								Zero:	3.9178	1.8427
TO 40SWBD9101	46SWGR9001	In	2	20	350	Copper	Non-Magnetic		Pos:	0.1649	0.1736
	40SWBD9101								Zero:	0.4414	0.3307
TO 40XFMR9201P	40DP9201	In	1	5	10	Copper	Magnetic		Pos:	2.6089	0.1367
	40XFMR9201P								Zero:	2.7750	0.4881
TO 40XFMR9202P	40DP9202	In	1	5	10	Copper	Magnetic		Pos:	2.6089	0.1367
	40XFMR9202P								Zero:	2.7750	0.4881
TO 45VFD1001	46SWBD9101	In	3	30	500	Copper	Non-Magnetic		Pos:	0.1176	0.1693
	45VFD1001								Zero:	0.3945	0.2765
TO 45VFD1003	46SWBD9101	In	3	30	500	Copper	Non-Magnetic		Pos:	0.1176	0.1693
	45VFD1003								Zero:	0.3945	0.2765
TO 45VFD1006	46SWBD9101	In	1	50	500	Copper	Non-Magnetic		Pos:	0.5881	0.8464
	45VFD1006								Zero:	1.9727	1.3824
TO 45VFD1007	46SWBD9101	In	1	60	500	Copper	Non-Magnetic		Pos:	0.7057	1.0156
	45VFD1007								Zero:	2.3672	1.6589
TO 46SWBD9101	46SWGR9001	In	5	45	600	Copper	Non-Magnetic		Pos:	0.0898	0.1523
	46SWBD9101								Zero:	0.3387	0.2367
TO 46SWGR9001	05XFMR9004S	In	5	60	750	Copper	Non-Magnetic		Pos:	0.0995	0.1979
	46SWGR9001								Zero:	0.4297	0.2745
TO 50DP9201	46SWBD9101	In	1	240	4-0	Copper	Magnetic		Pos:	6.5729	5.3125
	50DP9201								Zero:	13.0625	11.3229
TO 50LP9201	50XFMR9201S	In	1	5	1	Copper	Magnetic		Pos:	1.8526	0.6587
	50LP9201								Zero:	2.5252	1.6029
TO 50LP9202	50LP9201	In	1	15	1	Copper	Magnetic		Pos:	5.5577	1.9762
	50LP9202								Zero:	7.5756	4.8088
TO 50XFMR9201P	50DP9201	In	1	5	6	Copper	Magnetic		Pos:	1.0653	0.1389
	50XFMR9201P								Zero:	1.2014	0.3908

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 70DP9201	10SWBD9101	In	1	320	4-0	Copper	Magnetic		Pos:	8.7639	7.0833
	70DP9201								Zero:	17.4167	15.0972
TO 70LP9201	70XFMR9201S	In	1	5	1	Copper	Magnetic		Pos:	1.8526	0.6587
	70LP9201								Zero:	2.5252	1.6029
TO 70LP9202	70XFMR9202S	In	1	5	1	Copper	Magnetic		Pos:	1.8526	0.6587
	70LP9202								Zero:	2.5252	1.6029
TO 70XFMR9201P	70DP9201	In	1	5	6	Copper	Magnetic		Pos:	1.0653	0.1389
	70XFMR9201P								Zero:	1.2014	0.3908
TO 70XFMR9202P	70DP9201	In	1	5	6	Copper	Magnetic		Pos:	1.0653	0.1389
	70XFMR9202P								Zero:	1.2014	0.3908

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)		
05XFMR9001	In	05XFMR9001P	D	16,000	90	2,500.0	Pos:	0.3247	2.2770
		05XFMR9001S	WG	480	3,007		Zero:	0.3247	2.2770
05XFMR9002	In	05XFMR9002P	D	16,000	90	2,500.0	Pos:	0.3247	2.2770
		05XFMR9002S	WG	480	3,007		Zero:	0.3247	2.2770
05XFMR9004	In	05XFMR9004P	D	16,000	90	2,500.0	Pos:	0.3247	2.2770
		05XFMR9004S	WG	480	3,007		Zero:	0.3247	2.2770
10XFMR9201	In	10XFMR9201P	D	480	18	15.0	Pos:	206.6667	153.3333
		10XFMR9201S	WG	208	42		Zero:	206.6667	153.3333
20XFMR9201	In	20XFMR9201P	D	480	18	15.0	Pos:	206.6667	153.3333
		20XFMR9201S	WG	208	42		Zero:	206.6667	153.3333
30XFMR9201	In	30XFMR9201P	D	480	18	15.0	Pos:	206.6667	153.3333
		30XFMR9201S	WG	208	42		Zero:	206.6667	153.3333
40XFMR9201	In	40XFMR9201P	D	480	18	15.0	Pos:	206.6667	153.3333
		40XFMR9201S	WG	208	42		Zero:	206.6667	153.3333
40XFMR9202	In	40XFMR9202P	D	480	18	15.0	Pos:	206.6667	153.3333
		40XFMR9202S	WG	208	42		Zero:	206.6667	153.3333
50XFMR9201	In	50XFMR9201P	D	480	36	30.0	Pos:	103.3333	76.6667
		50XFMR9201S	WG	208	83		Zero:	103.3333	76.6667
70XFMR9201	In	70XFMR9201P	D	480	36	30.0	Pos:	103.3333	76.6667
		70XFMR9201S	WG	208	83		Zero:	103.3333	76.6667
70XFMR9202	In	70XFMR9202P	D	480	36	30.0	Pos:	103.3333	76.6667
		70XFMR9202S	WG	208	83		Zero:	103.3333	76.6667

Project: 1104042-1

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
05PMS9001	16,000	4,118	114.12	5.01	4,112	37.98	5.01	5,161	4,120	4,118	4,118
05PMS9002	16,000	4,074	112.90	5.00	4,073	37.62	5.00	5,104	4,076	4,074	4,074
05XFMR9001P	16,000	4,043	112.05	4.44	4,016	37.09	4.35	4,927	4,044	4,043	4,043
05XFMR9001S	480	38,183	31.74	6.06	42,070	11.66	6.29	49,919	38,259	38,184	38,183
05XFMR9002P	16,000	4,043	112.03	4.43	4,015	37.09	4.35	4,926	4,043	4,043	4,043
05XFMR9002S	480	37,772	31.40	6.04	41,644	11.54	6.27	49,350	37,846	37,773	37,772
05XFMR9004P	16,000	4,028	111.64	4.63	4,014	37.08	4.58	4,958	4,030	4,028	4,028
05XFMR9004S	480	37,777	31.41	6.14	41,659	11.54	6.35	49,528	37,858	37,778	37,777
10DP9201	480	22,009	18.30	2.14	19,987	5.54	1.59	23,146	22,009	22,009	22,009
10LP9201	208	1,031	0.37	0.73	1,038	0.12	0.73	1,031	1,031	1,031	1,031

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
10SWBD9101	480	25,865	21.50	3.52	24,942	6.91	2.25	29,889	25,865	25,865	25,865
10VFD1001	480	24,195	20.12	3.12	22,723	6.30	2.02	27,228	24,195	24,195	24,195
10VFD1002	480	24,195	20.12	3.12	22,723	6.30	2.02	27,228	24,195	24,195	24,195
10VFD1003	480	24,195	20.12	3.12	22,723	6.30	2.02	27,228	24,195	24,195	24,195
10XFMR9201P	480	16,989	14.12	1.03	15,154	4.20	0.91	17,028	16,989	16,989	16,989
10XFMR9201S	208	1,050	0.38	0.75	1,059	0.13	0.75	1,050	1,050	1,050	1,050
15SWGR9001	480	28,650	23.82	4.09	28,680	7.95	2.67	34,268	28,652	28,650	28,650
20DP9201	480	16,059	13.35	1.04	14,120	3.91	0.95	16,097	16,059	16,059	16,059
20LP9201	208	1,021	0.37	0.72	1,031	0.12	0.73	1,021	1,021	1,021	1,021
20MCC9101	480	25,547	21.24	3.23	24,346	6.75	2.15	28,979	25,547	25,547	25,547
20XFMR9201P	480	12,574	10.45	0.71	11,184	3.10	0.69	12,576	12,574	12,574	12,574
20XFMR9201S	208	1,040	0.37	0.74	1,053	0.13	0.74	1,040	1,040	1,040	1,040
30DP9201	480	13,016	10.82	0.98	11,018	3.05	0.93	13,037	13,016	13,016	13,016
30LP9201	208	1,014	0.37	0.73	1,027	0.12	0.73	1,014	1,014	1,014	1,014
30MCC9101	480	25,995	21.61	2.21	24,812	6.88	1.74	27,472	25,995	25,995	25,995
30MTS8601	480	28,222	23.46	3.55	27,932	7.74	2.47	32,679	28,223	28,222	28,222
30SWBD9001	480	30,587	25.43	4.42	31,440	8.71	3.06	37,238	30,593	30,587	30,587
30VFD1001	480	29,347	24.40	4.10	29,678	8.22	2.78	35,127	29,350	29,347	29,347
30VFD1002	480	29,347	24.40	4.10	29,678	8.22	2.78	35,127	29,350	29,347	29,347
30VFD7600	480	28,222	23.46	3.55	27,932	7.74	2.47	32,679	28,223	28,222	28,222
30VFD8601	480	25,504	21.20	2.90	24,197	6.71	2.05	28,272	25,504	25,504	25,504
30XFMR9201P	480	10,612	8.82	0.72	9,155	2.54	0.72	10,614	10,612	10,612	10,612
30XFMR9201S	208	1,033	0.37	0.74	1,048	0.13	0.74	1,033	1,033	1,033	1,033
40DP9201	480	26,417	21.96	2.04	25,291	7.01	1.74	27,603	26,417	26,417	26,417
40DP9202	480	11,429	9.50	0.85	9,647	2.67	0.86	11,436	11,429	11,429	11,429
40LP9201	208	1,034	0.37	0.73	1,040	0.12	0.73	1,034	1,034	1,034	1,034
40LP9202	208	1,009	0.36	0.72	1,023	0.12	0.72	1,009	1,009	1,009	1,009

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
40MCC9201	480	21,646	18.00	1.15	20,033	5.55	1.06	21,739	21,646	21,646	21,646
40SWBD9101	480	33,450	27.81	4.54	35,140	9.74	3.62	40,977	33,458	33,450	33,450
40XFMR9201P	480	19,227	15.99	0.92	18,027	5.00	0.87	19,247	19,227	19,227	19,227
40XFMR9201S	208	1,053	0.38	0.75	1,062	0.13	0.74	1,053	1,053	1,053	1,053
40XFMR9202P	480	9,473	7.88	0.66	8,161	2.26	0.69	9,474	9,473	9,473	9,473
40XFMR9202S	208	1,028	0.37	0.74	1,044	0.13	0.74	1,028	1,028	1,028	1,028
45VFD1001	480	32,066	26.66	4.48	33,294	9.23	3.33	39,159	32,073	32,066	32,066
45VFD1003	480	32,066	26.66	4.48	33,294	9.23	3.33	39,159	32,073	32,066	32,066
45VFD1006	480	26,581	22.10	3.37	25,732	7.13	2.28	30,416	26,581	26,581	26,581
45VFD1007	480	25,476	21.18	3.21	24,310	6.74	2.15	28,842	25,476	25,476	25,476
46SWBD9101	480	33,777	28.08	4.99	35,809	9.92	3.92	42,285	33,795	33,777	33,777
46SWGR9001	480	35,434	29.46	5.47	38,260	10.60	4.68	45,297	35,470	35,435	35,434
50DP9201	480	10,533	8.76	1.21	8,437	2.34	1.11	10,591	10,533	10,533	10,533
50LP9201	208	1,947	0.70	0.76	1,998	0.24	0.75	1,947	1,947	1,947	1,947
50LP9202	208	1,873	0.67	0.74	1,905	0.23	0.74	1,873	1,873	1,873	1,873
50XFMR9201P	480	9,837	8.18	1.07	7,923	2.20	1.01	9,865	9,837	9,837	9,837
50XFMR9201S	208	1,973	0.71	0.77	2,031	0.24	0.76	1,973	1,973	1,973	1,973
70DP9201	480	7,859	6.53	1.15	6,124	1.70	1.04	7,892	7,859	7,859	7,859
70LP9201	208	1,895	0.68	0.77	1,961	0.24	0.76	1,896	1,895	1,895	1,895
70LP9202	208	1,895	0.68	0.77	1,961	0.24	0.76	1,896	1,895	1,895	1,895
70XFMR9201P	480	7,459	6.20	1.05	5,844	1.62	0.98	7,479	7,459	7,459	7,459
70XFMR9201S	208	1,920	0.69	0.77	1,993	0.24	0.76	1,920	1,920	1,920	1,920
70XFMR9202P	480	7,459	6.20	1.05	5,844	1.62	0.98	7,479	7,459	7,459	7,459
70XFMR9202S	208	1,920	0.69	0.77	1,993	0.24	0.76	1,920	1,920	1,920	1,920

TAB 6

SC Import Adjustment: 100%
Scenario 1: Utility Power

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
05PMS9001	05PMS9001	16000	FUSE	12.5		20.0				5.01	4.1	5.2			1	3 P				
		Comment: Ratings Based On Fuse, Utility's Responsibility.																		
05PMS9002	05PMS9002	16000	FUSE	12.5		20.0				5.00	4.1	5.1			1	3 P				
		Comment: Ratings Based On Fuse, Utility's Responsibility.																		
05XFMR9001	05XFMR9001 PRI	16000	N/A							4.44	4.0	4.9			1	3 P				
		Comment:																		
05XFMR9002	05XFMR9002 PRI	16000	N/A							4.43	4.0	4.9			1	3 P				
		Comment:																		
05XFMR9004	05XFMR9004 PRI	16000	N/A							4.63	4.0	5.0			1	3 P				
		Comment:																		
PME-5067	PME 5067	16000	N/A																	
		Comment:																		
PME-7189	PME 7189	16000	N/A																	
		Comment:																		

SC Import Adjustment: 100%
Scenario 1: Utility Power

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
05XFMR9001	05XFMR9001 SEC	480	N/A				6.29	42.1	55.4			1	Line To Ground		
		Comment:													
05XFMR9002	05XFMR9002 SEC	480	N/A				6.27	41.6	54.8			1	Line To Ground		
		Comment:													
05XFMR9004	05XFMR9004 SEC	480	N/A				6.35	41.7	55.0			1	Line To Ground		
		Comment:													
10DP9201	10DP9201	480	MCCB	2		35.0	2.14	22.0	23.1	1	22.0	1	3 Phase		
		Comment:													
10LP9201	10LP9201	208	MCCB	4		10.0	0.73	1.0	1.0	1	1.0	1	Line To Ground		
		Comment:													
10SWBD910	10SWBD9101	480	MCCB	2		50.0	3.52	25.9	29.9	1	25.9	1	3 Phase		
		Comment:													
10VFD1001	10VFD1001	480	MCCB	2		65.0	3.12	24.2	27.2	1	24.2	1	3 Phase		
		Comment:													
10VFD1002	10VFD1002	480	MCCB	2		65.0	3.12	24.2	27.2	1	24.2	1	3 Phase		
		Comment:													
10VFD1003	10VFD1003	480	MCCB	2		65.0	3.12	24.2	27.2	1	24.2	1	3 Phase		
		Comment:													
10XFMR9201	10XFMR9201 PRI	480	N/A				1.03	17.0	17.0			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
10XFMR9201	10XFMR9201 SEC	208	N/A				0.75	1.1	1.1			1	Line To Ground		
		Comment:													
15SWGR900	15SWGR9001	480	MCCB	2		100.0	4.09	28.6	34.3	1	28.6	1	3 Phase		
		Comment:													
20DP9201	20DP9201	480	MCCB	2		35.0	1.04	16.1	16.1	1	16.1	1	3 Phase		
		Comment:													
20LP9201	20LP9201	208	MCCB	4		10.0	0.73	1.0	1.0	1	1.0	1	Line To Ground		
		Comment:													
20MCC9101	20MCC9101	480	MCCB	2		65.0	3.23	25.5	29.0	1	25.5	1	3 Phase		
		Comment:													
20XFMR9201	20XFMR9201 PRI	480	N/A				0.71	12.6	12.6			1	3 Phase		
		Comment:													
20XFMR9201	20XFMR9201 SEC	208	N/A				0.74	1.1	1.1			1	Line To Ground		
		Comment:													
30DP9201	30DP9201	480	MCCB	2		35.0	0.98	13.0	13.0	1	13.0	1	3 Phase		
		Comment:													
30LP9201	30LP9201	208	MCCB	4		10.0	0.73	1.0	1.0	1	1.0	1	Line To Ground		
		Comment:													
30MCC9101	30MCC9101	480	MCCB	2		65.0	2.21	26.0	27.5	1	26.0	1	3 Phase		
		Comment:													
30MTS8601	30MTS8601	480	ATS		65.0		3.55	28.2	32.7			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
30SWBD900	30SWBD9001	480	MCCB	2		50.0	4.42	30.6	37.2	1	30.6	1	3 Phase		
		Comment:													
30VFD1001	30VFD1001	480	MCCB	2		50.0	4.10	29.3	35.1	1	29.3	1	3 Phase		
		Comment:													
30VFD1002	30VFD1002	480	MCCB	2		50.0	4.10	29.3	35.1	1	29.3	1	3 Phase		
		Comment:													
30VFD7600	30VFD7600	480	MCCB	2		65.0	3.55	28.2	32.7	1	28.2	1	3 Phase		
		Comment:													
30VFD8601	30VFD8601	480	MCCB	2		65.0	2.90	25.5	28.3	1	25.5	1	3 Phase		
		Comment:													
30XFMR9201	30XFMR9201 PRI	480	N/A				0.72	10.6	10.6			1	3 Phase		
		Comment:													
30XFMR9201	30XFMR9201 SEC	208	N/A				0.74	1.0	1.0			1	Line To Ground		
		Comment:													
40DP9201	40DP9201	480	MCCB	2		35.0	2.04	26.4	27.6	1	26.4	1	3 Phase		
		Comment:													
40DP9202	40DP9202	480	MCCB	2		35.0	0.85	11.4	11.4	1	11.4	1	3 Phase		
		Comment:													
40LP9201	40LP9201	208	MCCB	4		10.0	0.73	1.0	1.0	1	1.0	1	Line To Ground		
		Comment:													
40LP9202	40LP9202	208	MCCB	4		10.0	0.72	1.0	1.0	1	1.0	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
40MCC9201	40MCC9201	480	MCCB	2		65.0	1.15	21.6	21.7	1	21.6	1	3 Phase		
		Comment:													
40SWBD910	40SWBD9101	480	MCCB	2		50.0	4.54	33.5	41.0	1	33.5	1	3 Phase		
		Comment:													
40XFMR9201	40XFMR9201 PRI	480	N/A				0.92	19.2	19.2			1	3 Phase		
		Comment:													
40XFMR9201	40XFMR9201 SEC	208	N/A				0.74	1.1	1.1			1	Line To Ground		
		Comment:													
40XFMR9202	40XFMR9202 PRI	480	N/A				0.66	9.5	9.5			1	3 Phase		
		Comment:													
40XFMR9202	40XFMR9202 SEC	208	N/A				0.74	1.0	1.0			1	Line To Ground		
		Comment:													
45VFD1001	45VFD1001	480	MCCB	2		50.0	4.48	32.1	39.2	1	32.1	1	3 Phase		
		Comment:													
45VFD1003	45VFD1003	480	MCCB	2		50.0	4.48	32.1	39.2	1	32.1	1	3 Phase		
		Comment:													
45VFD1006	45VFD1006	480	MCCB	2		65.0	3.37	26.6	30.4	1	26.6	1	3 Phase		
		Comment:													
45VFD1007	45VFD1007	480	MCCB	2		65.0	3.21	25.5	28.8	1	25.5	1	3 Phase		
		Comment:													
46SWBD910	46SWBD9101	480	MCCB	2		50.0	3.92	35.8	42.4	1	35.8	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
46SWGR900	46SWGR9001	480	MCCB	2		100.0	4.68	38.3	47.2	1	38.3	1	Line To Ground		
		Comment:													
50DP9201	50DP9201	480	MCCB	2		35.0	1.21	10.5	10.6	1	10.5	1	3 Phase		
		Comment:													
50LP9201	50LP9201	208	MCCB	4		10.0	0.75	2.0	2.0	1	2.0	1	Line To Ground		
		Comment:													
50LP9202	50LP9202	208	MCCB	4		10.0	0.74	1.9	1.9	1	1.9	1	Line To Ground		
		Comment:													
50XFMR9201	50XFMR9201 PRI	480	N/A				1.07	9.8	9.9			1	3 Phase		
		Comment:													
50XFMR9201	50XFMR9201 SEC	208	N/A				0.76	2.0	2.0			1	Line To Ground		
		Comment:													
70DP9201	70DP9201	480	MCCB	2		35.0	1.15	7.9	7.9	1	7.9	1	3 Phase		
		Comment:													
70LP9201	70LP9201	208	MCCB	4		10.0	0.76	2.0	2.0	1	2.0	1	Line To Ground		
		Comment:													
70LP9202	70LP9202	208	MCCB	4		10.0	0.76	2.0	2.0	1	2.0	1	Line To Ground		
		Comment:													
70XFMR9201	70XFMR9201 PRI	480	N/A				1.05	7.5	7.5			1	3 Phase		
		Comment:													
70XFMR9201	70XFMR9201 SEC	208	N/A				0.76	2.0	2.0			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
70XFMR9202	70XFMR9202 PRI	480	N/A				1.05	7.5	7.5			1	3 Phase		
		Comment:													
70XFMR9202	70XFMR9202 SEC	208	N/A				0.76	2.0	2.0			1	Line To Ground		
		Comment:													
M-20MCC91	20MCC9101 MTRS	480	N/A												
		Comment:													
M-30MCC91	MTRS-30MCC9101	480	N/A												
		Comment:													
M-40MCC92	MTRS 40MCC9201	480	N/A												
		Comment:													
MTR-10P100	MTR 10P1001	480	N/A												
		Comment:													
MTR-10P100	MTR 10P1002	480	N/A												
		Comment:													
MTR-10P100	MTR 10P1003	480	N/A												
		Comment:													
MTR-30P100	MTR 30P1001	480	N/A												
		Comment:													
MTR-30P100	MTR 30P1002	480	N/A												
		Comment:													
MTR-30P760	MTR 30P7600	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-30P860	MTR 30P8601	480	N/A												
		Comment:													
MTR-45P100	MTR 45P1001	480	N/A												
		Comment:													
MTR-45P100	MTR 45P1003	480	N/A												
		Comment:													
MTR-45P100	MTR 45P1006	480	N/A												
		Comment:													
MTR-45P100	MTR 45P1007	480	N/A												
		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	05PMS9001	05XFMR9001 PRI
2	05XFMR9001P	Transformer Damage Curve
3	15SWGR9001	MAIN
4	15SWGR9001	10SWBD9101
5	10SWBD9101	10VFD1001
6	10VFD1001	VFD BREAKER
7	MTR-10P1001	Motor Starting Curve

There is overlapping between the feeder breaker to 10VFD1001 (Device #5) and 10VFD1001 breaker (Device #6). This overlap is considered acceptable since they are in series; if either devices trip, it will have the same effect. Switchgear 15SWGR9001 Main (Device #3) and Feeder to Switchboard 10SWBD9101 (Device #4) over lap in the instantaneous region.

