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Operation and Maintenance Manuals

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SHORT-CIRCUIT, OVERCURRENT DEVICE COORDINATION, & ARC FLASH HAZARD ANALYSES

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DISCLAIMER

The following report was prepared by the Power System Engineering group of Schneider Electric Engineering Services, LLC (SEES) utilizing industry-accepted standards and practices along with the proprietary methodologies and analysis tools of SEES. Data used in this analysis was acquired by Power System Engineering and provided by others, through onsite discovery, published information, equipment nameplates, manufacturer ratings, testing, analysis, or other means. SEES assumes no responsibility for inaccuracies in data provided by others. The study is intended for use by qualified individuals to facilitate the installation, operation, maintenance, and safety of the electrical power system depicted. Modification of equipment, changes to system configuration, adjustment of protective device settings, or failure to properly maintain equipment may invalidate these results.

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1 EXECUTIVE SUMMARY

1.1 Overview

This report documents the results of a Power System Engineering analysis for the Kelly Walsh HS in Casper, WY. The objective of this section is to briefly summarize the results of the analysis and highlight key issues and findings in the electrical distribution equipment. For items addressed by equipment, conductor, or device settings changes, the power system study results may need to be re-evaluated in a revision to this study. The full analysis can be found in the main body of the report.

The scope of this study is limited to that equipment shown on the study one-line diagram located in the back of the report. Unless specifically required by job specifications, branch circuit utilization equipment, as defined per NEC Article 100, was not included in this study (this may consist of small equipment, 100A and less, such as: safety switches, industrial control panels, and enclosed starters/drives).

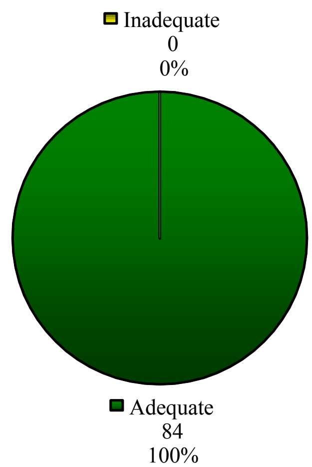
1.2 Revision History

This section will document revision history after the initial study has been submitted. Subsequent revision numbers are each listed on the front cover of the report and are explained below by indicating the following details: date of issue, reason for revision, and who initiated the revision. When necessary, engineer’s comments and/or pertinent emails will be referred to in the references section of the report.

1.3 Study Highlights

1.3.1 Short-Circuit Results

Of the device locations evaluated for adequacy to interrupt or withstand the maximum three-phase short-circuit current to which they could be subjected, none were identified to be INADEQUATE.



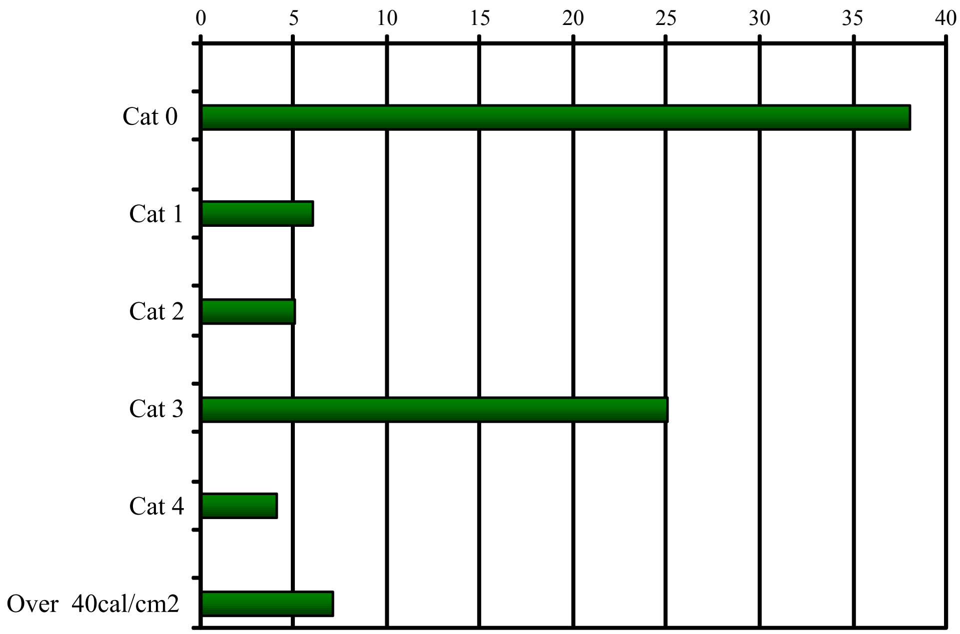
Graph of equipment short-circuit capability