TCC# 1GF	Equipment Name	Circuit Description
Device# 3	15SWGR9001	MAIN
4	15SWGR9001	10SWBD9101

The ground fault devices coordinate.

TCC# 2	Equipment Name	Circuit Description
Device# 3	15SWGR9001	MAIN
8	15SWGR9001	20MCC9101
9	20MCC9101	LRG BRK

The devices are coordinated in the long time and short time region.

TCC# 2GF	Equipment Name	Circuit Description
Device# 3	15SWGR9001	MAIN
8	15SWGR9001	20MCC9101

The ground fault devices coordinate.

TCC# 3	Equipment Name	Circuit Description
Device# 10	05PMS9001	05XFMR9002 PRI
11	05XFMR9002P	Transformer Damage Curve
12	30SWBD9001	MAIN
13	30SWBD9001	30VFD1001
14	30VFD1001	VFD BREAKER

	15	MTR-30P1001	Motor Starting Curve

There is overlapping between the feeder breaker to 30VFD1001 (Device #13) and 30VFD1001 breaker (Device #14). This overlap is considered acceptable since they are in series; if either devices trip, it will have the same effect. There is also some overlap of all devices in the instantaneous region.

TCC#	4	**Equipment Name**	**Circuit Description**
Device#	16	05PMS9002	05XFMR9004 PRI
	17	05XFMR9004P	Transformer Damage Curve
	18	46SWGR9001	MAIN
	19	46SWGR9001	46SWBD9101
	20	46SWBD9101	45VFD1001
	21	45VFD1001	VFD BREAKER
	22	MTR-45P1001	Motor Starting Curve

There is overlapping between the feeder breaker to 45VFD1001 (Device #20) and 45VFD1001 breaker (Device #21). This overlap is considered acceptable since they are in series; if either devices trip, it will have the same effect. There is also some overlap of all devices in the instantaneous region.

TCC#	4GF	**Equipment Name**	**Circuit Description**
Device#	18	46SWGR9001	MAIN
	19	46SWGR9001	46SWBD9101

The ground fault devices coordinate.

TCC#	5	**Equipment Name**	**Circuit Description**
Device#	19	46SWGR9001	46SWBD9101
	23	46SWBD9101	45VFD1006
	24	45VFD1006	VFD BREAKER
	25	MTR-45P1006	Motor Starting Curve

There is overlapping between the feeder breaker to 45VFD1006 (Device #23) and 45VFD1006 breaker (Device #24). This overlap is considered acceptable since they are in series; if either devices trip, it will have the same effect. There is also some overlap of all devices in the instantaneous region.

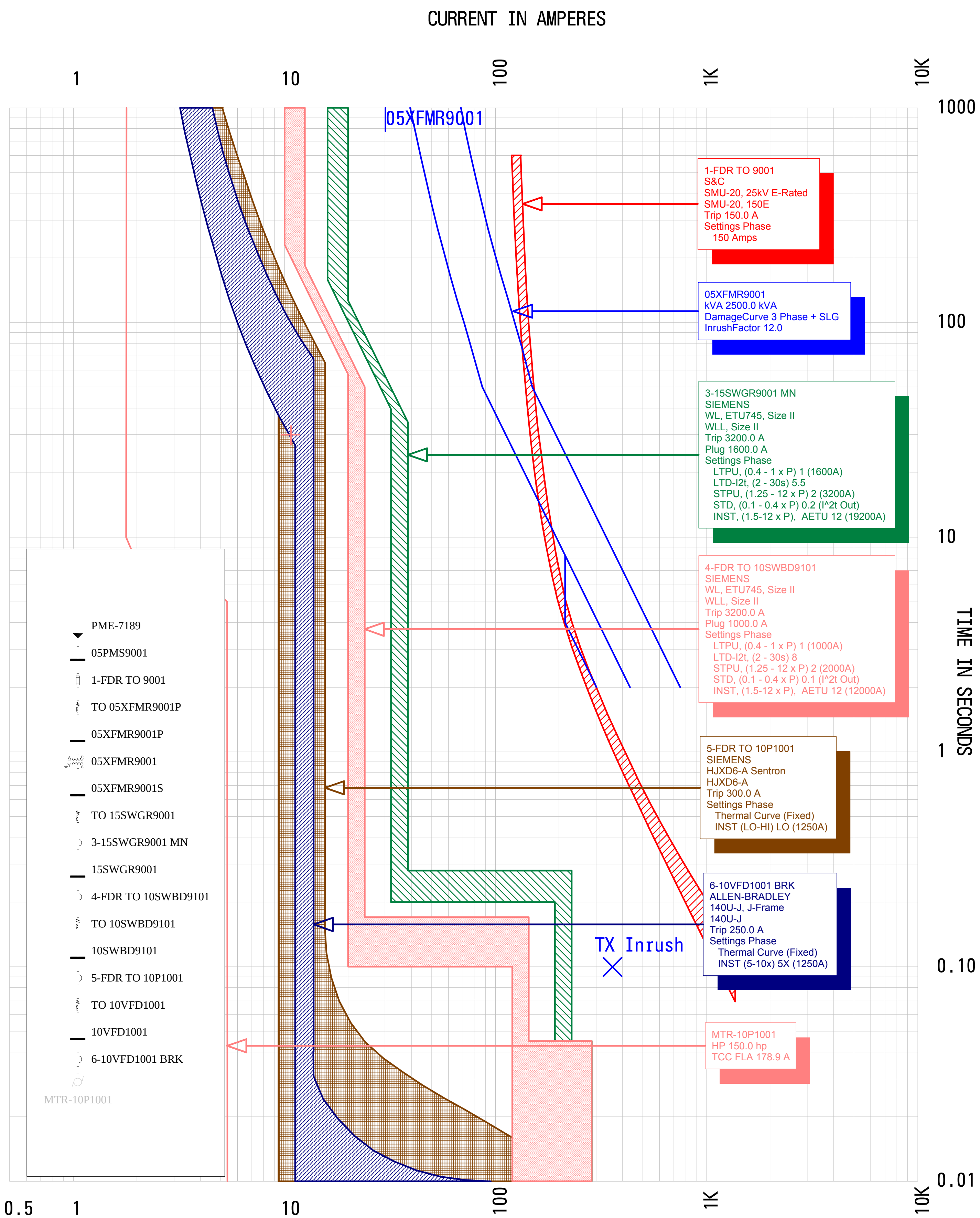
TCC#	6	**Equipment Name**	**Circuit Description**
Device#	18	46SWGR9001	MAIN
	26	46SWGR9001	40SWBD9101
	27	40SWBD9101	40MCC9201

The devices are coordinated in the long time and short time region. There is also some overlap of all devices in the instantaneous region.

TCC#	6GF	**Equipment Name**	**Circuit Description**
Device#	18	46SWGR9001	MAIN
	26	46SWGR9001	40SWBD9101

The ground fault devices coordinate.

TAB 8



TCC Sheet: 1-Fdr to 05XFMR9001, 05XFMR9001 Crv, 15SWGR9001 Mn, Fdr to 10SWBD9101, Fdr to 10VFD1001, 10VFD1001 Brk, and 10P1001 I

Oneline: tcc1
April 28, 2011 10:20 AM
SKM Systems Analysis, Inc.

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

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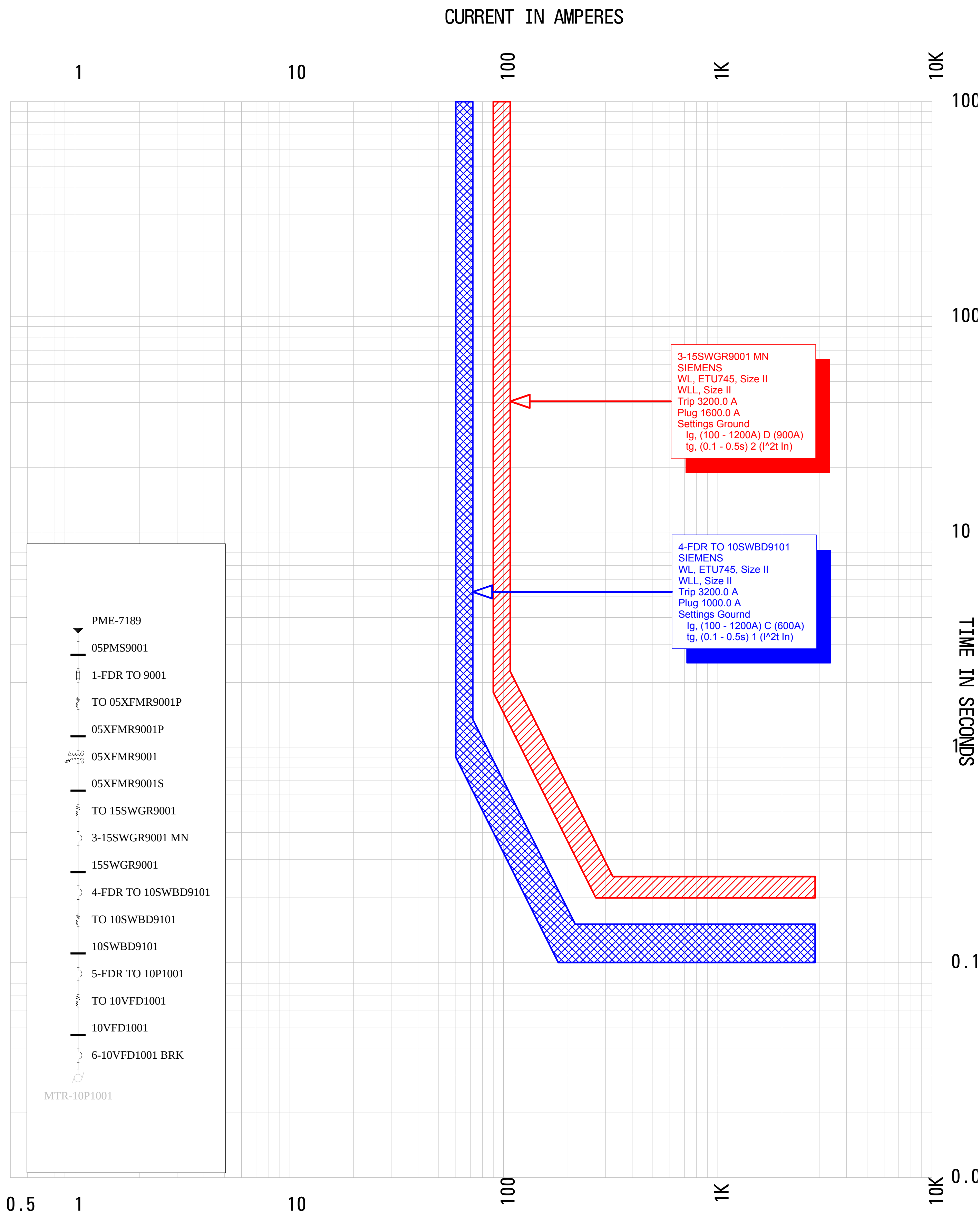

TCC Sheet: 1GF-15SWGR9001 Main and Feeder to 10SWBD9101

Oneline: tcc1
April 28, 2011 10:20 AM
SKM Systems Analysis, Inc.

Current Scale x 10
Reference Voltage: 480
Fault Type: InitSym SLG

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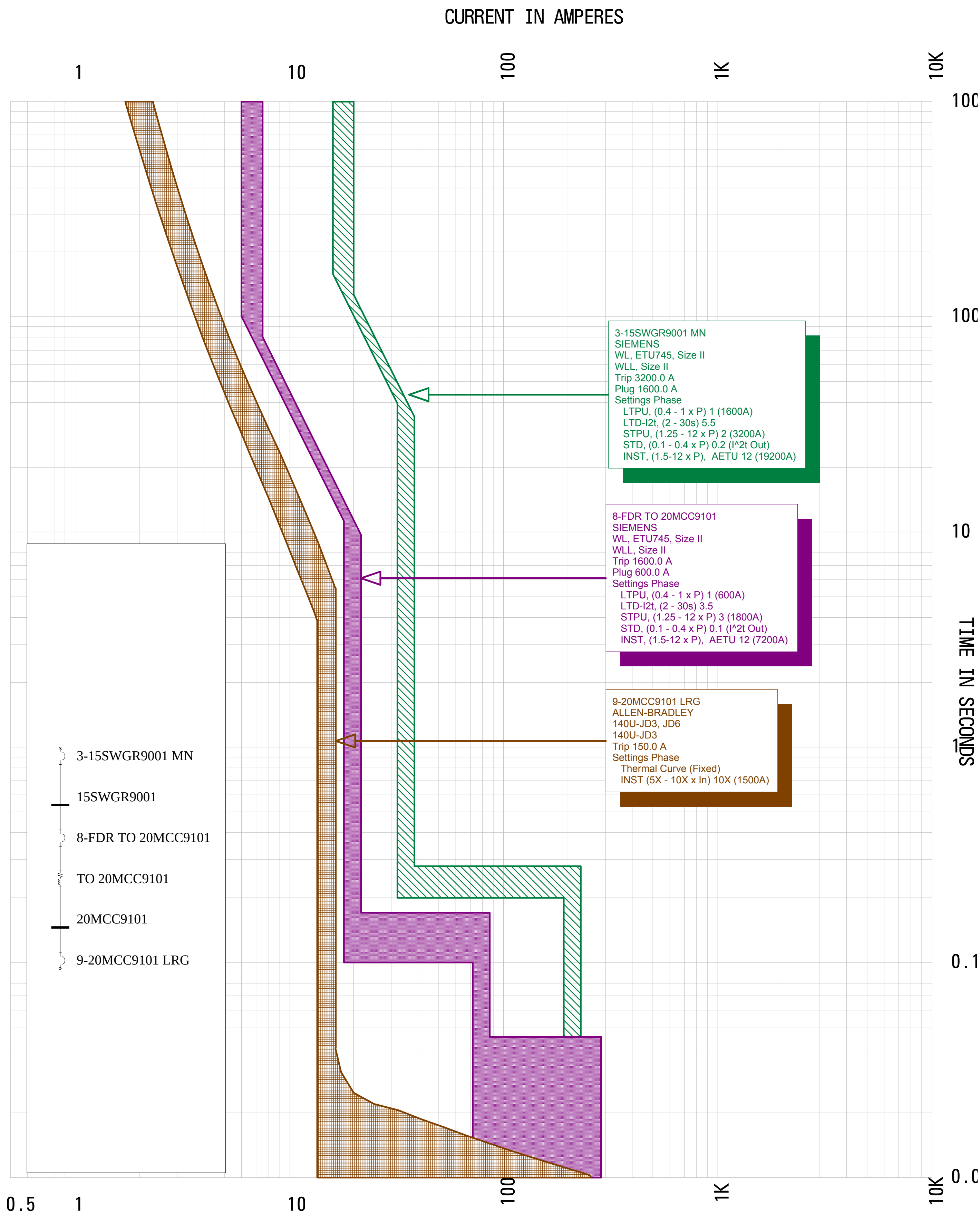

TCC Sheet: 2-15SWGR9001 Main, Feeder to 20MCC9101, and 20MCC9101 Largest Breaker

Oneline: tcc2
April 28, 2011 10:20 AM
SKM Systems Analysis, Inc.

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

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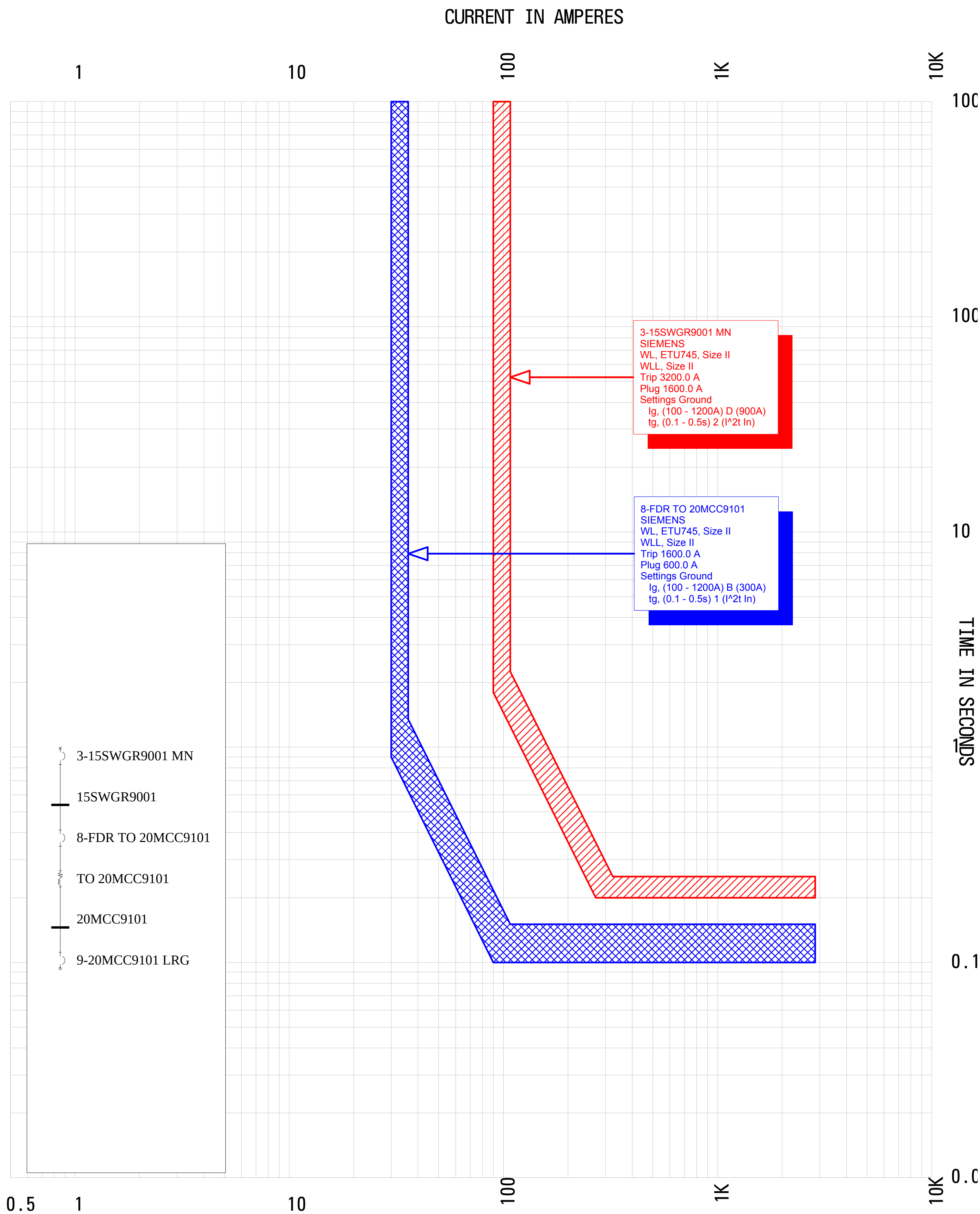

TCC Sheet: 2GF-15SWGR9001 Main and Feeder to 20MCC9101

Oneline: tcc2
April 28, 2011 10:20 AM
SKM Systems Analysis, Inc.

Current Scale x 10
Reference Voltage: 480
Fault Type: InitSym SLG

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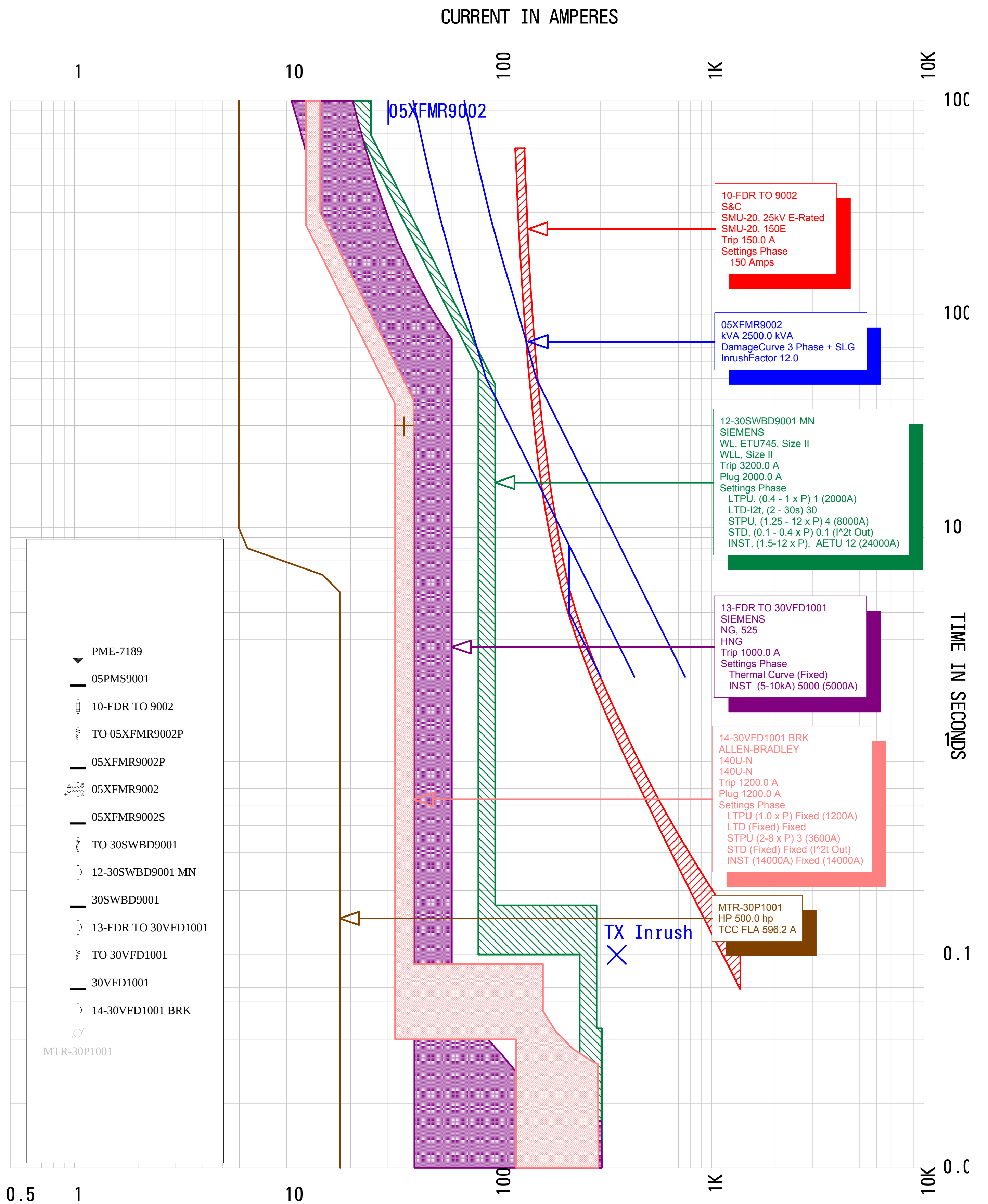

TCC Sheet: 3-Fdr to 05XFMR9002, 05XFMR9002 Crv, 30SWBD9001 Mn, Fdr to 00VFD1001, 30VFD1001 Brk, and 30P1001 Mtr Crv

Oneline: tcc3
April 28, 2011 10:20 AM
SKM Systems Analysis, Inc.

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

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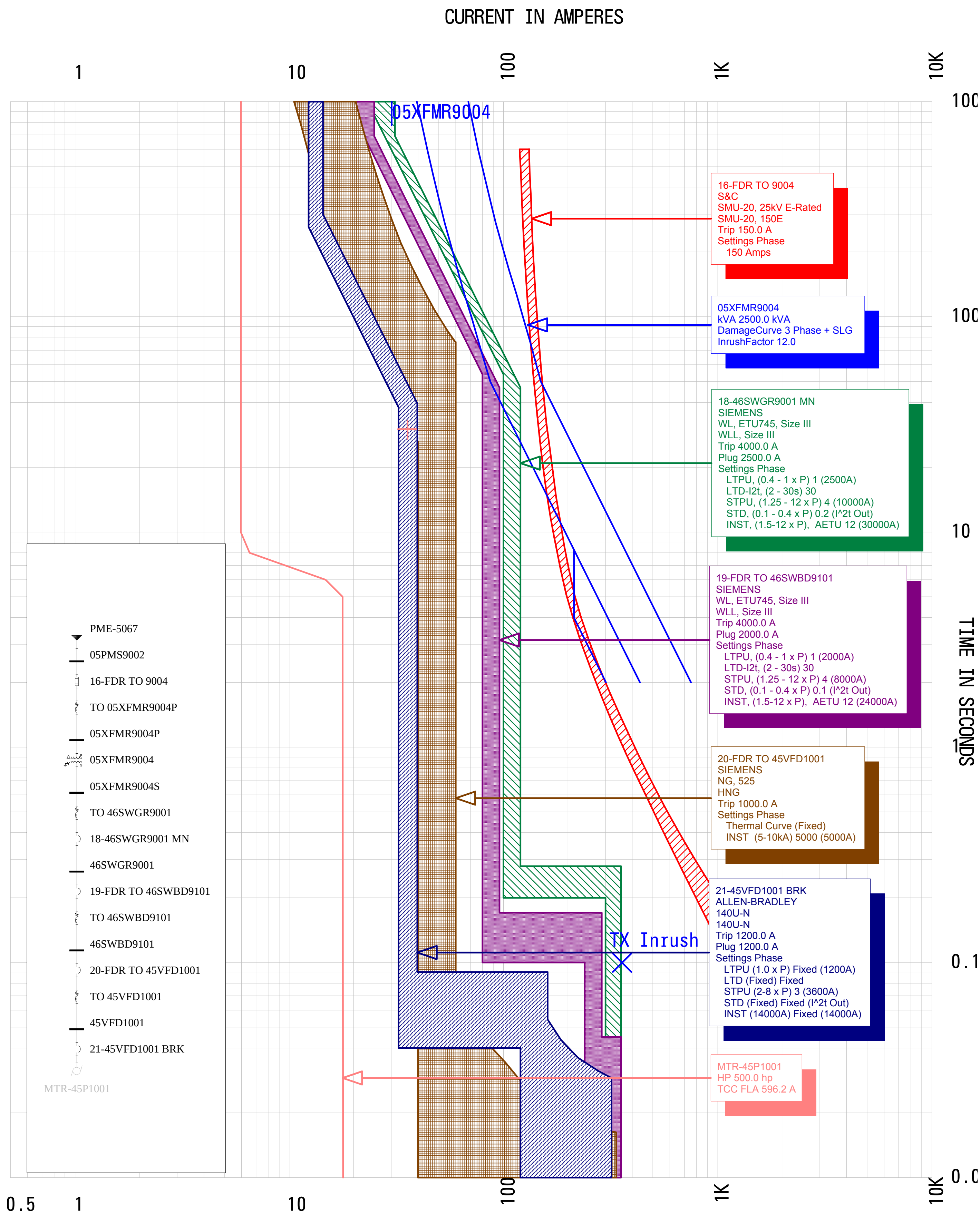

TCC Sheet: 4-Fdr to 05XFMR9004, 05XFMR9004 Crv, 46SWGR9001 Mn, Fdr to 46SWBD9101, Fdr to 45VFD1001, 45VFD1001 Brk, and 45P1001 I

Oneline: tcc4
April 28, 2011 10:20 AM
SKM Systems Analysis, Inc.

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

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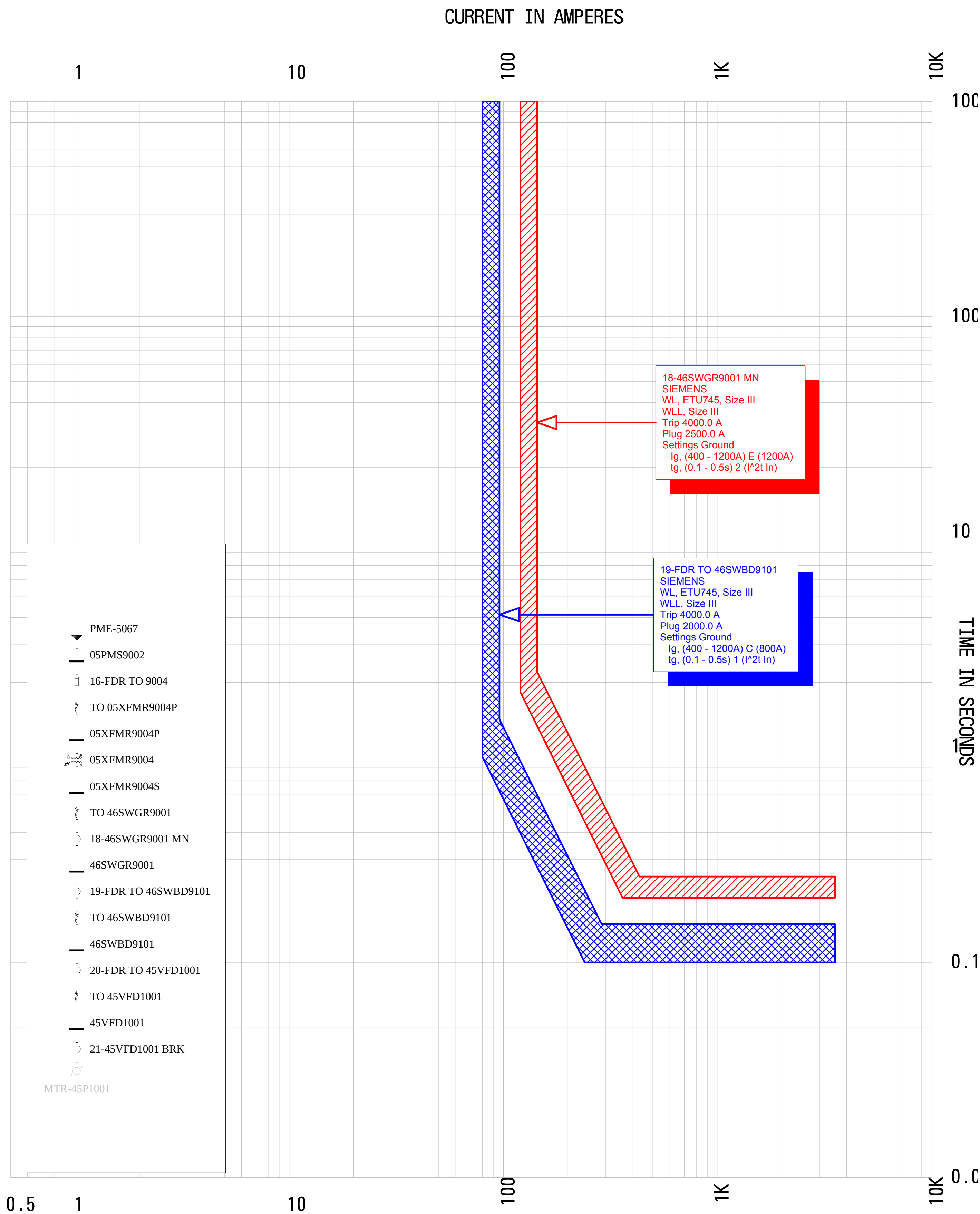

TCC Sheet: 4GF-46SWGR9001 Main and Feeder to 46SWBD9101

Oneline: tcc4
April 28, 2011 10:20 AM
SKM Systems Analysis, Inc.

Current Scale x 10
Reference Voltage: 480
Fault Type: InitSym SLG

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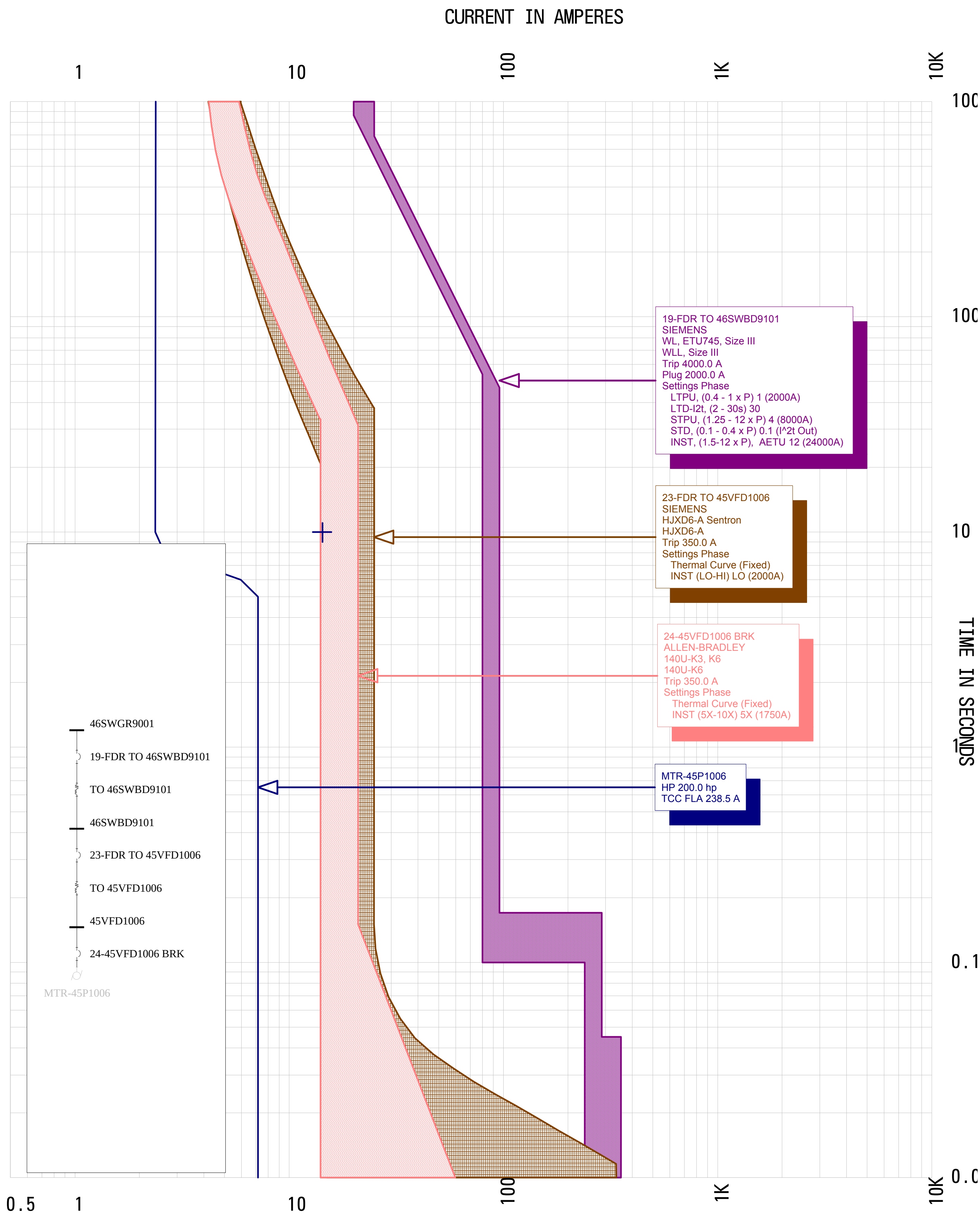

TCC Sheet: 5-Feeder to 46SWBD9101, Feeder to 45VFD1006, 45VFD1006 Breaker, and 45P1006 Motor Curve

Oneline: tcc5
April 28, 2011 10:20 AM
SKM Systems Analysis, Inc.

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

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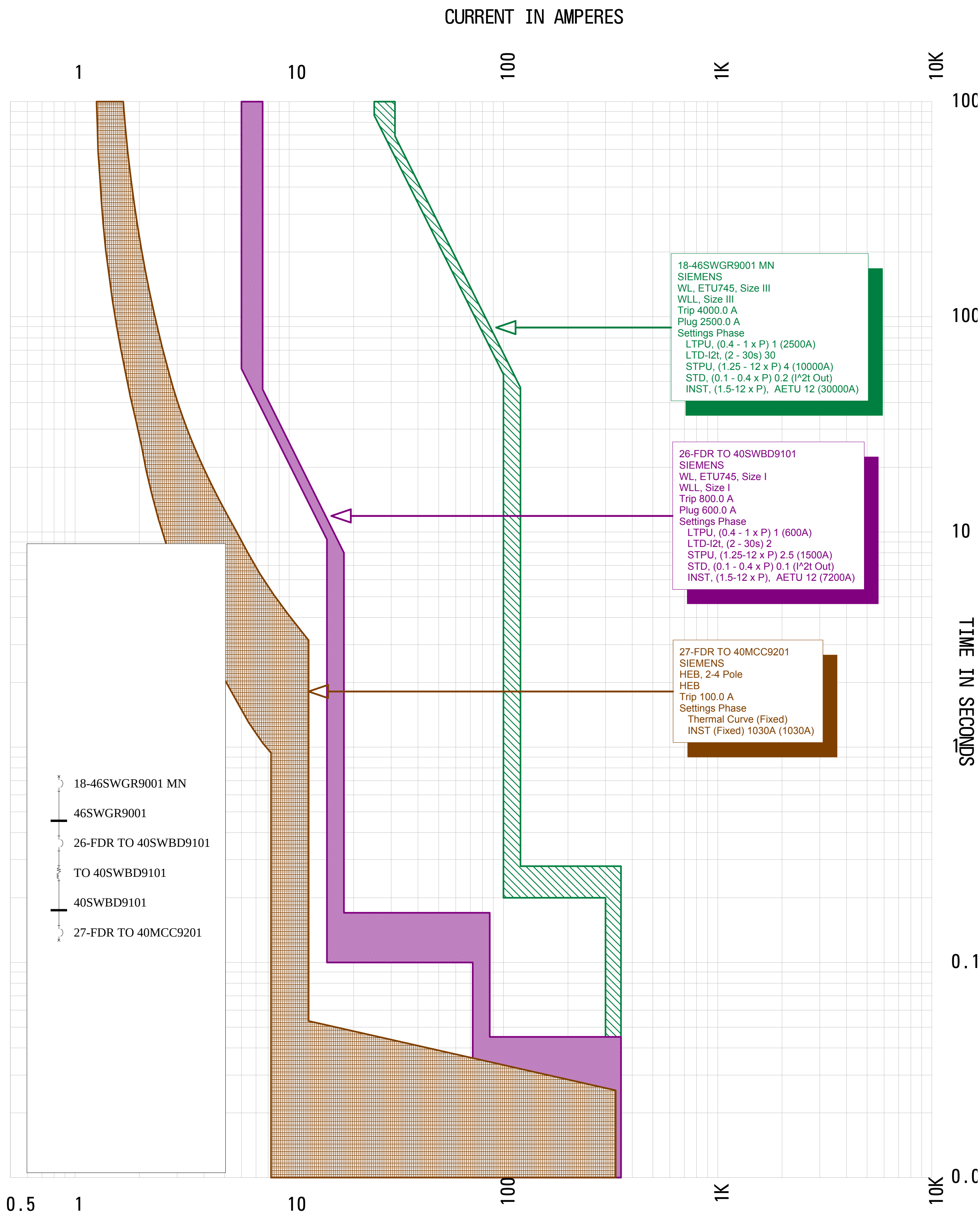

TCC Sheet: 6-46SWGR9001 Main, Feeder to 40SWBD9101, and Feeder to 40MCC9201

Oneline: tcc6
April 28, 2011 10:20 AM
SKM Systems Analysis, Inc.