1.3.2 Coordination Results

Setting recommendations have been made for the adjustable devices, to ensure optimum selectivity, reduce arc flash, or protect equipment. Overall, the coordination study showed that acceptable levels of selectivity were achieved among devices in the system except as shown on TCC-12 E1B1, TCC-13 E1B1, TCC-21 MDPH2, TCC-22 E2B1, TCC-23 E2B1, EMER TCC-01 and EMER TCC-02.

1.3.3 Arc Flash Results

Equipment locations were analyzed to determine the level of arc flash incident energy to which a worker might be exposed during an arc flash event. The majority of locations were determined to be category 0 (lowest). The highest category for which personal protective equipment may be used is category 4. It is not recommended work be performed live for equipment with the "Over 40 cal./cm^2" designation (seven locations).



Graph of arc flash hazard category occurrence

2 INTRODUCTION

This report has the following components:

- ☑ Studies were performed using Power*Tools for Windows Software, version 7.0.3.3 Build 1.

- ☑ The system short-circuit analysis evaluates the adequacy of the distribution equipment shown on the enclosed one-line diagrams to withstand or to interrupt the calculated maximum available short-circuit current at its location.

- ☑ The overcurrent device time-current coordination analysis determines the suggested settings and, where appropriate, the ampere ratings and types for the electrical power system protective devices to achieve the desired system protection and electrical service continuity goals.

- ☑ The flash hazard analysis establishes the arc flash boundary around electrical equipment within which a worker exposed to an arcing fault would expect to receive 2^{nd} degree burns if not adequately protected. The analysis also determines the incident energy levels at specific working distances from equipment, which can be used to select appropriate personal protective equipment (PPE) to be worn when working within the arc flash boundary.

- ☑ This report supersedes and invalidates results from any prior study for the scope of equipment being reviewed.

- ☑ Electrical system changes within the facility or in the utility system can have a significant impact on the results of this power system analysis, which is a “snapshot” of as-found system conditions. As such, it is recommended that this analysis be re-evaluated on a regular basis, not to exceed 5 years, to account for electrical system changes. NFPA 70B and 70E address the issue of equipment maintenance and failure to properly maintain equipment may invalidate these results

- ☑ A “REFERENCES” section near the end of the report cites who supplied information or how the data was obtained. The majority of this data is filed with the project and has not been reproduced in this report. Abbreviations and trademarks referenced throughout this report are also listed in an appendix.

3 SYSTEM FINDINGS

3.1 Electrical System Description

UTC_MDPH1 and UTC_MDPH2 are fed by 1,500 kVA utility transformers.

200 kW Generator feeds two ATS's in the event power is lost to the normal service. The two ATS's; feeds panels E1B1 and E2B.

3.2 Study Analysis

Refer to <u>each</u> of the following sections for details. If issues are addressed by equipment, conductor, or device settings changes, the power system study results may need to be re-evaluated in a revision to this study.

3.2.1 Short-Circuit

The results of the short-circuit analysis show that the equipment considered in the study is adequately rated for the projected fault current levels.

3.2.2 Coordination

Recommendations for equipment changes can result in equipment which is larger in ampacity and/or physical footprint, may require changes to other parts of the electrical design (e.g., cable and conduit sizing), and could also impact the architectural design. For Square D distribution equipment, examples are NF panel to an I-Line panel, or a smaller I-Line to a larger I-Line. Recommendations are made for reasons such as coordination issues, protection violations, or transformer magnetic inrush concerns. When selective coordination, according to NEC 700, is required, further analysis beyond the scope of this study will be necessary as well as possible equipment construction or design changes.

Many protective devices are adjustable and were set for optimum operation. The coordination study showed for the most part, acceptable levels of selectivity were achieved among devices in the system except as shown on TCC-12 E1B1, TCC-13 E1B1, TCC-21 MDPH2, TCC-22 E2B1, TCC-23 E2B1, EMER TCC-01 and EMER TCC-02.

Based on the current system configuration the emergency system does not selectively coordinate to .1 seconds. The devices have been optimized to provide the highest level of selectivity possible for the equipment and system design. Where improved selectivity is required, breaker types need to be evaluated per selectivity tables, published in the current revision of the Schneider Electric data bulletin 0100DB0501, and other system design changes may need to be considered.

TCC-12 E1B1:
Time-current coordination graph shows device numbers 303-01 and 303-02 as well as other devices. The equipment designations for the installed devices are: MDPH1 and E1B1. As shown by the graph, these devices do not coordinate well; however, these are fixed devices and cannot be adjusted to improve coordination. If improving selective coordination is required for this particular circuit and we recommend to upgrading device 303-01, ED thermal magnetic to JD LI 3.2.

TCC-13 E1B1:
Time-current coordination graph shows device numbers 306-01 and 306-02 as well as other devices. The equipment designations for the installed devices are: E1BL1. As shown by the graph, these devices do not coordinate well; however, these are fixed devices and cannot be adjusted to improve coordination. If improving selective coordination is required for this particular circuit and we recommend to upgrading device 306-01, QOB thermal magnetic to JD LI 3.2 and 306-02, QOB thermal magnetic to HD LI 3.2

TCC-21 MDPH2:
Time-current coordination graph shows device numbers 308-01 E2B1 MCB and 308-04 as well as other devices. The equipment designations for the installed devices are: E2B1. As shown by the graph, these devices do not selectively coordinate well. DPB2_L1E device has been adjusted to obtain the highest level of selectivity possible for the protection level required. If improving selective coordination is required for this particular circuit and we recommend to upgrading device 308-01 E2B1 MCB, JG thermal magnetic to JG LI 3.2 and 308-04, EG thermal magnetic to HG LI 3.2.

TCC-22 E2B1:
Time-current coordination graph shows device numbers 313-04 and 316-03 as well as other devices. The equipment designations for the installed devices are: E2B1 and E2B2. As shown by the graph, these devices do not coordinate well; however, these are fixed devices and cannot be adjusted to improve coordination. If improving selective coordination is required for this particular circuit and we recommend to upgrading device 313-01, ED thermal magnetic to HD LI 3.2.

TCC-23 E2B1:
Time-current coordination graph shows device numbers 308-02 and 309-02 as well as other devices. The equipment designations for the installed devices are: E2B1 and E2BL1. As shown by the graph, these devices do not coordinate well; however, these are fixed devices and cannot be adjusted to improve coordination. If improving selective coordination is required for this particular circuit and we recommend to upgrading device 308-02, EG thermal magnetic to HG LI 3.2.

TCC-23 E2B1:
Time-current coordination graph shows device numbers 309-01 E2BL1 MCB and 309-02 as well as other devices. The equipment designations for the installed devices are: E2B1. As shown by the graph, these devices do not selectively coordinate well. 309-01 E2BL1 MCB device has been adjusted to obtain the highest level of selectivity possible for the protection level required. If improving selective coordination is required for this particular circuit and we recommend to upgrading device 309-01 E2BL1 MCB, JD thermal magnetic to JD LI 3.2.