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

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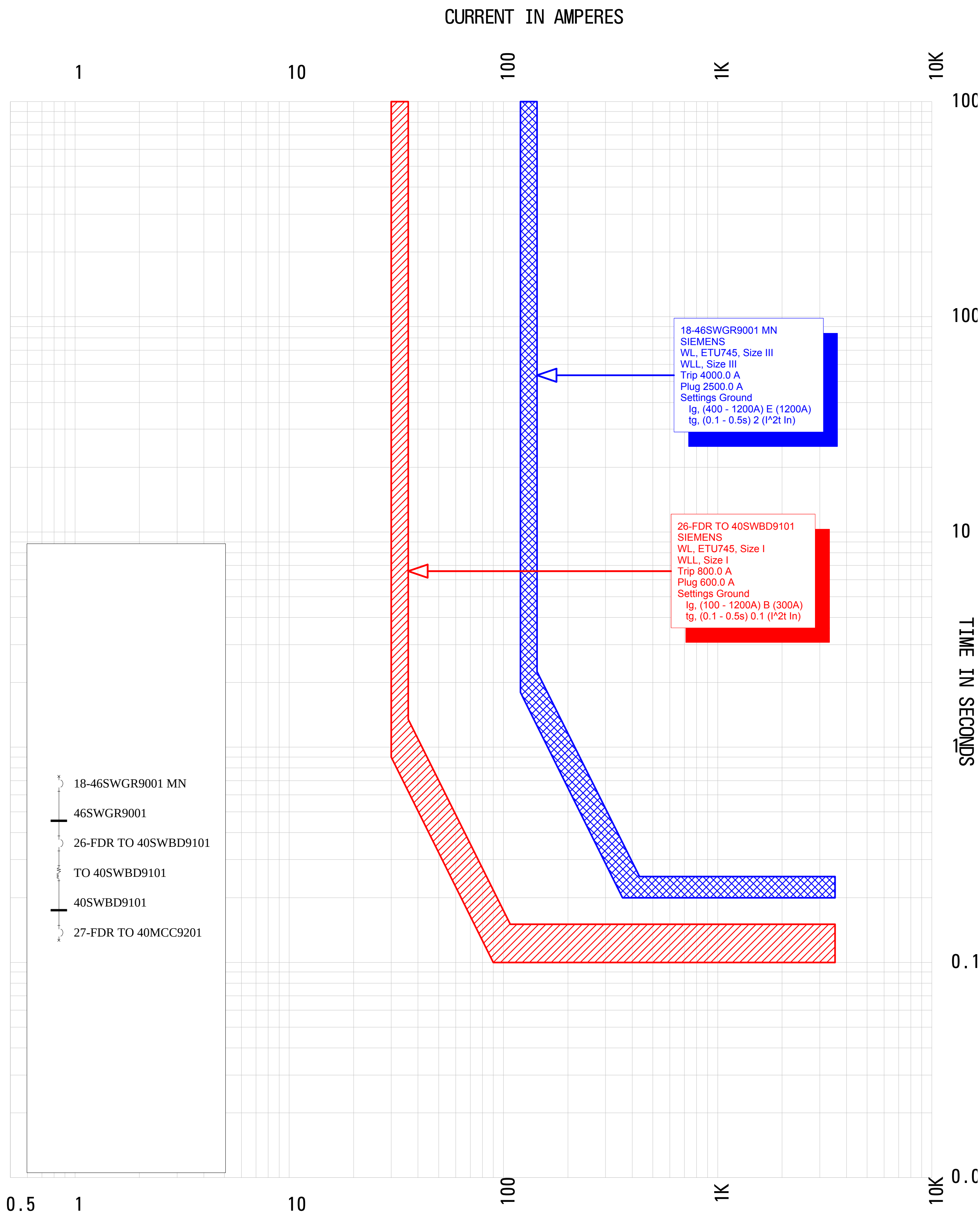

TCC Sheet: 6GF-46SWGR9001 Main and Feeder to 40SWBD9101

Oneline: tcc6
April 28, 2011 10:20 AM
SKM Systems Analysis, Inc.

Current Scale x 10
Reference Voltage: 480
Fault Type: InitSym SLG

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TAB 9

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*

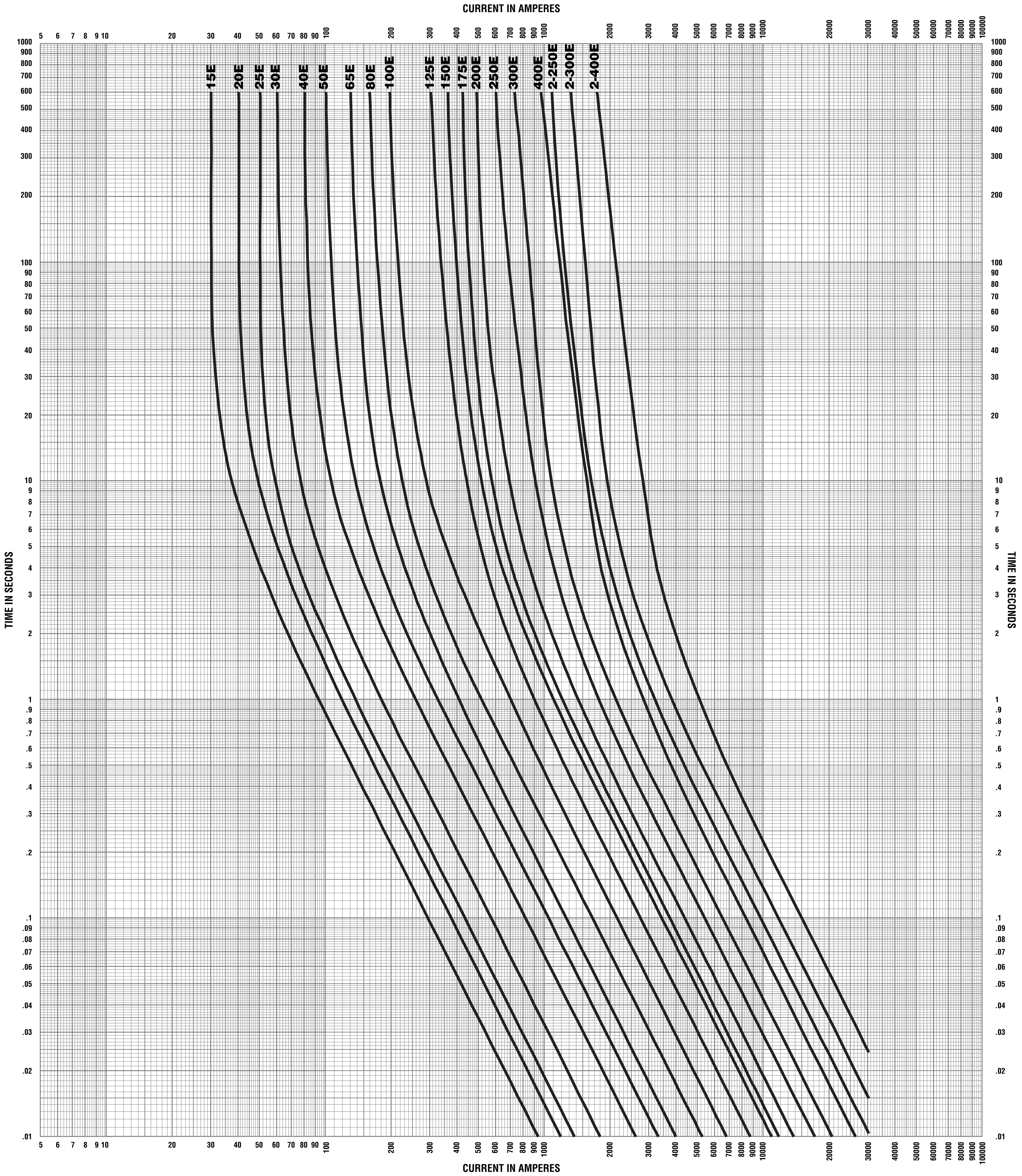
Motor Service Factor – 1.15	**Setting <125% x I(nameplate Amps)** (Up to 140% if nuisance tripping occurs)
Motor with Temp Rise 40º C	**Setting <125% x I(nameplate Amps)** (Up to 140% if nuisance tripping occurs)
All other Motors	**Setting <115% x I(nameplate Amps)** (Up to 130% if nuisance tripping 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.

TAB 10



MINIMUM MELTING TIME-CURRENT CHARACTERISTIC CURVES

SMU FUSE UNITS—S&C SLOW SPEED

BASIS—These fuse units are tested in accordance with the procedures described in ANSI Standard C37.41-1981, and they are rated to comply with ANSI Standard C37.46-1981. As required by these standards, the minimum melting current is not less than 200% of fuse-unit ampere rating, and the minimum melting curves are based on tests starting with the fuse unit at an ambient temperature of 25°C and no initial load.

CONSTRUCTION—Fusible elements are silver, helically coiled, and of solderless construction.

TOLERANCES—Curves are plotted to minimum test points. Maximum variations expressed in current values are plus 10%.

APPLICATION—Like all high-voltage fuses, these fuse units are intended to accommodate overloads, not to interrupt them. Accordingly, they feature fusible elements which are designed with a minimum melting current of 200% of the fuse-unit ampere rating (for fuse units rated 100 amperes or less) or 240% of the fuse-unit ampere rating (for fuse units rated over 100 amperes). As a result, these fuse units have considerable peak-load capabilities; however, they should never be exposed to loading in excess of the peak-load capabilities listed in S&C Data Bulletin 240-190.

Since these fuse units have silver element construction which is not subject to damage by aging or transient overcurrents, it is unnecessary to replace unblown fuse units in single-phase or three-phase installations when one or more fuse units have blown.

COORDINATION—Any preloading reduces melting time. While this phenomenon is especially pronounced in other makes of fuses having minimum melting currents appreciably less than 200% of rating, the effect of preloading must nonetheless be determined for the S&C fuse units represented by these curves (see S&C Data Bulletin 240-195) and adjustments to these curves must be made:

1. When close coordination is required;
2. When, regardless of the preciseness of coordination, the fuse unit is subjected to temporary overloads.

There are cases where the coordination requirements may be very exacting, for example, in coordinating a transformer primary fuse with a secondary breaker and a source-side breaker. The time interval between the operating characteristics of the two breakers may be very narrow. Under these circumstances there must be an extremely short time interval between the minimum melting and the total clearing characteristics of the fuse.

The fuse units represented by these curves possess this short time interval feature, since—having a nondamageable fusible element of precise construction—they require:

1. As little as 10% *total* tolerance in melting current—compared to the 20% tolerance of many fuses (20% and 40% respectively in terms of time).
2. No "safety-zone" or setback allowances.

This narrow time band normally will provide the desired coordination. If the selected S&C Slow Speed fuse unit does not meet the coordination requirements, check to see if the same ampere rating in the S&C Very Slow Speed will satisfy.

Sometimes a selected ampere rating will fail to meet the coordination requirements in any available speed. In this case the selection of another ampere rating for either the protecting or protected fuse usually will satisfy all requirements.

Do not assume that other fuses that do not employ S&C's silver, helically coiled fusible element construction can better resolve a coordination impasse than the use of another ampere rating in one of the S&C speed options. Such other fuses, including "time-lag" speeds, "super-slow" speeds, and "high-surge" speeds, require the use of "safety-zone" or setback allowances and, in addition, they have larger construction tolerances (plus 20% in current; plus 40% in terms of time). The application of these two factors will give a time interval between the adjusted minimum melting curve and the total clearing curve greater than in the case of S&C speed options.

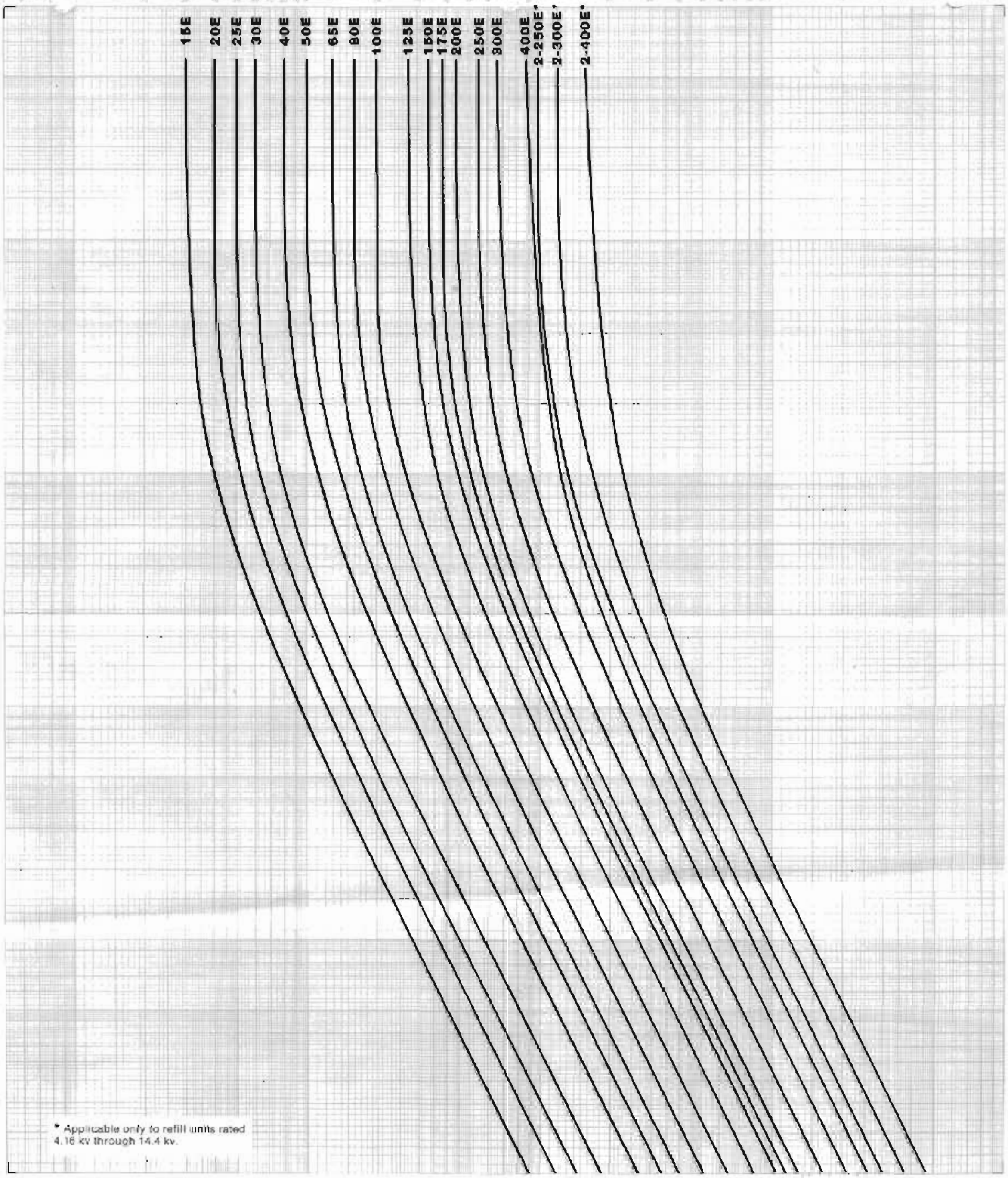
FUSE UNITS AVAILABLE—

Type	Kv Nom. Ratings	Ampere Ratings
SMU-20®★	14.4 through 34.5	15E through 200E
SMD-40®	4.8 through 25	15E through 400E

★ These curves are also applicable to a previous design designated SMD-20.

Supersedes TCC No. 119-2 dated 8-29-88

S&C ELECTRIC COMPANY • Chicago
S&C ELECTRIC CANADA LTD. • Toronto



MINIMUM MELTING TIME-CURRENT CHARACTERISTIC CURVES

SM REFILL UNITS—S&C SLOW SPEED

BASIS—These refill units are tested in accordance with the procedures described in ANSI Standard C37.41-1981, and they are rated to comply with ANSI Standard C37.46-1981. As required by these standards, the minimum melting current is not less than 200% of refill-unit ampere rating, and the minimum melting curves are based on tests starting with the refill unit at an ambient temperature of 25°C and no initial load.

CONSTRUCTION—Fusible elements are silver, helically coiled, and of solderless construction.

TOLERANCES—Curves are plotted to minimum test points. Maximum variations expressed in current values are plus 10%.

APPLICATION—Like all high-voltage fuses, these refill units are intended to accommodate overloads, not to interrupt them. Accordingly, they feature fusible elements which are designed with a minimum melting current of 200% of the refill-unit ampere rating (for refill units rated 100 amperes or less), or 220% of the refill-unit ampere rating (for refill units rated over 100 amperes). As a result, these refill units have considerable peak-load capabilities; however, they should never be exposed to loading in excess of the peak-load capabilities listed in S&C Data Bulletin 240-190.

Since these refill units have silver element construction which is not subject to damage by aging or transient overcurrents, it is unnecessary to replace unblown refill units in single-phase or three-phase installations when one or more refill units have blown.

COORDINATION—Any preloading reduces melting time. While this phenomenon is especially pronounced in other makes of fuses having minimum melting currents appreciably less than 200% of rating, the effect of preloading must nonetheless be determined for the S&C refill units represented by these curves (see S&C Data Bulletin 240-196) and adjustments to these curves must be made:

1. When close coordination is required
2. When, regardless of the preciseness of coordination, the refill unit is subjected to temporary overloads

There are cases where the coordination requirements may be very exacting, for example in coordinating a transformer-primary fuse with a secondary breaker and a source-side breaker. The time interval between the operating characteristics of the two breakers may be very narrow. Under these circumstances there must be an extremely short time interval between the minimum melting and the total clearing characteristics of the fuse.

The refill units represented by these curves possess this short time interval feature, since—having a nondamageable fusible element of precise construction—they require:

1. As little as 10% total tolerance in melting current—compared to the 20% tolerance of many fuses (20% and 40% respectively in terms of time)
2. No "safety-zone" or setback allowances

This narrow time band normally will provide the desired coordination. If the selected S&C Slow Speed refill unit does not meet the coordination requirements, check to see if an S&C Coordinating Speed refill unit will satisfy.

Sometimes a selected ampere rating will fail to meet the coordination requirements in any available speed. In this case the selection of another ampere rating for either the protecting or protected fuse usually will satisfy all requirements.

Do not assume that other fuses that do not employ S&C's silver, helically coiled fusible element construction can better resolve a coordination impasse than the use of another ampere rating in one of the S&C speed options. Such other fuses, including "time-lag" speeds, "super-slow" speeds, and "high-surge" speeds, require the use of "safety-zone" or setback allowances and in addition, they have larger construction tolerances (plus 20% in current, plus 40% in terms of time). The application of these two factors will give a time interval between the adjusted minimum melting curve and the total clearing curve greater than in the case of S&C speed options.