TCC-23 E2B1:
Time-current coordination graph shows device numbers 309-02 and 310-02 as well as other devices. The equipment designations for the installed devices are: E2BL1 and E2BL2. As shown by the graph, these devices do not coordinate well; however, these are fixed devices and cannot be adjusted to improve coordination. If improving selective coordination is required for this particular circuit and we recommend to upgrading device 309-02, QO-VH thermal magnetic to HD LI 3.2 and 310-02, QOB to EDB thermal magnetic.

EMER TCC-01:
Time-current coordination graph shows device numbers 300-02 GEN SEC_ATS_E1B1 and 303-03 as well as other devices. The equipment designations for the installed devices are: GEN SEC and E1B1. As shown by the graph, these devices do not coordinate well; however, these are fixed devices and cannot be adjusted to improve coordination. If improving selective coordination is required for this particular circuit and we recommend to upgrading device 300-02 GEN SEC_ATS_E1B1, JGE thermal magnetic to FDE 310+ LS.

EMER TCC-02:
Reference selective coordination comment on time-current coordination graph **TCC-21 MDPH2:**

The breakers in the system should be set to the recommended levels found in the Overcurrent Device Setting Tables section.

3.2.3 Arc Flash

The results of the arc flash analysis show both the calculated arc flash incident energy (AFIE) and arc flash boundary distances at each bus under study.

Overly conservative available fault current values should not be used solely for an arc flash analysis. Therefore, three arc flash fault current scenarios were considered. The first consisted of a high utility source 80,000 Amps at 13.2kV, based on maximum fault current. The second considered a minimum utility source 1,531Amps at 13.2kV, available fault current assumed. The third was a generator source for equipment fed by the emergency generator. All arc flash scenarios were considered with motor loads turned off and on to find the worst case. The results of all the scenarios were combined into one composite table showing the worst case results for each piece of equipment evaluated.

It is recognized that recommendations in this report may not be implemented simultaneously. It is Customer's responsibility to apply and update labels as recommendations are implemented or as conditions change.

There were seven locations where the arc flash incident energy level is greater than 40 cal/cm^2 which is considered the upper limit defined by NFPA 70E. Flash hazard levels at (100 UTC_MDPH1, 101 MDPH1, 108 SDPL1, 200 UTC2_MDPH2, 201 MDPH2, 213 SDPH21 and 229 SDPH22) exceeded 40 cal/cm2, and this equipment is reported as "Dangerous" in the Flash Hazard Table. The arcing fault current must be cleared by the upstream utility transformer primary fuse. Equipment protected by a transformer primary overcurrent device generally results in long trip delay times which cannot be adjusted lower because of the load and/or transformer inrush, or due to limitations or non-adjustability of the protective device. Knowing the actual device information for this project is not likely to result in any improvement at this equipment location.

- Work should not be performed on 100 UTC_MDPH1 and 200 UTC2_MDPH2 without first opening and locking out power on the primary side of the Utilities service transformer.
- Work should not be performed on 101 MDPH1, 108 SDPL1, 201 MDPH2, 213 SDPH21 and 229 SDPH22 without first opening and locking out power on the protective device that feeds each equipment.

The arc flash hazard analysis and recommended PPE levels are no substitutes for safe work practices. As stated in NFPA 70E, burn injuries can occur even when adequate PPE is employed, and the recommended PPE may provide little or no protection against arc blast and its effects. Protection from arc flash can best be provided by working only on circuits or equipment that have been placed in an electrically safe work condition. Work should not be performed on or near equipment listed "Dangerous" unless it has been placed in an electrically safe work condition.

4 SHORT-CIRCUIT ANALYSIS

4.1 General Procedure

An electrical system short-circuit analysis is used for the following:

1) To compare the calculated maximum fault current with the interrupting ratings of overcurrent protective devices such as fuses and circuit breakers.

2) To investigate applicable short-circuit series ratings and the protection of electrical equipment by current-limiting devices.

3) To verify the adequacy of other equipment, such as switches and equipment bussing, to withstand the effects of the calculated maximum fault current levels.

4) To assist in the selection and/or determination of settings for relays, fuses and circuit breakers.

5) To provide input (along with device trip characteristics) to an arc flash hazard analysis.

This analysis was made utilizing SKM Power Tools software. The software was programmed to calculate the maximum available three-phase, RMS symmetrical, short-circuit amperes at each piece of equipment in the system. The calculation procedures are based on recommendations included in ANSI/IEEE standards C37.13, C37.010, and C37.5.

The AFAULT module of the Power*Tools software simulates a bolted three-phase fault at each point of consideration in the system and calculates the maximum available short-circuit current at that point without any reduction due to current-limiting overcurrent devices which may be present. (However, the effects of current-limiting devices are considered when determining the adequacy of the equipment.) The calculated short-circuit values are RMS symmetrical amperes and are comparable with the RMS symmetrical short-circuit ratings of electrical equipment.

Electrical distribution equipment must be able to withstand and/or interrupt the most severe fault duty that it may be subjected to at its location in the system. In particular, NEC Section 110.9

requires circuit breakers to have a rating sufficient for interrupting the maximum available fault current present at their line side terminals. For locations where calculated fault currents exceed the ratings of the equipment, recommendations for corrective actions are provided.

Equipment short-circuit withstand and interrupting ratings are expressed in symmetrical RMS current. However, fault currents are not purely symmetrical in practice, as system inductance introduces a degree of asymmetry for at least the first few cycles of a fault. The magnitude and duration of this asymmetrical component depends on several factors, including characteristics of system components (conductors, transformers, and loads) and the exact point on the current waveform that the fault begins—the level of asymmetry even differs from phase to phase in a three-phase system. Because of the uncertainty in asymmetry for a given fault event, the capability of devices to interrupt asymmetrical fault current is based on the maximum possible asymmetrical fault current level at the point of application. The more inductive the circuit, as measured by the calculated system X/R ratio, the more asymmetrical the fault current can be. If the calculated X/R level exceeds a certain level, then the increased asymmetrical duty must be taken into account when breaker ratings are assessed.

Low-voltage circuit breakers and fuses are tested to establish their interrupting ratings based on a circuit with a fixed X/R ratio, as defined in the various product standards (UL and ANSI). For example, an ANSI low-voltage power circuit breaker is tested in a circuit with an X/R ratio of 6.591. If such a breaker is applied at a system bus with a calculated X/R ratio of 6.591 or less and the calculated RMS symmetrical fault current is within the symmetrical interrupting rating of the breaker, then it is assumed that the breaker is also able to interrupt and withstand the asymmetrical current resulting from a fault at that location. If a low voltage breaker is applied at a location with an X/R ratio greater than that of the design test circuit, the calculated fault current must be multiplied by an adjustment factor that accounts for this. This resultant "fault duty," which is greater than the calculated fault current, is then compared to the breaker's interrupting rating in order to determine if the breaker is adequately rated. Different classes of low-voltage breakers have different test X/R values, and each type has its own set of multiplication factors. Design test circuit power factors and associated X/R ratios are as shown in **Table 1**. The SKM low-voltage short-circuit output report shows the calculated fault duty levels calculated at each bus, and when these values differ from the calculated short-circuit current levels, they are used in the device evaluation tables. See IEEE 1015-1997, *IEEE Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems*, for additional details.

Table 1: Summary of Test Power Factor and X/R Values for LV Devices.

Device	pf	X/R Ratio
Power circuit breaker, unfused	0.15	6.591
Power circuit breaker, fused	0.20	4.899
Molded case breaker, interrupting rating greater than 20000 A	0.15-0.20	6.591-4.899
Molded case breaker, interrupting rating 10001 to 20000 A	0.25-0.30	3.9-3.18
Molded case breaker, interrupting rating 10000 A and less	0.45-0.50	2.0-1.732

For power circuit breakers, the power factors are taken from ANSI/IEEE C37.13. For molded case breakers, the power factors are taken from NEMA standard AB1. Since the NEMA standard specifies a range of test circuit power factors, the highest value (lowest X/R ratio) is used to determine the multiplying factor. This produces the most conservative (largest) factor.