REFILL UNITS AVAILABLE—

Refill Unit	Kv Nom. Ratings	Ampere Ratings
SM-4	7.2 through 34.5	15E through 200E
SM-5	4.16 through 14.4	15E through 400E
SM-5	25 and 34.5	15E through 300E

Time Current Characteristics Curve

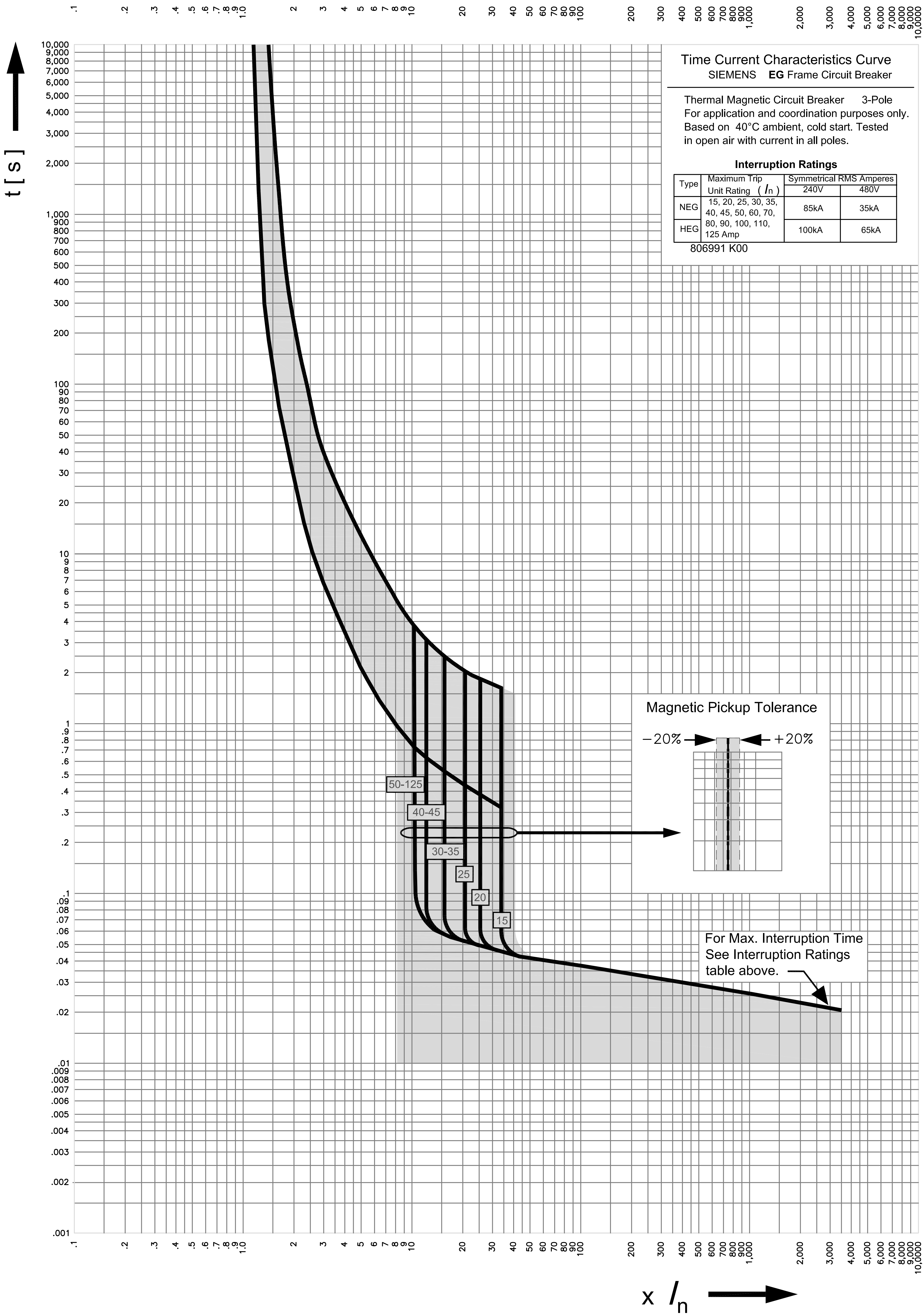
SIEMENS **EG** Frame Circuit Breaker

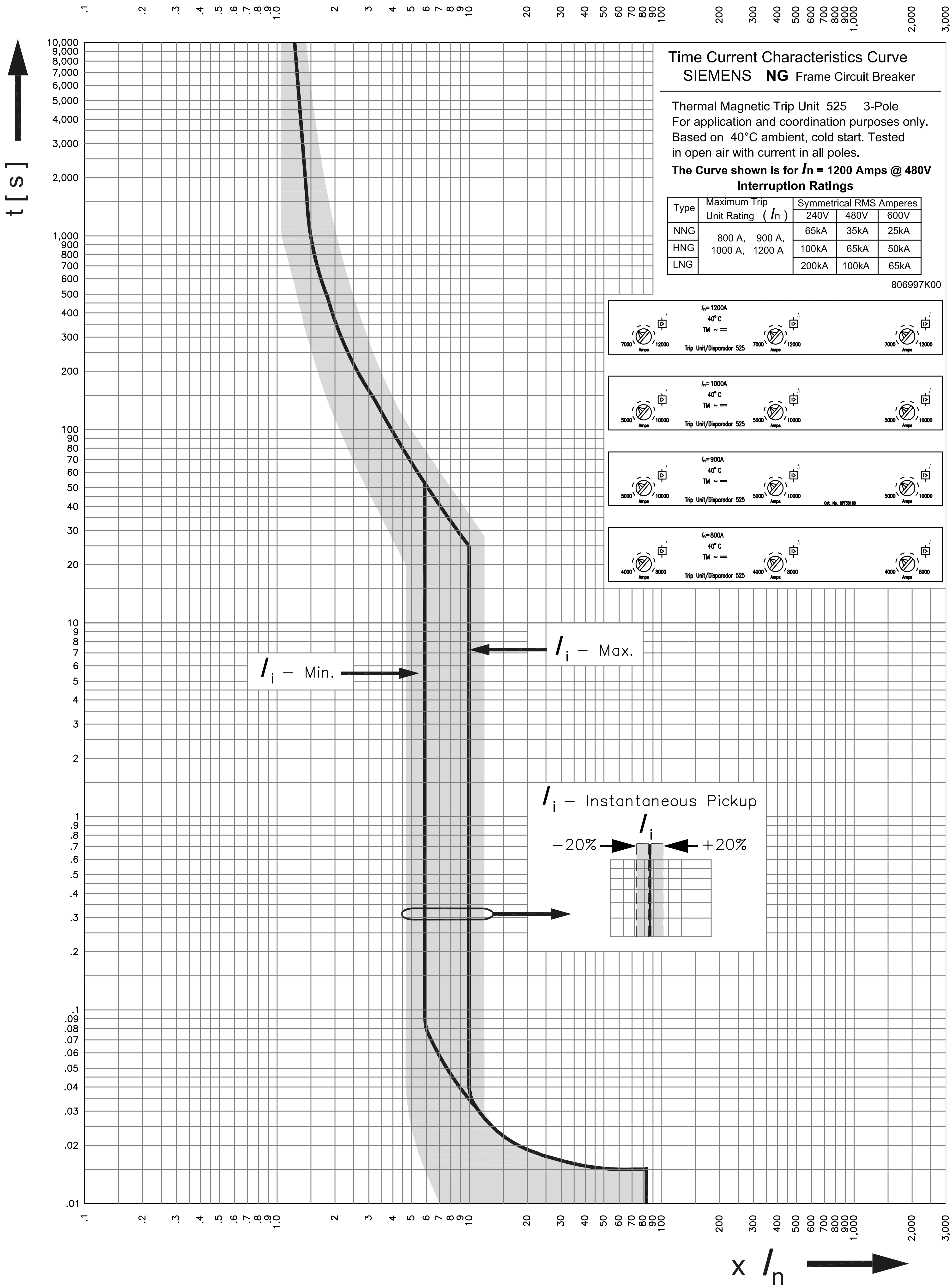
Thermal Magnetic Circuit Breaker 3-Pole
For application and coordination purposes only.
Based on 40°C ambient, cold start. Tested
in open air with current in all poles.

Interruption Ratings

Type	Maximum Trip Unit Rating (I_n)	Symmetrical RMS Amperes 240V	Symmetrical RMS Amperes 480V
NEG	15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100, 110, 125 Amp	85kA	35kA
HEG		100kA	65kA

806991 K00





Type	Maximum Trip Unit Rating (In)	Symmetrical RMS Amperes		
		240V	480V	600V
NNG	800 A, 900 A, 1000 A, 1200 A	65kA	35kA	25kA
HNG		100kA	65kA	50kA
LNG		200kA	100kA	65kA

Time-Current Characteristic Curve
I-T-E® Sentron™ Circuit Breaker

JD-Frame **2 & 3 Pole**
Types JXD2, JXD6, JD6, HJD6, HHJD6, HHJXD6 **60 Hz**

For application and coordination purposes only. Based on 40°C ambient cold start. Connected with 4 feet of rated wire (75°C) per terminal. Tested in open air with current in all poles.

Type JXD2
240 Volts 60 HZ — 250 Volts DC

Types JXD6, JD6, HJD6, HHJXD6, HHJD6
600 Volts 60 HZ — 500 Volts DC

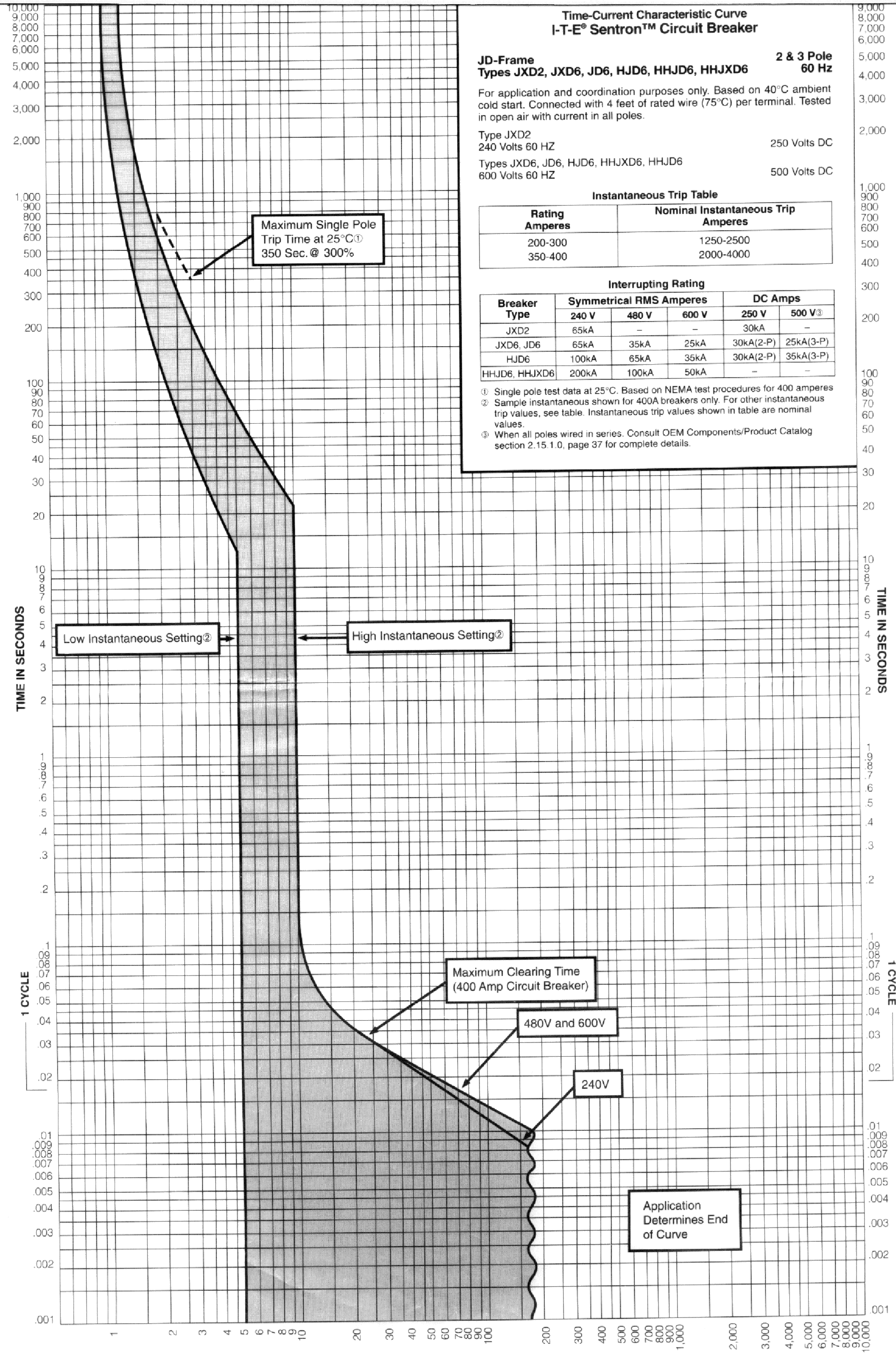
Instantaneous Trip Table

Rating Amperes	Nominal Instantaneous Trip Amperes
200-300	1250-2500
350-400	2000-4000

Interrupting Rating

Breaker Type	Symmetrical RMS Amperes			DC Amps	
	240 V	480 V	600 V	250 V	500 V③
JXD2	65kA	–	–	30kA	–
JXD6, JD6	65kA	35kA	25kA	30kA(2-P)	25kA(3-P)
HJD6	100kA	65kA	35kA	30kA(2-P)	35kA(3-P)
HHJD6, HHJXD6	200kA	100kA	50kA	–	–

① Single pole test data at 25°C. Based on NEMA test procedures for 400 amperes
② Sample instantaneous shown for 400A breakers only. For other instantaneous trip values, see table. Instantaneous trip values shown in table are nominal values.
③ When all poles wired in series. Consult OEM Components/Product Catalog section 2.15.1.0, page 37 for complete details.



I-T-E® Sentron™ Series Circuit Breakers
Multiples of Circuit Breaker Continuous Current Rating

TAB 11

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 $\leq$ IB $\leq$ 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 $\geq$ 1 kV and 700A $\leq$ IB $\leq$ 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 $En = 10^{lg\ En}$

Incident Energy is converted from normalized:

$E = 4.184\ Cf\ En\ (t/0.2)\ (610^X / D^X)$

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.

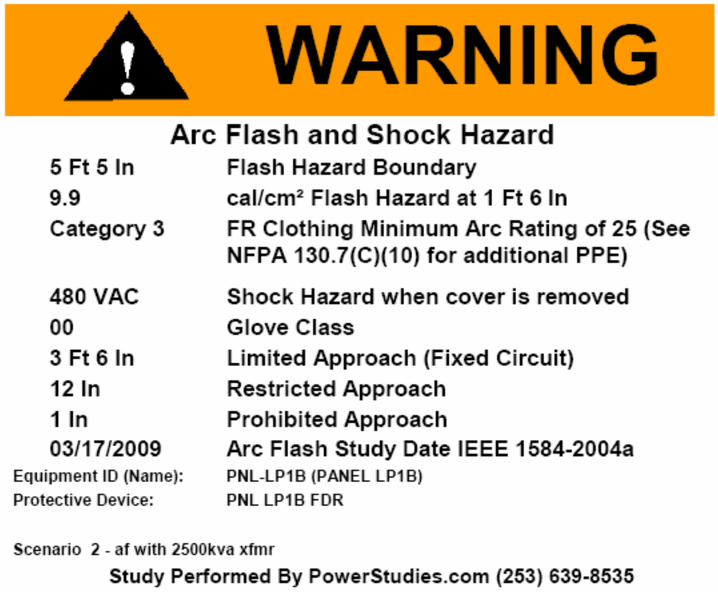


Figure 2– Example Arc Flash Label

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.

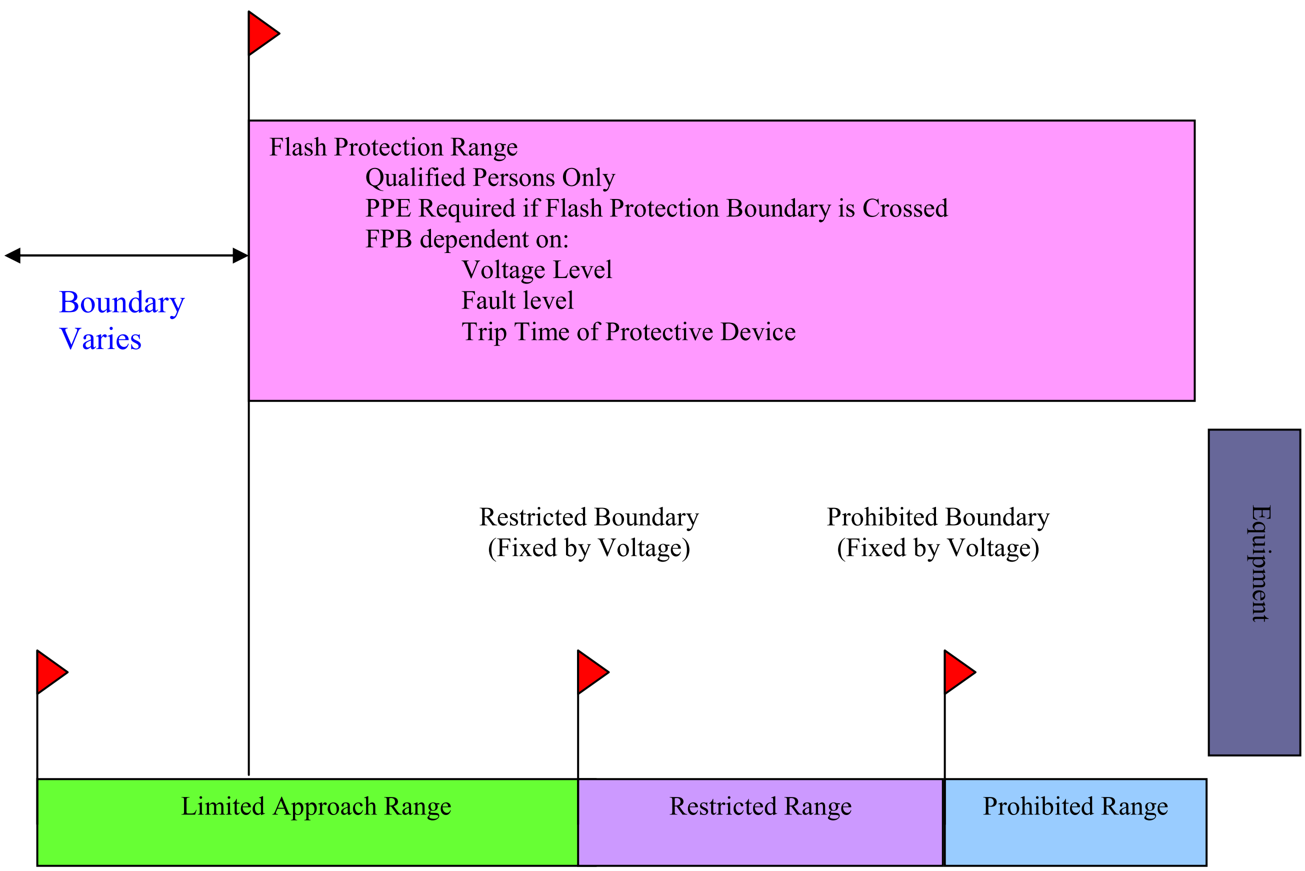


Figure 3 – Arc Flash Boundary Relationship and Determination

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 Power

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
15SWGR9001 (15SWGR9001) (3-15SWGR9001 MN LineSide)	1	1-FDR TO 9001	480	28.65	28.13	15.82	2.00	0.000	Y	PNL	25	282	18	109.00	Dangerous! (*N9)
30SWBD9001 (30SWBD9001) (12-30SWBD9001 MN LineSide)	1	10-FDR TO 9002	480	30.59	30.51	17.00	2.00	0.000	Y	PNL	25	295	18	118.00	Dangerous! (*N9)
46SWGR9001 (46SWGR9001) (18-46SWGR9001 MN LineSide)	1	16-FDR TO 9004	480	35.43	35.30	19.25	2.00	0.000	Y	PNL	25	321	18	135.00	Dangerous! (*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 12

Maximum Arc Flash Energy (US) – All

Scenario Descriptions

Scenario 1: Utility Power

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
10DP9201 (10DP9201)	1	FDR TO 10DP9201	480	22.01	22.01	12.86	0.01	0.000	Y	PNL	25	10	18	0.44	Category 0
10DP9201 (10DP9201) (10DP9201 MAIN LineSide)	1	FDR TO 10DP9201	480	22.01	22.01	12.86	0.01	0.000	Y	PNL	25	10	18	0.44	Category 0
10LP9201 (10LP9201)	1	FDR TO 10XFMR9201	208	1.03	1.03	0.88	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
10SWBD9101 (10SWBD9101)	1	4-FDR TO 10SWBD91	480	25.86	25.86	12.55	0.17	0.000	Y	PNL	25	54	18	7.20	Category 2 (*N3)
10VFD1001 (10VFD1001)	1	5-FDR TO 10P1001	480	24.19	24.19	13.95	0.01	0.000	Y	PNL	25	13	18	0.70	Category 0
10VFD1002 (10VFD1002)	1	FDR TO 10P1002	480	24.19	24.19	13.95	0.01	0.000	Y	PNL	25	13	18	0.70	Category 0
10VFD1003 (10VFD1003)	1	FDR TO 10P1003	480	24.19	24.19	13.95	0.01	0.000	Y	PNL	25	13	18	0.70	Category 0
10XFMR9201P (10XFMR9201 PRI)	1	FDR TO 10DP9201	480	16.99	16.99	10.31	0.01	0.000	Y	PNL	25	8	18	0.34	Category 0 (*N5)
10XFMR9201S (10XFMR9201 SEC)	1	FDR TO 10XFMR9201	208	1.05	1.05	0.89	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
15SWGR9001 (15SWGR9001)	1	3-15SWGR9001 MN	480	28.65	28.13	15.82	0.28	0.000	Y	PNL	25	85	18	15.00	Category 3
15SWGR9001 (15SWGR9001) (3-15SWGR9001 MN LineSide)	1	1-FDR TO 9001	480	28.65	28.13	15.82	2.00	0.000	Y	PNL	25	282	18	109.00	Dangerous! (*N9)
20DP9201 (20DP9201)	1	FDR TO 20DP9201	480	16.06	16.06	9.83	0.01	0.000	Y	PNL	25	10	18	0.45	Category 0
20LP9201 (20LP9201)	1	FDR TO 20XFMR9201	208	1.02	1.02	0.88	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
20MCC9101 (20MCC9101)	1	8-FDR TO 20MCC9101	480	25.55	25.03	14.32	0.05	0.000	Y	PNL	25	26	18	2.30	Category 1
20XFMR9201P (20XFMR9201 PRI)	1	FDR TO 20DP9201	480	12.57	12.57	7.97	0.01	0.000	Y	PNL	25	9	18	0.37	Category 0 (*N5)
20XFMR9201S (20XFMR9201 SEC)	1	FDR TO 20XFMR9201	208	1.04	1.04	0.89	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
30DP9201 (30DP9201)	1	FDR TO 30DP9201	480	13.02	13.02	8.21	0.01	0.000	Y	PNL	25	7	18	0.27	Category 0
30LP9201 (30LP9201)	1	FDR TO 30XFMR9201	208	1.01	1.01	0.87	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
30MCC9101 (30MCC9101)	1	FDR TO 30MCC9101	480	25.99	25.92	14.79	0.01	0.000	Y	PNL	25	11	18	0.51	Category 0
30MTS8601 (30MTS8601)	1	FDR TO 30MTS8601	480	28.22	28.22	15.91	0.01	0.000	Y	PNL	25	14	18	0.75	Category 0
30SWBD9001 (30SWBD9001)	1	12-30SWBD9001 MN	480	30.59	30.51	17.00	0.17	0.000	Y	PNL	25	66	18	10.00	Category 3
30SWBD9001 (30SWBD9001) (12-30SWBD9001 MN LineSide)	1	10-FDR TO 9002	480	30.59	30.51	17.00	2.00	0.000	Y	PNL	25	295	18	118.00	Dangerous! (*N9)
30VFD1001 (30VFD1001)	1	13-FDR TO 30VFD100	480	29.35	29.35	16.45	0.02	0.000	Y	PNL	25	18	18	1.20	Category 1
30VFD1002 (30VFD1002)	1	FDR TO 30VFD1002	480	29.35	29.35	16.45	0.02	0.000	Y	PNL	25	18	18	1.20	Category 1
30VFD7600 (30VFD7600)	1	FDR TO 30VFD7600	480	28.22	28.22	15.91	0.01	0.000	Y	PNL	25	14	18	0.75	Category 0
30VFD8601 (30VFD8601)	1	FDR TO 30MTS8601	480	25.50	25.50	14.59	0.01	0.000	Y	PNL	25	13	18	0.71	Category 0
30XFMR9201P (30XFMR9201 PRI)	1	FDR TO 30DP9201	480	10.61	10.61	6.90	0.01	0.000	Y	PNL	25	6	18	0.22	Category 0 (*N5)
30XFMR9201S (30XFMR9201 SEC)	1	FDR TO 30XFMR9201	208	1.03	1.03	0.88	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
40DP9201 (40DP9201)	1	FDR TO 40DP9201	480	26.42	26.42	15.04	0.01	0.000	Y	PNL	25	11	18	0.52	Category 0
40DP9202 (40DP9202)	1	FDR TO 40DP9202	480	11.43	11.43	7.35	0.01	0.000	Y	PNL	25	7	18	0.24	Category 0
40LP9201 (40LP9201)	1	FDR TO 40XFMR9201	208	1.03	1.03	0.88	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
40LP9202 (40LP9202)	1	FDR TO 40XFMR9202	208	1.01	1.01	0.87	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
40MCC9201 (40MCC9201)	1	27-FDR TO 40MCC920	480	21.65	21.54	12.62	0.03	0.000	Y	PNL	25	19	18	1.40	Category 1
40SWBD9101 (40SWBD9101)	1	26-FDR TO 40SWBD9	480	33.45	33.32	18.32	0.05	0.000	Y	PNL	25	31	18	2.90	Category 1

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
40XFMR9201P (40XFMR9201 PRI)	1	FDR TO 40DP9201	480	19.23	19.23	11.46	0.01	0.000	Y	PNL	25	9	18	0.38	Category 0 (*N5)
40XFMR9201S (40XFMR9201 SEC)	1	FDR TO 40XFMR9201	208	1.05	1.05	0.90	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
40XFMR9202P (40XFMR9202 PRI)	1	FDR TO 40DP9202	480	9.47	9.47	6.26	0.01	0.000	Y	PNL	25	6	18	0.20	Category 0 (*N5)
40XFMR9202S (40XFMR9202 SEC)	1	FDR TO 40XFMR9202	208	1.03	1.03	0.88	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
45VFD1001 (45VFD1001)	1	20-FDR TO 45VFD100	480	32.07	32.07	17.74	0.02	0.000	Y	PNL	25	19	18	1.30	Category 1
45VFD1003 (45VFD1003)	1	FDR TO 45VFD1003	480	32.07	32.07	17.74	0.02	0.000	Y	PNL	25	19	18	1.30	Category 1
45VFD1006 (45VFD1006)	1	23-FDR TO 45VFD100	480	26.58	26.58	15.12	0.02	0.000	Y	PNL	25	16	18	0.95	Category 0
45VFD1007 (45VFD1007)	1	FDR TO 45VFD1007	480	25.48	25.48	14.58	0.02	0.000	Y	PNL	25	15	18	0.93	Category 0
46SWBD9101 (46SWBD9101)	1	19-FDR TO 46SWBD9	480	33.78	33.78	18.55	0.17	0.000	Y	PNL	25	70	18	11.00	Category 3
46SWGR9001 (46SWGR9001)	1	18-46SWGR9001 MN	480	35.43	35.30	19.25	0.28	0.000	Y	PNL	25	97	18	19.00	Category 3
46SWGR9001 (46SWGR9001) (18-46SWGR9001 MN LineSide)	1	16-FDR TO 9004	480	35.43	35.30	19.25	2.00	0.000	Y	PNL	25	321	18	135.00	Dangerous! (*N9)
50DP9201 (50DP9201)	1	FDR TO 50DP9201	480	10.53	10.53	6.85	0.01	0.000	Y	PNL	25	8	18	0.29	Category 0
50DP9201 (50DP9201) (50DP9201 MAIN LineSide)	1	FDR TO 50DP9201	480	10.53	10.53	6.85	0.01	0.000	Y	PNL	25	8	18	0.29	Category 0
50LP9201 (50LP9201)	1	FDR TO 50XFMR9201	208	1.95	1.95	1.38	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
50LP9202 (50LP9202)	1	FDR TO 50XFMR9201	208	1.87	1.87	1.34	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
50XFMR9201P (50XFMR9201 PRI)	1	FDR TO 50DP9201	480	9.84	9.84	6.47	0.01	0.000	Y	PNL	25	7	18	0.28	Category 0 (*N5)
50XFMR9201S (50XFMR9201 SEC)	1	FDR TO 50XFMR9201	208	1.97	1.97	1.39	2.00	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N9) (*N15)
70DP9201 (70DP9201)	1	70DP9201 MAIN	480	7.86	7.86	5.34	0.01	0.000	Y	PNL	25	7	18	0.25	Category 0
70DP9201 (70DP9201) (70DP9201 MAIN LineSide)	1	FDR TO 70DP9201	480	7.86	7.86	4.54	0.02	0.000	Y	PNL	25	7	18	0.28	Category 0 (*N3)
70LP9201 (70LP9201)	1	FDR TO 70XFMR9201	208	1.90	1.90	1.35	1.15	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N15)
70LP9202 (70LP9202)	1	FDR TO 70XFMR9202	208	1.90	1.90	1.35	1.15	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N15)
70XFMR9201P (70XFMR9201 PRI)	1	70DP9201 MAIN	480	7.46	7.46	5.11	0.01	0.000	Y	PNL	25	7	18	0.25	Category 0 (*N5)
70XFMR9201S (70XFMR9201 SEC)	1	FDR TO 70XFMR9201	208	1.92	1.92	1.37	1.13	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N15)
70XFMR9202P (70XFMR9202 PRI)	1	70DP9201 MAIN	480	7.46	7.46	5.11	0.01	0.000	Y	PNL	25	7	18	0.25	Category 0 (*N5)
70XFMR9202S (70XFMR9202 SEC)	1	FDR TO 70XFMR9202	208	1.92	1.92	1.37	1.13	0.000	Y	PNL	25	18	18	1.20	Category 0 (*N15)

TAB 13

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 Panelboard, Switchboards, Motor Control Centers 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.

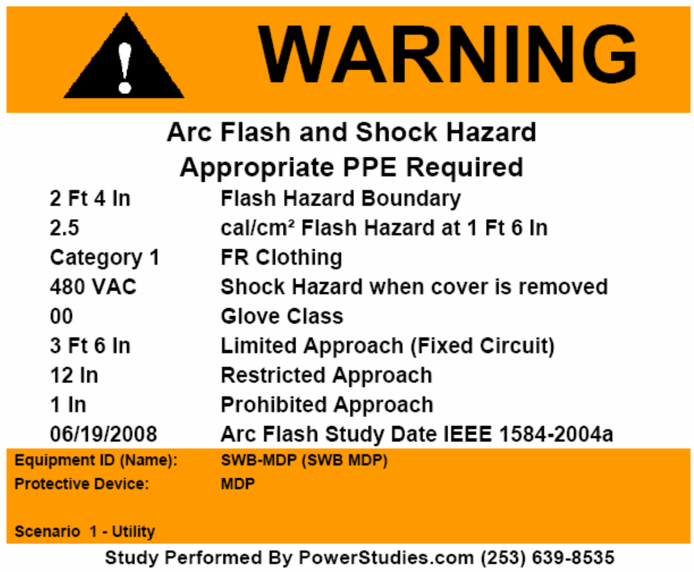


Figure 4 – Example of Bus Side Label

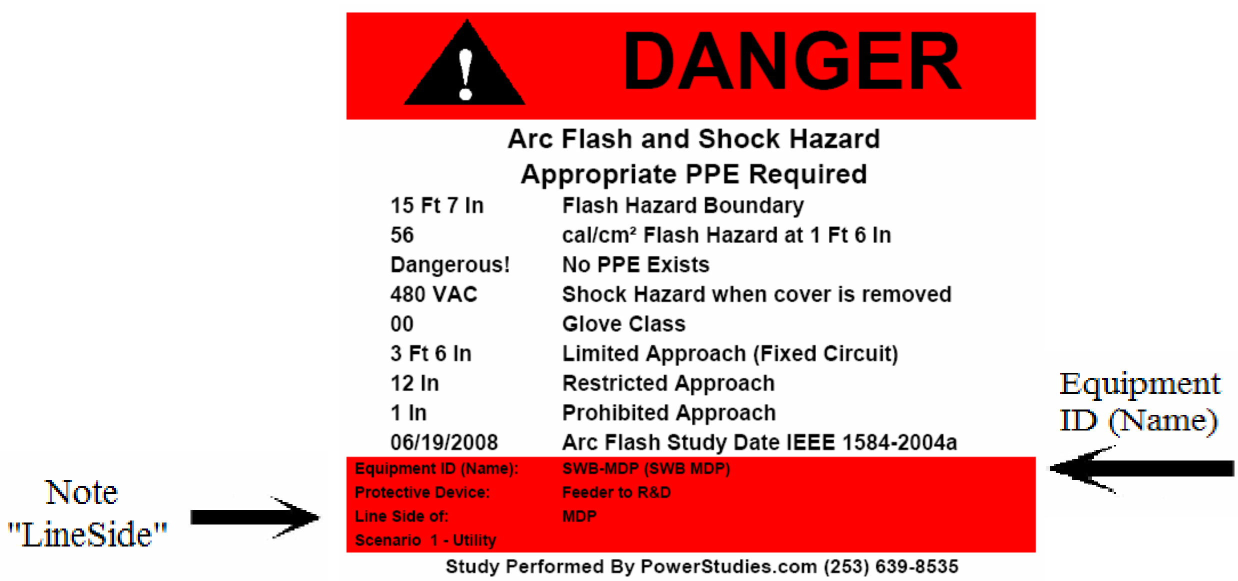


Figure 5 – Example of Line Side of a Protective Device

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
0.44	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	10DP9201 (10DP9201)
Protective Device:	FDR TO 10DP9201

Scenario 1 - Utility Power

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WARNING

Arc Flash and Shock Hazard

0 Ft 10 In	Flash Hazard Boundary
0.44	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	10DP9201 (10DP9201)
Protective Device:	FDR TO 10DP9201
Line Side of:	10DP9201 MAIN

Scenario 1 - Utility Power

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

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	10LP9201 (10LP9201)
Protective Device:	FDR TO 10XFMR9201

Scenario 1 - Utility Power

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WARNING

Arc Flash and Shock Hazard

0 Ft 8 In	Flash Hazard Boundary
0.34	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	10XFMR9201P (10XFMR9201 PRI)
Protective Device:	FDR TO 10DP9201

Scenario 1 - Utility Power

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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	10XFMR9201S (10XFMR9201 SEC)
Protective Device:	FDR TO 10XFMR9201

Scenario 1 - Utility Power

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

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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	20DP9201 (20DP9201)
Protective Device:	FDR TO 20DP9201

Scenario 1 - Utility Power

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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	20LP9201 (20LP9201)
Protective Device:	FDR TO 20XFMR9201

Scenario 1 - Utility Power

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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	20XFMR9201P (20XFMR9201 PRI)
Protective Device:	FDR TO 20DP9201

Scenario 1 - Utility Power

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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	20XFMR9201S (20XFMR9201 SEC)
Protective Device:	FDR TO 20XFMR9201

Scenario 1 - Utility Power

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WARNING

Arc Flash and Shock Hazard

0 Ft 7 In	Flash Hazard Boundary
0.27	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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	30DP9201 (30DP9201)
Protective Device:	FDR TO 30DP9201

Scenario 1 - Utility Power

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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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	30LP9201 (30LP9201)
Protective Device:	FDR TO 30XFMR9201

Scenario 1 - Utility Power

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WARNING

Arc Flash and Shock Hazard

0 Ft 11 In	Flash Hazard Boundary
0.51	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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	30MCC9101 (30MCC9101)
Protective Device:	FDR TO 30MCC9101

Scenario 1 - Utility Power

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WARNING

Arc Flash and Shock Hazard

1 Ft 2 In	Flash Hazard Boundary
0.75	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	30MTS8601 (30MTS8601)
Protective Device:	FDR TO 30MTS8601

Scenario 1 - Utility Power

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WARNING

Arc Flash and Shock Hazard

0 Ft 6 In	Flash Hazard Boundary
0.22	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	30XFMR9201P (30XFMR9201 PRI)
Protective Device:	FDR TO 30DP9201

Scenario 1 - Utility Power

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WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	30XFMR9201S (30XFMR9201 SEC)
Protective Device:	FDR TO 30XFMR9201

Scenario 1 - Utility Power

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WARNING

Arc Flash and Shock Hazard

0 Ft 11 In	Flash Hazard Boundary
0.52	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	40DP9201 (40DP9201)
Protective Device:	FDR TO 40DP9201

Scenario 1 - Utility Power

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WARNING

Arc Flash and Shock Hazard

0 Ft 7 In	Flash Hazard Boundary
0.24	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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	40DP9202 (40DP9202)
Protective Device:	FDR TO 40DP9202

Scenario 1 - Utility Power

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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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	40LP9201 (40LP9201)
Protective Device:	FDR TO 40XFMR9201

Scenario 1 - Utility Power

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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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	40LP9202 (40LP9202)
Protective Device:	FDR TO 40XFMR9202

Scenario 1 - Utility Power

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WARNING

Arc Flash and Shock Hazard

1 Ft 7 In	Flash Hazard Boundary
1.4	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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	40MCC9201 (40MCC9201)
Protective Device:	27-FDR TO 40MCC9201

Scenario 1 - Utility Power

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WARNING

Arc Flash and Shock Hazard

0 Ft 9 In	Flash Hazard Boundary
0.38	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	40XFMR9201P (40XFMR9201 PRI)
Protective Device:	FDR TO 40DP9201

Scenario 1 - Utility Power

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WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	40XFMR9201S (40XFMR9201 SEC)
Protective Device:	FDR TO 40XFMR9201

Scenario 1 - Utility Power

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WARNING

Arc Flash and Shock Hazard

0 Ft 6 In	Flash Hazard Boundary
0.2	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	40XFMR9202P (40XFMR9202 PRI)
Protective Device:	FDR TO 40DP9202

Scenario 1 - Utility Power

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

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	40XFMR9202S (40XFMR9202 SEC)
Protective Device:	FDR TO 40XFMR9202

Scenario 1 - Utility Power

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

WARNING

Arc Flash and Shock Hazard

0 Ft 8 In	Flash Hazard Boundary
0.29	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	50DP9201 (50DP9201)
Protective Device:	FDR TO 50DP9201

Scenario 1 - Utility Power

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

WARNING

Arc Flash and Shock Hazard

0 Ft 8 In	Flash Hazard Boundary
0.29	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	50DP9201 (50DP9201)
Protective Device:	FDR TO 50DP9201
Line Side of:	50DP9201 MAIN

Scenario 1 - Utility Power

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

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	50LP9201 (50LP9201)
Protective Device:	FDR TO 50XFMR9201

Scenario 1 - Utility Power

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

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	50LP9202 (50LP9202)
Protective Device:	FDR TO 50XFMR9201

Scenario 1 - Utility Power

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

WARNING

Arc Flash and Shock Hazard

0 Ft 7 In	Flash Hazard Boundary
0.28	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	50XFMR9201P (50XFMR9201 PRI)
Protective Device:	FDR TO 50DP9201

Scenario 1 - Utility Power

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

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	50XFMR9201S (50XFMR9201 SEC)
Protective Device:	FDR TO 50XFMR9201

Scenario 1 - Utility Power

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

WARNING

Arc Flash and Shock Hazard

0 Ft 7 In	Flash Hazard Boundary
0.25	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	70DP9201 (70DP9201)
Protective Device:	70DP9201 MAIN

Scenario 1 - Utility Power

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

WARNING

Arc Flash and Shock Hazard

0 Ft 7 In	Flash Hazard Boundary
0.28	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	70DP9201 (70DP9201)
Protective Device:	FDR TO 70DP9201
Line Side of:	70DP9201 MAIN

Scenario 1 - Utility Power

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

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	70LP9201 (70LP9201)
Protective Device:	FDR TO 70XFMR9201

Scenario 1 - Utility Power

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

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	70LP9202 (70LP9202)
Protective Device:	FDR TO 70XFMR9202

Scenario 1 - Utility Power

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

WARNING

Arc Flash and Shock Hazard

0 Ft 7 In	Flash Hazard Boundary
0.25	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	70XFMR9201P (70XFMR9201 PRI)
Protective Device:	70DP9201 MAIN

Scenario 1 - Utility Power

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

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	70XFMR9201S (70XFMR9201 SEC)
Protective Device:	FDR TO 70XFMR9201

Scenario 1 - Utility Power

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

WARNING

Arc Flash and Shock Hazard

0 Ft 7 In	Flash Hazard Boundary
0.25	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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	70XFMR9202P (70XFMR9202 PRI)
Protective Device:	70DP9201 MAIN

Scenario 1 - Utility Power

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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	70XFMR9202S (70XFMR9202 SEC)
Protective Device:	FDR TO 70XFMR9202

Scenario 1 - Utility Power

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WARNING

Arc Flash and Shock Hazard

4 Ft 6 In	Flash Hazard Boundary
7.2	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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	10SWBD9101 (10SWBD9101)
Protective Device:	4-FDR TO 10SWBD9101

Scenario 1 - Utility Power

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WARNING

Arc Flash and Shock Hazard

1 Ft 1 In	Flash Hazard Boundary
0.7	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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	10VFD1001 (10VFD1001)
Protective Device:	5-FDR TO 10P1001

Scenario 1 - Utility Power

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

WARNING

Arc Flash and Shock Hazard

1 Ft 1 In	Flash Hazard Boundary
0.7	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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	10VFD1002 (10VFD1002)
Protective Device:	FDR TO 10P1002

Scenario 1 - Utility Power

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

WARNING

Arc Flash and Shock Hazard

1 Ft 1 In	Flash Hazard Boundary
0.7	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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	10VFD1003 (10VFD1003)
Protective Device:	FDR TO 10P1003

Scenario 1 - Utility Power

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

WARNING

Arc Flash and Shock Hazard

7 Ft 1 In	Flash Hazard Boundary
15	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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	15SWGR9001 (15SWGR9001)
Protective Device:	3-15SWGR9001 MN

Scenario 1 - Utility Power

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

DANGER

Arc Flash and Shock Hazard

23 Ft 6 In	Flash Hazard Boundary
109	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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	15SWGR9001 (15SWGR9001)
Protective Device:	1-FDR TO 9001
Line Side of:	3-15SWGR9001 MN

Scenario 1 - Utility Power

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

WARNING

Arc Flash and Shock Hazard

2 Ft 2 In	Flash Hazard Boundary
2.3	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	20MCC9101 (20MCC9101)
Protective Device:	8-FDR TO 20MCC9101

Scenario 1 - Utility Power

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

WARNING

Arc Flash and Shock Hazard

5 Ft 6 In	Flash Hazard Boundary
10	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	30SWBD9001 (30SWBD9001)
Protective Device:	12-30SWBD9001 MN

Scenario 1 - Utility Power

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

DANGER

Arc Flash and Shock Hazard

24 Ft 7 In	Flash Hazard Boundary
118	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	30SWBD9001 (30SWBD9001)
Protective Device:	10-FDR TO 9002
Line Side of:	12-30SWBD9001 MN

Scenario 1 - Utility Power

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

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	30VFD1001 (30VFD1001)
Protective Device:	13-FDR TO 30VFD1001

Scenario 1 - Utility Power

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

WARNING

Arc Flash and Shock Hazard

1 Ft 6 In	Flash Hazard Boundary
1.2	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	30VFD1002 (30VFD1002)
Protective Device:	FDR TO 30VFD1002

Scenario 1 - Utility Power

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

WARNING

Arc Flash and Shock Hazard

1 Ft 2 In	Flash Hazard Boundary
0.75	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	30VFD7600 (30VFD7600)
Protective Device:	FDR TO 30VFD7600

Scenario 1 - Utility Power

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

WARNING

Arc Flash and Shock Hazard

1 Ft 1 In	Flash Hazard Boundary
0.71	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	30VFD8601 (30VFD8601)
Protective Device:	FDR TO 30MTS8601

Scenario 1 - Utility Power

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

WARNING

Arc Flash and Shock Hazard

2 Ft 7 In	Flash Hazard Boundary
2.9	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	40SWBD9101 (40SWBD9101)
Protective Device:	26-FDR TO 40SWBD9101