The included one-line diagram is a simplified version of the system drawings, showing only those parts of the electrical system under consideration. The various circuit locations on the diagram have been labeled with bus identification numbers so input data could be supplied to the computer and the computer output could be readily interpreted.

4.2 Data Used in the Calculations

4.2.1 Power Company Data

The maximum available three-phase short-circuit current at the 1,500 KVA service point was calculated to be 34,594A at 480V. An X/R ratio of 8 was assumed for this current. This short-circuit current was obtained from an infinite-source calculation and determined the starting point for the short-circuit analysis. No minimum or alternate switching levels were given.

4.2.2 Generator Data

It has been determined that the 200kW generator has a subtransient reactance of 15% with an 80% PF and an estimated X/R ratio of 12.40 at 480V. The calculated maximum available bolted three-phase RMS symmetrical short-circuit current at the point of common coupling to the system (i.e. ATS) is considerably higher from the normal source compared to the generator source. The "Short Circuit Evaluation Table" is based on the higher source calculations. Therefore, all equipment determined to be adequate under normal utility supply conditions will also be adequate when the generator is in operation.

4.2.3 Cable Data

The "FEEDER INPUT DATA" computer printouts list the conductor (cable and/or busway) data used for each circuit segment. Included are lengths, number per phase, size, conductor material, cable insulation type, conduit material and resistance and reactance values. Also, conductor lengths, number per phase, and size and conductor material are recorded on the one-line diagram.

Resistance values are based on 25 degrees Celsius (room temperature) rather than the full load temperature usually shown in descriptive literature since short-circuits can occur when the circuit is initially energized or lightly loaded as well as when fully loaded. The resistance and reactance values are typical values obtained from a study of data from various conductor manufacturers. Values are tabulated according to whether several single conductors or one multiple conductor is used and whether the conduit is steel, aluminum or plastic.

4.2.4 Transformer Data

Schneider Electric nameplate transformer percent impedance and typical X/R ratio values were used for all the low voltage transformers. The exact R and X component values used are shown on the "TRANSFORMER INPUT DATA" printouts.

4.2.5 Assumptions and Estimates

Some assumptions, or estimates, were required and may affect the results of this study. In general, assumptions, or estimates, are needed because of limited access, safety concerns in obtaining equipment nameplate data, or lack of documentation. Significant differences between the assumptions, or estimates, listed here and actual values will require that this power system analysis be revised.

The following assumptions, or estimates, were made for the reasons given above:

- Where motor loads were not given, motors sized per NEC table 430.15 were used in this analysis. MDPH1 and MDPH2 motor loads are sized per 25% of the utility transformers kVA
- Transformer MD/G X/R was assumed.
- Utility fuse type and size was assumed.

4.2.6 Motor Contribution To Short-Circuit Current

Motor contribution to the short-circuit current is taken into account in this short-circuit analysis. During the first few cycles of a fault, running motors act as generators and produce a current which will combine with the source short-circuit current flowing to the fault as illustrated in **Figure 1**. Sources may be, but are not limited to, the Power Company, local generators, or both.

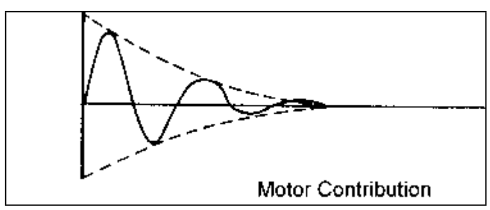


Figure 1: Example motor contribution.

Connected motors shown on the study one-line were assumed to be running at the time of the fault. Motors fed by adjustable speed drives equipped with bypass contactors were considered to contribute to system fault currents as well. However, motors fed by drives without bypass contactors were not considered since they do not contribute to fault current. Redundant motors shown on the study one-line were also assumed to be running at the time of the fault unless operating controls prohibit these conditions.