Scenario 1 - Utility Power

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WARNING

Arc Flash and Shock Hazard

1 Ft 7 In	Flash Hazard Boundary
1.3	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	45VFD1001 (45VFD1001)
Protective Device:	20-FDR TO 45VFD1001

Scenario 1 - Utility Power

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

WARNING

Arc Flash and Shock Hazard

1 Ft 7 In	Flash Hazard Boundary
1.3	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	45VFD1003 (45VFD1003)
Protective Device:	FDR TO 45VFD1003

Scenario 1 - Utility Power

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

WARNING

Arc Flash and Shock Hazard

1 Ft 4 In	Flash Hazard Boundary
0.95	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	45VFD1006 (45VFD1006)
Protective Device:	23-FDR TO 45VFD1006

Scenario 1 - Utility Power

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

WARNING

Arc Flash and Shock Hazard

1 Ft 3 In	Flash Hazard Boundary
0.93	cal/cm^2 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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	45VFD1007 (45VFD1007)
Protective Device:	FDR TO 45VFD1007

Scenario 1 - Utility Power

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

WARNING

Arc Flash and Shock Hazard

5 Ft 10 In	Flash Hazard Boundary
11	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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	46SWBD9101 (46SWBD9101)
Protective Device:	19-FDR TO 46SWBD9101

Scenario 1 - Utility Power

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

WARNING

Arc Flash and Shock Hazard

8 Ft 1 In	Flash Hazard Boundary
19	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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	46SWGR9001 (46SWGR9001)
Protective Device:	18-46SWGR9001 MN

Scenario 1 - Utility Power

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

DANGER

Arc Flash and Shock Hazard

26 Ft 9 In	Flash Hazard Boundary
135	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
04/28/2011	Arc Flash Study Date IEEE 1584-2004a
Equipment ID (Name):	46SWGR9001 (46SWGR9001)
Protective Device:	16-FDR TO 9004
Line Side of:	18-46SWGR9001 MN

Scenario 1 - Utility Power

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TAB 14

Project Name: 1104042-1

CAPTOR (Computer Aided Plotting for Time Overcurrent Reporting)

```
Device Name:     1-FDR TO 9001                         TCC Name:          1-Fdr to 05XFMR9001, 05XFMR9001 Crv, 15SWGR9001 Mn, Fdr to 10SWBD9101, Fdr
Bus Name:        05PMS9001                             Bus Voltage:       16000.0V
Function Name:   Phase
Manufacturer:    S&C
Description:     15E-200E Slow Speed
Type:            SMU-20, 25kV E-Rated
AIC Rating:      13kA                                  Fault Duty:        4117.8A
Cartridge:       SMU-20, 150E 16500V 150A              Curve Multiplier: 1
Time Multiplier: 1                                     Time Adder:        0
Size:            150A
```

```
Device Name:     10-FDR TO 9002                        TCC Name:          3-Fdr to 05XFMR9002, 05XFMR9002 Crv, 30SWBD9001 Mn, Fdr to 00VFD1001, 30VFD
Bus Name:        05PMS9001                             Bus Voltage:       16000.0V
Function Name:   Phase
Manufacturer:    S&C
Description:     15E-200E Slow Speed
Type:            SMU-20, 25kV E-Rated
AIC Rating:      13kA                                  Fault Duty:        4117.8A
Cartridge:       SMU-20, 150E 16500V 150A              Curve Multiplier: 1
Time Multiplier: 1                                     Time Adder:        0
Size:            150A
```

```
Device Name:     16-FDR TO 9004                        TCC Name:          4-Fdr to 05XFMR9004, 05XFMR9004 Crv, 46SWGR9001 Mn, Fdr to 46SWBD9101, Fdr
Bus Name:        05PMS9002                             Bus Voltage:       16000.0V
Function Name:   Phase
Manufacturer:    S&C
Description:     15E-200E Slow Speed
Type:            SMU-20, 25kV E-Rated
AIC Rating:      13kA                                  Fault Duty:        4073.9A
Cartridge:       SMU-20, 150E 16500V 150A              Curve Multiplier: 1
Time Multiplier: 1                                     Time Adder:        0
Size:            150A
```

```
Device Name:     10DP9201 MAIN                         TCC Name:
Bus Name:        10DP9201                              Bus Voltage:       480.0V
Function Name:   Phase
Manufacturer:    CUTLER-HAMMER
Description:     15-225A
Type:            FD
AIC Rating:      25kA                                  Fault Duty:        22009.1A
Frame:           FD 480V 150A                          Curve Multiplier: 1
Time Multiplier: 1                                     Time Adder:        0
Trip:            150A
Setting: 1) Fixed
```

Device Name: FDR TO 10XFMR9201 TCC Name:
Bus Name: 10DP9201 Bus Voltage: 480.0V
Function Name: Phase
Manufacturer: CUTLER-HAMMER
Description: 15-225A
Type: FD
AIC Rating: 25kA Fault Duty: 22009.1A
Frame: FD 480V 30A Curve Multiplier: 1
Time Multiplier: 1 Time Adder: 0
Trip: 30A
Setting: 1) Fixed

Device Name: 5-FDR TO 10P1001 TCC Name: 1-Fdr to 05XFMR9001, 05XFMR9001 Crv, 15SWGR9001 Mn, Fdr to 10SWBD9101, Fdr
Bus Name: 10SWBD9101 Bus Voltage: 480.0V
Function Name: Phase
Manufacturer: SIEMENS
Description: 200-400A
Type: HJXD6-A Sentron
AIC Rating: 65kA Fault Duty: 25864.7A
Frame: HJXD6-A 480V 300A Curve Multiplier: 1
Time Multiplier: 1 Time Adder: 0
Trip: 300A
Setting: 1) Thermal Curve (Fixed
2) INST (LO-HI) LO (1250A)

Device Name: FDR TO 10DP9201 TCC Name:
Bus Name: 10SWBD9101 Bus Voltage: 480.0V
Function Name: Phase
Manufacturer: SIEMENS
Description: 70-250A
Type: HFXD6 Sentron
AIC Rating: 65kA Fault Duty: 25864.7A
Frame: HFXD6 480V 150A Curve Multiplier: 1
Time Multiplier: 1 Time Adder: 0
Trip: 150A
Setting: 1) Thermal Curve (Fixed
2) INST (LO-HI) HI (1500A)

Device Name: FDR TO 10P1002 TCC Name:
Bus Name: 10SWBD9101 Bus Voltage: 480.0V
Function Name: Phase
Manufacturer: SIEMENS
Description: 200-400A
Type: HJXD6-A Sentron
AIC Rating: 65kA Fault Duty: 25864.7A
Frame: HJXD6-A 480V 300A Curve Multiplier: 1
Time Multiplier: 1 Time Adder: 0
Trip: 300A
Setting: 1) Thermal Curve (Fixed
2) INST (LO-HI) LO (1250A)

```
-----------------------------------------------------------------------------------------
Device Name:     FDR TO 10P1003                              TCC Name:
Bus Name:        10SWBD9101                                  Bus Voltage:      480.0V
Function Name:   Phase
Manufacturer:    SIEMENS
Description:     200-400A
Type:            HJXD6-A Sentron
AIC Rating:      65kA                                        Fault Duty:       25864.7A
Frame:           HJXD6-A 480V 300A                           Curve Multiplier: 1
Time Multiplier: 1                                           Time Adder:       0
Trip:            300A
Setting: 1) Thermal Curve (Fixed
         2) INST (LO-HI)          LO          (1250A)

-----------------------------------------------------------------------------------------
Device Name:     FDR TO 70DP9201                             TCC Name:
Bus Name:        10SWBD9101                                  Bus Voltage:      480.0V
Function Name:   Phase
Manufacturer:    SIEMENS
Description:     70-250A
Type:            HFXD6 Sentron
AIC Rating:      65kA                                        Fault Duty:       25864.7A
Frame:           HFXD6 480V 250A                             Curve Multiplier: 1
Time Multiplier: 1                                           Time Adder:       0
Trip:            225A
Setting: 1) Thermal Curve (Fixed
         2) INST (LO-HI)          HI          (2500A)

-----------------------------------------------------------------------------------------
Device Name:     6-10VFD1001 BRK                             TCC Name:         1-Fdr to 05XFMR9001, 05XFMR9001 Crv, 15SWGR9001 Mn, Fdr to 10SWBD9101, Fdr
Bus Name:        10VFD1001                                   Bus Voltage:      480.0V
Function Name:   Phase
Manufacturer:    ALLEN-BRADLEY
Description:     90-250A
Type:            140U-J, J-Frame
AIC Rating:      65kA                                        Fault Duty:       24195.0A
Frame:           140U-J 480V 250A                            Curve Multiplier: 1
Time Multiplier: 1                                           Time Adder:       0
Trip:            250A
Setting: 1) Thermal Curve (Fixed
         2) INST (5-10x)          5X          (1250A)

-----------------------------------------------------------------------------------------
Device Name:     10VFD1002 BRK                               TCC Name:
Bus Name:        10VFD1002                                   Bus Voltage:      480.0V
Function Name:   Phase
Manufacturer:    ALLEN-BRADLEY
Description:     90-250A
Type:            140U-J, J-Frame
AIC Rating:      65kA                                        Fault Duty:       24195.0A
Frame:           140U-J 480V 250A                            Curve Multiplier: 1
Time Multiplier: 1                                           Time Adder:       0
Trip:            250A
Setting: 1) Thermal Curve (Fixed
         2) INST (5-10x)          5X          (1250A)
```

Device Name: 10VFD1003 BRK TCC Name:
Bus Name: 10VFD1003 Bus Voltage: 480.0V
Function Name: Phase
Manufacturer: ALLEN-BRADLEY
Description: 90-250A
Type: 140U-J, J-Frame
AIC Rating: 65kA Fault Duty: 24195.0A
Frame: 140U-J 480V 250A Curve Multiplier: 1
Time Multiplier: 1 Time Adder: 0
Trip: 250A
Setting: 1) Thermal Curve (Fixed
2) INST (5-10x) 5X (1250A)

Device Name: 3-15SWGR9001 MN TCC Name: 1-Fdr to 05XFMR9001, 05XFMR9001 Crv, 15SWGR9001 Mn, Fdr to 10SWBD9101, Fdr
Bus Name: 15SWGR9001 Bus Voltage: 480.0V
Function Name: Phase
Manufacturer: SIEMENS
Description: LSI, 200-3200AP
Type: WL, ETU745, Size II
AIC Rating: 100kA Override:100 ShortTime:85 Fault Duty: 28649.6A
Frame: WLL, Size II 508V 3200A Curve Multiplier: 1
Time Multiplier: 1 Time Adder: 0
Sensor: 3200A
Plug: 1600A
Setting: 1) LTPU, (0.4 - 1 x P) 1 (1600A)
2) LTD-I2t, (2 - 30s) 5.5
3) STPU, (1.25 - 12 x P 2 (3200A)
4) STD, (0.1 - 0.4 x P) 0.2 I^2 t Out
5) INST, (1.5-12 x P), 12 (19200A)

Function Name: Ground
Manufacturer: SIEMENS
Description: GF, 200-3200AP
Type: WL, ETU745, Size II
AIC Rating: 100kA ShortTime:100 Fault Duty: 28649.6A
Frame: WLL, Size II 508V 3200A Curve Multiplier: 1
Time Multiplier: 1 Time Adder: 0
Sensor: 3200A
Plug: 1600A
Setting: 1) Ig, (100 - 1200A) D (900A)
2) tg, (0.1 - 0.5s) 2 I^2 t In

```
-----------------------------------------------------------------------------------------
Device Name:     4-FDR TO 10SWBD9101                     TCC Name:        1-Fdr to 05XFMR9001, 05XFMR9001 Crv, 15SWGR9001 Mn, Fdr to 10SWBD9101, Fdr
Bus Name:        15SWGR9001                              Bus Voltage:     480.0V
Function Name:   Phase
Manufacturer:    SIEMENS
Description:     LSI, 200-3200AP
Type:            WL, ETU745, Size II
AIC Rating:      100kA Override:100 ShortTime:85         Fault Duty:      28649.6A
Frame:           WLL, Size II 508V 3200A                 Curve Multiplier: 1
Time Multiplier: 1                                       Time Adder:      0
Sensor:          3200A
Plug:            1000A
Setting: 1) LTPU, (0.4 - 1 x P)    1           (1000A)
         2) LTD-I2t, (2 - 30s)     8
         3) STPU, (1.25 - 12 x P   2           (2000A)
         4) STD, (0.1 - 0.4 x P)   0.1        I^2 t Out
         5) INST, (1.5-12 x P),    12          (12000A)


Function Name:   Gournd
Manufacturer:    SIEMENS
Description:     GF, 200-3200AP
Type:            WL, ETU745, Size II
AIC Rating:      100kA ShortTime:100                     Fault Duty:      28649.6A
Frame:           WLL, Size II 508V 3200A                 Curve Multiplier: 1
Time Multiplier: 1                                       Time Adder:      0
Sensor:          3200A
Plug:            1000A
Setting: 1) Ig, (100 - 1200A)      C           (600A)
         2) tg, (0.1 - 0.5s)       1          I^2 t In

-----------------------------------------------------------------------------------------
Device Name:     8-FDR TO 20MCC9101                      TCC Name:        2-15SWGR9001 Main, Feeder to 20MCC9101, and 20MCC9101 Largest Breaker.tcc
Bus Name:        15SWGR9001                              Bus Voltage:     480.0V
Function Name:   Phase
Manufacturer:    SIEMENS
Description:     LSI, 200-3200AP
Type:            WL, ETU745, Size II
AIC Rating:      100kA Override:100 ShortTime:85         Fault Duty:      28649.6A
Frame:           WLL, Size II 508V 1600A                 Curve Multiplier: 1
Time Multiplier: 1                                       Time Adder:      0
Sensor:          1600A
Plug:            600A
Setting: 1) LTPU, (0.4 - 1 x P)    1           (600A)
         2) LTD-I2t, (2 - 30s)     3.5
         3) STPU, (1.25 - 12 x P   3           (1800A)
         4) STD, (0.1 - 0.4 x P)   0.1        I^2 t Out
         5) INST, (1.5-12 x P),    12          (7200A)


Function Name:   Ground
Manufacturer:    SIEMENS
Description:     GF, 200-3200AP
Type:            WL, ETU745, Size II
AIC Rating:      100kA ShortTime:100                     Fault Duty:      28649.6A
Frame:           WLL, Size II 508V 1600A                 Curve Multiplier: 1
Time Multiplier: 1                                       Time Adder:      0
Sensor:          1600A
Plug:            600A
Setting: 1) Ig, (100 - 1200A)      B           (300A)
         2) tg, (0.1 - 0.5s)       1          I^2 t In
```

```
---------------------------------------------------------------------------------------
Device Name:     FDR TO 20XFMR9201                          TCC Name:
Bus Name:        20DP9201                                   Bus Voltage:      480.0V
Function Name:   Phase
Manufacturer:    CUTLER-HAMMER
Description:     15-225A
Type:            FD
AIC Rating:      25kA                                       Fault Duty:       16059.2A
Frame:           FD 480V 30A                                Curve Multiplier: 1
Time Multiplier: 1                                          Time Adder:       0
Trip:            30A
Setting: 1) Fixed

---------------------------------------------------------------------------------------
Device Name:     9-20MCC9101 LRG                            TCC Name:         2-15SWGR9001 Main, Feeder to 20MCC9101, and 20MCC9101 Largest Breaker.tcc
Bus Name:        20MCC9101                                  Bus Voltage:      480.0V
Function Name:   Phase
Manufacturer:    ALLEN-BRADLEY
Description:     70-250A, UL
Type:            140U-JD3, JD6
AIC Rating:      35kA                                       Fault Duty:       25546.9A
Frame:           140U-JD3 480V 250A                         Curve Multiplier: 1
Time Multiplier: 1                                          Time Adder:       0
Trip:            150A
Setting: 1) Thermal Curve (Fixed
         2) INST (5X - 10X x In)   10X          (1500A)

---------------------------------------------------------------------------------------
Device Name:     FDR TO 20DP9201                            TCC Name:
Bus Name:        20MCC9101                                  Bus Voltage:      480.0V
Function Name:   Phase
Manufacturer:    ALLEN-BRADLEY
Description:     15-150A, 3 Pole
Type:            140U-I3, I6
AIC Rating:      35kA                                       Fault Duty:       25546.9A
Frame:           140U-I3 480V 30A                           Curve Multiplier: 1
Time Multiplier: 1                                          Time Adder:       0
Trip:            30A
Setting: 1) Opening Clearing Cur

---------------------------------------------------------------------------------------
Device Name:     FDR TO 30XFMR9201                          TCC Name:
Bus Name:        30DP9201                                   Bus Voltage:      480.0V
Function Name:   Phase
Manufacturer:    CUTLER-HAMMER
Description:     15-225A
Type:            FD
AIC Rating:      25kA                                       Fault Duty:       13015.7A
Frame:           FD 480V 50A                                Curve Multiplier: 1
Time Multiplier: 1                                          Time Adder:       0
Trip:            50A
Setting: 1) Fixed
```

```
-----------------------------------------------------------------------------------------
Device Name:     12-30SWBD9001 MN                        TCC Name:        3-Fdr to 05XFMR9002, 05XFMR9002 Crv, 30SWBD9001 Mn, Fdr to 00VFD1001, 30VFI
Bus Name:        30SWBD9001                              Bus Voltage:     480.0V
Function Name:   Phase
Manufacturer:    SIEMENS
Description:     LSI, 200-3200AP
Type:            WL, ETU745, Size II
AIC Rating:      100kA Override:100 ShortTime:85         Fault Duty:      30586.6A
Frame:           WLL, Size II 508V 3200A                 Curve Multiplier: 1
Time Multiplier: 1                                       Time Adder:      0
Sensor:          3200A
Plug:            2000A
Setting: 1) LTPU, (0.4 - 1 x P)    1            (2000A)
         2) LTD-I2t, (2 - 30s)     30
         3) STPU, (1.25 - 12 x P   4            (8000A)
         4) STD, (0.1 - 0.4 x P)   0.1         I^2 t Out
         5) INST, (1.5-12 x P),    12           (24000A)


Function Name:   Ground
Manufacturer:    SIEMENS
Description:     GF, 200-3200AP
Type:            WL, ETU745, Size II
AIC Rating:      100kA ShortTime:100                     Fault Duty:      30586.6A
Frame:           WLL, Size II 508V 3200A                 Curve Multiplier: 1
Time Multiplier: 1                                       Time Adder:      0
Sensor:          3200A
Plug:            2000A
Setting: 1) Ig, (100 - 1200A)      E            (1200A)
         2) tg, (0.1 - 0.5s)       1           I^2 t In

-----------------------------------------------------------------------------------------
Device Name:     13-FDR TO 30VFD1001                     TCC Name:        3-Fdr to 05XFMR9002, 05XFMR9002 Crv, 30SWBD9001 Mn, Fdr to 00VFD1001, 30VFI
Bus Name:        30SWBD9001                              Bus Voltage:     480.0V
Function Name:   Phase
Manufacturer:    SIEMENS
Description:     800-1200A
Type:            NG, 525
AIC Rating:      65kA                                    Fault Duty:      30586.6A
Frame:           HNG 480V 1000A                          Curve Multiplier: 1
Time Multiplier: 1                                       Time Adder:      0
Trip:            1000A
Setting: 1) Thermal Curve (Fixed
         2) INST  (5-10kA)         5000         (5000A)

-----------------------------------------------------------------------------------------
Device Name:     FDR TO 30DP9201                         TCC Name:
Bus Name:        30SWBD9001                              Bus Voltage:     480.0V
Function Name:   Phase
Manufacturer:    SIEMENS
Description:     70-250A
Type:            HFXD6 Sentron
AIC Rating:      65kA                                    Fault Duty:      30586.6A
Frame:           HFXD6 480V 150A                         Curve Multiplier: 1
Time Multiplier: 1                                       Time Adder:      0
Trip:            150A
Setting: 1) Thermal Curve (Fixed
         2) INST (LO-HI)           HI           (1500A)
```

```
---------------------------------------------------------------------------------------
Device Name:     FDR TO 30MCC9101                          TCC Name:
Bus Name:        30SWBD9001                                Bus Voltage:      480.0V
Function Name:   Phase
Manufacturer:    SIEMENS
Description:     70-250A
Type:            HFXD6 Sentron
AIC Rating:      65kA                                      Fault Duty:       30586.6A
Frame:           HFXD6 480V 150A                           Curve Multiplier: 1
Time Multiplier: 1                                         Time Adder:       0
Trip:            150A
Setting: 1) Thermal Curve (Fixed
         2) INST (LO-HI)          HI          (1500A)

---------------------------------------------------------------------------------------
Device Name:     FDR TO 30MTS8601                          TCC Name:
Bus Name:        30SWBD9001                                Bus Voltage:      480.0V
Function Name:   Phase
Manufacturer:    SIEMENS
Description:     200-400A
Type:            HJXD6-A Sentron
AIC Rating:      65kA                                      Fault Duty:       30586.6A
Frame:           HJXD6-A 480V 300A                         Curve Multiplier: 1
Time Multiplier: 1                                         Time Adder:       0
Trip:            300A
Setting: 1) Thermal Curve (Fixed
         2) INST (LO-HI)          LO          (1250A)

---------------------------------------------------------------------------------------
Device Name:     FDR TO 30VFD1002                          TCC Name:
Bus Name:        30SWBD9001                                Bus Voltage:      480.0V
Function Name:   Phase
Manufacturer:    SIEMENS
Description:     800-1200A
Type:            NG, 525
AIC Rating:      65kA                                      Fault Duty:       30586.6A
Frame:           HNG 480V 1000A                            Curve Multiplier: 1
Time Multiplier: 1                                         Time Adder:       0
Trip:            1000A
Setting: 1) Thermal Curve (Fixed
         2) INST  (5-10kA)        5000        (5000A)

---------------------------------------------------------------------------------------
Device Name:     FDR TO 30VFD7600                          TCC Name:
Bus Name:        30SWBD9001                                Bus Voltage:      480.0V
Function Name:   Phase
Manufacturer:    SIEMENS
Description:     200-400A
Type:            HJXD6-A Sentron
AIC Rating:      65kA                                      Fault Duty:       30586.6A
Frame:           HJXD6-A 480V 300A                         Curve Multiplier: 1
Time Multiplier: 1                                         Time Adder:       0
Trip:            300A
Setting: 1) Thermal Curve (Fixed
         2) INST (LO-HI)          LO          (1250A)
```

```
------------------------------------------------------------------------------------------
Device Name:     14-30VFD1001 BRK                          TCC Name:          3-Fdr to 05XFMR9002, 05XFMR9002 Crv, 30SWBD9001 Mn, Fdr to 00VFD1001, 30VFD
Bus Name:        30VFD1001                                 Bus Voltage:       480.0V
Function Name:   Phase
Manufacturer:    ALLEN-BRADLEY
Description:     LSI, 600-1200A Fixed Plug
Type:            140U-N
AIC Rating:      50kA                                      Fault Duty:        29346.8A
Frame:           140U-N 480V 1200A                         Curve Multiplier: 1
Time Multiplier: 1                                         Time Adder:        0
Sensor:          1200A
Plug:            1200A
Setting: 1) LTPU (1.0 x P)         Fixed        (1200A)
         2) LTD (Fixed)            Fixed
         3) STPU (2-8 x P)         3            (3600A)
         4) STD (Fixed)            Fixed       I^2 t Out
         5) INST (14000A)          Fixed        (14000A)

------------------------------------------------------------------------------------------
Device Name:     30VFD1002 BRK                             TCC Name:
Bus Name:        30VFD1002                                 Bus Voltage:       480.0V
Function Name:   Phase
Manufacturer:    ALLEN-BRADLEY
Description:     LSI, 600-1200A Fixed Plug
Type:            140U-N
AIC Rating:      50kA                                      Fault Duty:        29346.8A
Frame:           140U-N 480V 1200A                         Curve Multiplier: 1
Time Multiplier: 1                                         Time Adder:        0
Sensor:          1200A
Plug:            1200A
Setting: 1) LTPU (1.0 x P)         Fixed        (1200A)
         2) LTD (Fixed)            Fixed
         3) STPU (2-8 x P)         3            (3600A)
         4) STD (Fixed)            Fixed       I^2 t Out
         5) INST (14000A)          Fixed        (14000A)

------------------------------------------------------------------------------------------
Device Name:     30VFD7600 BRK                             TCC Name:
Bus Name:        30VFD7600                                 Bus Voltage:       480.0V
Function Name:   Phase
Manufacturer:    ALLEN-BRADLEY
Description:     90-250A
Type:            140U-J, J-Frame
AIC Rating:      65kA                                      Fault Duty:        28222.1A
Frame:           140U-J 480V 250A                          Curve Multiplier: 1
Time Multiplier: 1                                         Time Adder:        0
Trip:            250A
Setting: 1) Thermal Curve (Fixed
         2) INST (5-10x)           5X           (1250A)
```

```
------------------------------------------------------------------------------------------
Device Name:     30VFD8601 BRK                          TCC Name:
Bus Name:        30VFD8601                              Bus Voltage:     480.0V
Function Name:   Phase
Manufacturer:    ALLEN-BRADLEY
Description:     90-250A
Type:            140U-J, J-Frame
AIC Rating:      65kA                                   Fault Duty:      25504.1A
Frame:           140U-J 480V 250A                       Curve Multiplier: 1
Time Multiplier: 1                                      Time Adder:      0
Trip:            250A
Setting: 1) Thermal Curve (Fixed
         2) INST (5-10x)          5X           (1250A)

------------------------------------------------------------------------------------------
Device Name:     FDR TO 40XFMR9201                      TCC Name:
Bus Name:        40DP9201                               Bus Voltage:     480.0V
Function Name:   Phase
Manufacturer:    CUTLER-HAMMER
Description:     15-225A
Type:            FD
AIC Rating:      25kA                                   Fault Duty:      26416.5A
Frame:           FD 480V 30A                            Curve Multiplier: 1
Time Multiplier: 1                                      Time Adder:      0
Trip:            30A
Setting: 1) Fixed

------------------------------------------------------------------------------------------
Device Name:     FDR TO 40XFMR9202                      TCC Name:
Bus Name:        40DP9202                               Bus Voltage:     480.0V
Function Name:   Phase
Manufacturer:    CUTLER-HAMMER
Description:     15-225A
Type:            FD
AIC Rating:      25kA                                   Fault Duty:      11428.8A
Frame:           FD 480V 60A                            Curve Multiplier: 1
Time Multiplier: 1                                      Time Adder:      0
Trip:            60A
Setting: 1) Fixed

------------------------------------------------------------------------------------------
Device Name:     27-FDR TO 40MCC9201                    TCC Name:        6-46SWGR9001 Main, Feeder to 40SWBD9101, and Feeder to 40MCC9201.tcc
Bus Name:        40SWBD9101                             Bus Voltage:     480.0V
Function Name:   Phase
Manufacturer:    SIEMENS
Description:     15-125A
Type:            HEB, 2-4 Pole
AIC Rating:      65kA                                   Fault Duty:      33450.1A
Frame:           HEB 480V 100A                          Curve Multiplier: 1
Time Multiplier: 1                                      Time Adder:      0
Trip:            100A
Setting: 1) Thermal Curve (Fixed
         2) INST (Fixed)          1030A        (1030A)
```

```
Device Name:     21-45VFD1001 BRK                        TCC Name:        4-Fdr to 05XFMR9004, 05XFMR9004 Crv, 46SWGR9001 Mn, Fdr to 46SWBD9101, Fdr
Bus Name:        45VFD1001                               Bus Voltage:     480.0V
Function Name:   Phase
Manufacturer:    ALLEN-BRADLEY
Description:     LSI, 600-1200A Fixed Plug
Type:            140U-N
AIC Rating:      50kA                                    Fault Duty:      32066.3A
Frame:           140U-N 480V 1200A                       Curve Multiplier: 1
Time Multiplier: 1                                       Time Adder:      0
Sensor:          1200A
Plug:            1200A
Setting: 1) LTPU (1.0 x P)        Fixed       (1200A)
         2) LTD (Fixed)           Fixed
         3) STPU (2-8 x P)        3           (3600A)
         4) STD (Fixed)           Fixed      I^2 t Out
         5) INST (14000A)         Fixed       (14000A)
```

```
Device Name:     45VFD1003 BRK                           TCC Name:
Bus Name:        45VFD1003                               Bus Voltage:     480.0V
Function Name:   Phase
Manufacturer:    ALLEN-BRADLEY
Description:     LSI, 600-1200A Fixed Plug
Type:            140U-N
AIC Rating:      50kA                                    Fault Duty:      32066.3A
Frame:           140U-N 480V 1200A                       Curve Multiplier: 1
Time Multiplier: 1                                       Time Adder:      0
Sensor:          1200A
Plug:            1200A
Setting: 1) LTPU (1.0 x P)        Fixed       (1200A)
         2) LTD (Fixed)           Fixed
         3) STPU (2-8 x P)        3           (3600A)
         4) STD (Fixed)           Fixed      I^2 t Out
         5) INST (14000A)         Fixed       (14000A)
```

```
Device Name:     24-45VFD1006 BRK                        TCC Name:        5-Feeder to 46SWBD9101, Feeder to 45VFD1006, 45VFD1006 Breaker, and 45P1006
Bus Name:        45VFD1006                               Bus Voltage:     480.0V
Function Name:   Phase
Manufacturer:    ALLEN-BRADLEY
Description:     100-400A, 3-Pole
Type:            140U-K3, K6
AIC Rating:      65kA                                    Fault Duty:      26580.7A
Frame:           140U-K6 480V 400A                       Curve Multiplier: 1
Time Multiplier: 1                                       Time Adder:      0
Trip:            350A
Setting: 1) Thermal Curve (Fixed
         2) INST (5X-10X)         5X          (1750A)
```

```
Device Name:     45VFD1007 BRK                          TCC Name:
Bus Name:        45VFD1007                              Bus Voltage:      480.0V
Function Name:   Phase
Manufacturer:    ALLEN-BRADLEY
Description:     100-400A, 3-Pole
Type:            140U-K3, K6
AIC Rating:      65kA                                   Fault Duty:       25476.1A
Frame:           140U-K6 480V 400A                      Curve Multiplier: 1
Time Multiplier: 1                                      Time Adder:       0
Trip:            350A
Setting: 1) Thermal Curve (Fixed
        2) INST (5X-10X)         5X          (1750A)
```

```
Device Name:     20-FDR TO 45VFD1001                    TCC Name:         4-Fdr to 05XFMR9004, 05XFMR9004 Crv, 46SWGR9001 Mn, Fdr to 46SWBD9101, Fdr
Bus Name:        46SWBD9101                             Bus Voltage:      480.0V
Function Name:   Phase
Manufacturer:    SIEMENS
Description:     800-1200A
Type:            NG, 525
AIC Rating:      65kA                                   Fault Duty:       33777.2A
Frame:           HNG 480V 1000A                         Curve Multiplier: 1
Time Multiplier: 1                                      Time Adder:       0
Trip:            1000A
Setting: 1) Thermal Curve (Fixed
        2) INST  (5-10kA)        5000        (5000A)
```

```
Device Name:     23-FDR TO 45VFD1006                    TCC Name:         5-Feeder to 46SWBD9101, Feeder to 45VFD1006, 45VFD1006 Breaker, and 45P1006
Bus Name:        46SWBD9101                             Bus Voltage:      480.0V
Function Name:   Phase
Manufacturer:    SIEMENS
Description:     200-400A
Type:            HJXD6-A Sentron
AIC Rating:      65kA                                   Fault Duty:       33777.2A
Frame:           HJXD6-A 480V 400A                      Curve Multiplier: 1
Time Multiplier: 1                                      Time Adder:       0
Trip:            350A
Setting: 1) Thermal Curve (Fixed
        2) INST (LO-HI)          LO          (2000A)
```

```
Device Name:     FDR TO 40DP9201                        TCC Name:
Bus Name:        46SWBD9101                             Bus Voltage:      480.0V
Function Name:   Phase
Manufacturer:    SIEMENS
Description:     70-250A
Type:            HFXD6 Sentron
AIC Rating:      65kA                                   Fault Duty:       33777.2A
Frame:           HFXD6 480V 150A                        Curve Multiplier: 1
Time Multiplier: 1                                      Time Adder:       0
Trip:            150A
Setting: 1) Thermal Curve (Fixed
        2) INST (LO-HI)          HI          (1500A)
```

```
Device Name:     FDR TO 40DP9202                        TCC Name:
Bus Name:        46SWBD9101                             Bus Voltage:      480.0V
Function Name:   Phase
Manufacturer:    SIEMENS
Description:     70-250A
Type:            HFXD6 Sentron
AIC Rating:      65kA                                   Fault Duty:       33777.2A
Frame:           HFXD6 480V 150A                        Curve Multiplier: 1
Time Multiplier: 1                                      Time Adder:       0
Trip:            150A
Setting: 1) Thermal Curve (Fixed
         2) INST (LO-HI)          HI          (1500A)
```

```
Device Name:     FDR TO 45VFD1003                       TCC Name:
Bus Name:        46SWBD9101                             Bus Voltage:      480.0V
Function Name:   Phase
Manufacturer:    SIEMENS
Description:     800-1200A
Type:            NG, 525
AIC Rating:      65kA                                   Fault Duty:       33777.2A
Frame:           HNG 480V 1000A                         Curve Multiplier: 1
Time Multiplier: 1                                      Time Adder:       0
Trip:            1000A
Setting: 1) Thermal Curve (Fixed
         2) INST  (5-10kA)        5000        (5000A)
```

```
Device Name:     FDR TO 45VFD1007                       TCC Name:
Bus Name:        46SWBD9101                             Bus Voltage:      480.0V
Function Name:   Phase
Manufacturer:    SIEMENS
Description:     200-400A
Type:            HJXD6-A Sentron
AIC Rating:      65kA                                   Fault Duty:       33777.2A
Frame:           HJXD6-A 480V 400A                      Curve Multiplier: 1
Time Multiplier: 1                                      Time Adder:       0
Trip:            350A
Setting: 1) Thermal Curve (Fixed
         2) INST (LO-HI)          LO          (2000A)
```

```
Device Name:     FDR TO 50DP9201                        TCC Name:
Bus Name:        46SWBD9101                             Bus Voltage:      480.0V
Function Name:   Phase
Manufacturer:    SIEMENS
Description:     70-250A
Type:            HFXD6 Sentron
AIC Rating:      65kA                                   Fault Duty:       33777.2A
Frame:           HFXD6 480V 250A                        Curve Multiplier: 1
Time Multiplier: 1                                      Time Adder:       0
Trip:            225A
Setting: 1) Thermal Curve (Fixed
         2) INST (LO-HI)          HI          (2500A)
```

```
-------------------------------------------------------------------------------------------
Device Name:     18-46SWGR9001 MN                           TCC Name:         4-Fdr to 05XFMR9004, 05XFMR9004 Crv, 46SWGR9001 Mn, Fdr to 46SWBD9101, Fdr
Bus Name:        46SWGR9001                                 Bus Voltage:      480.0V
Function Name:   Phase
Manufacturer:    SIEMENS
Description:     LSI, 800-5000AP
Type:            WL, ETU745, Size III
AIC Rating:      100kA Override:100 ShortTime:100           Fault Duty:       35434.3A
Frame:           WLL, Size III 508V 4000A                   Curve Multiplier: 1
Time Multiplier: 1                                          Time Adder:       0
Sensor:          4000A
Plug:            2500A
Setting: 1) LTPU, (0.4 - 1 x P)    1            (2500A)
         2) LTD-I2t, (2 - 30s)     30
         3) STPU, (1.25 - 12 x P   4            (10000A)
         4) STD, (0.1 - 0.4 x P)   0.2         I^2 t Out
         5) INST, (1.5-12 x P),    12           (30000A)


Function Name:   Ground
Manufacturer:    SIEMENS
Description:     GF, 800-5000AP
Type:            WL, ETU745, Size III
AIC Rating:      100kA ShortTime:100                        Fault Duty:       35434.3A
Frame:           WLL, Size III 508V 4000A                   Curve Multiplier: 1
Time Multiplier: 1                                          Time Adder:       0
Sensor:          4000A
Plug:            2500A
Setting: 1) Ig, (400 - 1200A)      E            (1200A)
         2) tg, (0.1 - 0.5s)       2           I^2 t In

-------------------------------------------------------------------------------------------
Device Name:     19-FDR TO 46SWBD9101                       TCC Name:         4-Fdr to 05XFMR9004, 05XFMR9004 Crv, 46SWGR9001 Mn, Fdr to 46SWBD9101, Fdr
Bus Name:        46SWGR9001                                 Bus Voltage:      480.0V
Function Name:   Phase
Manufacturer:    SIEMENS
Description:     LSI, 800-5000AP
Type:            WL, ETU745, Size III
AIC Rating:      100kA Override:100 ShortTime:100           Fault Duty:       35434.3A
Frame:           WLL, Size III 508V 4000A                   Curve Multiplier: 1
Time Multiplier: 1                                          Time Adder:       0
Sensor:          4000A
Plug:            2000A
Setting: 1) LTPU, (0.4 - 1 x P)    1            (2000A)
         2) LTD-I2t, (2 - 30s)     30
         3) STPU, (1.25 - 12 x P   4            (8000A)
         4) STD, (0.1 - 0.4 x P)   0.1         I^2 t Out
         5) INST, (1.5-12 x P),    12           (24000A)


Function Name:   Ground
Manufacturer:    SIEMENS
Description:     GF, 800-5000AP
Type:            WL, ETU745, Size III
AIC Rating:      100kA ShortTime:100                        Fault Duty:       35434.3A
Frame:           WLL, Size III 508V 4000A                   Curve Multiplier: 1
Time Multiplier: 1                                          Time Adder:       0
Sensor:          4000A
Plug:            2000A
Setting: 1) Ig, (400 - 1200A)      C            (800A)
         2) tg, (0.1 - 0.5s)       1           I^2 t In
```

```
Device Name:     26-FDR TO 40SWBD9101                  TCC Name:         6-46SWGR9001 Main, Feeder to 40SWBD9101, and Feeder to 40MCC9201.tcc
Bus Name:        46SWGR9001                            Bus Voltage:      480.0V
Function Name:   Phase
Manufacturer:    SIEMENS
Description:     LSI, 200-1200AP
Type:            WL, ETU745, Size I
AIC Rating:      100kA Override:100 ShortTime:65       Fault Duty:       35434.3A
Frame:           WLL, Size I 508V 800A                 Curve Multiplier: 1
Time Multiplier: 1                                     Time Adder:       0
Sensor:          800A
Plug:            600A
Setting: 1) LTPU, (0.4 - 1 x P)    1          (600A)
         2) LTD-I2t, (2 - 30s)     2
         3) STPU, (1.25-12 x P)    2.5        (1500A)
         4) STD, (0.1 - 0.4 x P)   0.1        I^2 t Out
         5) INST, (1.5-12 x P),    12         (7200A)


Function Name:   Ground
Manufacturer:    SIEMENS
Description:     GF, 200-1200AP
Type:            WL, ETU745, Size I
AIC Rating:      100kA ShortTime:100                   Fault Duty:       35434.3A
Frame:           WLL, Size I 508V 800A                 Curve Multiplier: 1
Time Multiplier: 1                                     Time Adder:       0
Sensor:          800A
Plug:            600A
Setting: 1) Ig, (100 - 1200A)      B          (300A)
         2) tg, (0.1 - 0.5s)       0.1        I^2 t In
```

```
Device Name:     50DP9201 MAIN                         TCC Name:
Bus Name:        50DP9201                              Bus Voltage:      480.0V
Function Name:   Phase
Manufacturer:    CUTLER-HAMMER
Description:     15-225A
Type:            FD
AIC Rating:      25kA                                  Fault Duty:       10532.8A
Frame:           FD 480V 225A                          Curve Multiplier: 1
Time Multiplier: 1                                     Time Adder:       0
Trip:            225A
Setting: 1) Fixed
```

```
Device Name:     FDR TO 50XFMR9201                     TCC Name:
Bus Name:        50DP9201                              Bus Voltage:      480.0V
Function Name:   Phase
Manufacturer:    CUTLER-HAMMER
Description:     15-225A
Type:            FD
AIC Rating:      25kA                                  Fault Duty:       10532.8A
Frame:           FD 480V 60A                           Curve Multiplier: 1
Time Multiplier: 1                                     Time Adder:       0
Trip:            60A
Setting: 1) Fixed
```

```
Device Name:     70DP9201 MAIN                         TCC Name:
Bus Name:        70DP9201                              Bus Voltage:      480.0V
Function Name:   Phase
Manufacturer:    CUTLER-HAMMER
Description:     70-250A
Type:            JD
AIC Rating:      35kA                                  Fault Duty:       7858.7A
Frame:           JD 480V 225A                          Curve Multiplier: 1
Time Multiplier: 1                                     Time Adder:       0
Trip:            225A
Setting: 1) Thermal Curve (Fixed
         2) INST (5-10 x Trip)     10          (2250A)
```

```
Device Name:     FDR TO 70XFMR9202                     TCC Name:
Bus Name:        70DP9201                              Bus Voltage:      480.0V
Function Name:   Phase
Manufacturer:    CUTLER-HAMMER
Description:     15-225A
Type:            FD
AIC Rating:      25kA                                  Fault Duty:       7858.7A
Frame:           FD 480V 30A                           Curve Multiplier: 1
Time Multiplier: 1                                     Time Adder:       0
Trip:            30A
Setting: 1) Fixed
```

```
Device Name:     FDR TO 70XFMR9201                     TCC Name:
Bus Name:        70DP9201                              Bus Voltage:      480.0V
Function Name:   Phase
Manufacturer:    CUTLER-HAMMER
Description:     15-225A
Type:            FD
AIC Rating:      25kA                                  Fault Duty:       7858.7A
Frame:           FD 480V 30A                           Curve Multiplier: 1
Time Multiplier: 1                                     Time Adder:       0
Trip:            30A
Setting: 1) Fixed
```

TAB 15

Please go to the Salisbury website to look at PPE gear and download a catalog.

http://www.whsalisbury.com/arc/arc.htm