A motor's contribution to a fault *at its terminals* is equal to the full-load ampere (FLA) rating of the motor divided by its per-unit subtransient reactance, similar to the contribution from a generator. However, at the upstream switchboard, panelboard, or motor-control center, the fault contribution from the individual motors is reduced by the impedance of the motor branch circuit conductors. Since data on motor subtransient reactances and branch-circuit conductor lengths is often difficult to obtain, assumptions regarding the motors' subtransient reactances are typically made when the system model is built.

For calculation of low-voltage fault duty, the contribution from induction motors and synchronous motors in the system are considered. For small induction motors (less than 50 hp) where the impedance of the installation (i.e., motor and conductor) is not known, an equivalent subtransient reactance of 0.25 pu, resulting in a fault contribution of 4 times rated current, is assumed. Larger motors (50 hp and above) have an assumed subtransient reactance of 0.2 pu, resulting in a fault contribution of 5 times rated current. This is consistent with recommendations in IEEE Std. 141, *IEEE Recommended Practice for Electric Power Distribution for Industrial Plants* (the IEEE Red Book).

If applicable, multiplying factors are adjusted per Table 7 of ANSI/IEEE C37.010, *IEEE Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis for* medium/high voltage fault duty. The table also shows contributions from induction motors less than 50 hp to be neglected.

The motor short-circuit contribution is determined and included in the computer short-circuit analysis so that the results should represent the highest short-circuit current to which the equipment might be subjected.

Unless otherwise indicated in the "CONTRIBUTION DATA" computer printouts, some motor loads are modeled as lumped induction motors connected directly to the low voltage buses using the recommended subtransient reactance values from C37.010, C37.13, and IEEE Std. 141. These modeled values appear on the "CONTRIBUTION DATA" and the "FAULT REPORT" computer printouts.

4.3 Short-Circuit Analysis Results and Recommendations

After making the calculations, the distribution equipment was checked to determine its adequacy to interrupt or withstand the effects of the calculated maximum short-circuit current at its location. For some solidly-grounded systems, like close-coupled unit substations and generator gear, it is possible the bolted three-phase fault current is not the maximum fault current. The power systems engineer performing the study considered applicable buses and has reported bolted line-to-ground fault current when required. The results are listed in the "SHORT-CIRCUIT EVALUATION TABLE".

Short-circuit case description(s): The Short circuit analysis is based upon the actual/maximum available fault current being provided to the system.

Listed in the tables are the calculated short-circuit currents at each piece of equipment and the ratings of the lowest rated device in the equipment enclosure. Comparing the two sets of values shows that all of the equipment examined is either adequate by itself or when used in series with another circuit breaker or protected by a line side current-limiting fuse or circuit breaker.

If applicable, equipment using series ratings that are shown in the short-circuit evaluation table must meet field labeling requirements per NEC Sections 110.22 and 240.86(B). There are two types of markings which must be present; the first requires series combination ratings to be marked on equipment by the manufacturer. The second equipment marking must be readily visible and state the following:

CAUTION – SERIES COMBINATION SYSTEM RATED _____ AMPERES.
IDENTIFIED REPLACEMENT COMPONENTS REQUIRED.

This labeling serves as a warning to those who may install new breakers or replace existing breakers at the given location in the future, alerting them to the fact that a specific device type must be used in order to ensure that the series rating is maintained.

Input data and short-circuit output data pages are included in separate appendices.

4.4 Short-Circuit Evaluation Tables

BUS NO.	EQUIP. DESCRIPTION PER SYSTEM ONE LINE DIAGRAM(S)	NOMINAL L-L VOLTS	LOWEST RATED DEVICE IN EQUIPMENT ENCLOSURE		MAXIMUM AVAILABLE SCA OR DUTY	X/R RATIO	LINE SIDE MAXIMUM DEVICE	LINE SIDE SERIES RATING	NOTES	
			TYPE	AIC OR WCR					EVALUATION	#
100	UTC_MDPH1	480.0	NW-H	100,000	37,875	8.108			Adequate	
101	MDPH1	480.0	JG	35,000	34,667	6.462			Adequate	
102	H1L1	480.0	EDB(1P)	18,000	27,263	2.761	LG	35,000	Adequate	
103	H1L2	480.0	EDB(1P)	18,000	16,148	1.039	HG	35,000	Adequate	
104	H1L3	480.0	EDB(1P)	18,000	15,160	1.340	JG	35,000	Adequate	
105	H1L4	480.0	EDB(1P)	18,000	16,748	1.583	LG	35,000	Adequate	
106	MD/G	208.0	THQB	10,000	7,936	2.272			Adequate	
107	G/GA	208.0	QOB-VH	22,000	6,864	2.021			Adequate	
108	SDPL1	208.0	FH(3P)	65,000	23,911	4.898			Adequate	
109	L1M1	208.0	QOB	10,000	2,688	0.670			Adequate	
110	L1L1	208.0	QOB(1P)/15-30A	10,000	17,385	2.570	LD	25,000	Adequate	
111	L1L2	208.0	QOB(1P)/15-30A	10,000	14,738	2.145	LG	65,000	Adequate	
112	L1L3	208.0	QOB(1P)/15-30A	10,000	10,956	1.164	LD	25,000	Adequate	
113	L1L31	208.0	QOB(1P)/15-30A	10,000	9,241	0.984	QOB-VH	22,000	Adequate	
114	L1L4	208.0	QOB(1P)/15-30A	10,000	5,335	0.909	QG	65,000	Adequate	
115	L1L5	208.0	QOB(1P)/15-30A	10,000	5,422	1.112	QG	65,000	Adequate	
116	L1L6	208.0	QOB(1P)/15-30A	10,000	7,102	0.630	QG	65,000	Adequate	
117	L1B1	208.0	QOB(1P)/15-30A	10,000	13,179	1.037	QG	65,000	Adequate	
118	L1B2	208.0	QOB(1P)/15-30A	10,000	2,534	0.353	QG	65,000	Adequate	
119	H1B1	480.0	EDB(1P)	18,000	15,630	0.782	EGB	35,000	Adequate	
200	UTC2_MDPH2	480.0	NW-H	100,000	35,170	7.161			Adequate	
201	MDPH2	480.0	JG	35,000	33,669	6.439			Adequate	
202	SDPL2	208.0	LG	65,000	16,266	3.330			Adequate	
203	L2M1	208.0	FH(3P)	65,000	12,232	2.242			Adequate	
204	L2M11	208.0	QOB(1P)/15-30A	10,000	10,145	1.906	LG	65,000	Adequate	
205	L2M2	208.0	QOB(1P)/15-30A	10,000	10,481	1.466	LG	65,000	Adequate	
206	L2M21	208.0	QOB(1P)/15-30A	10,000	6,695	0.705	HD	25,000	Adequate	
207	L2B2	208.0	QOB(1P)/15-30A	10,000	8,773	1.351	QG	65,000	Adequate	
208	L2B1	208.0	QOB(1P)/15-30A	10,000	10,105	0.988	QG	65,000	Adequate	
209	H2M1	480.0	EDB(1P)	18,000	19,068	1.703	JG	35,000	Adequate	
210	H2M2	480.0	EDB(1P)	18,000	20,652	1.717	LG	35,000	Adequate	
211	H2B2	480.0	EDB(1P)	18,000	29,137	3.802	LG	35,000	Adequate	
212	H2B1	480.0	EGB	35,000	13,489	0.583			Adequate	
213	SDPH21	480.0	FH(3P)	25,000	17,799	1.716			Adequate	
214	H21B1	480.0	EDB	18,000	11,096	0.733			Adequate	

#N/A = Number not available.

BUS NO.	EQUIP. DESCRIPTION PER SYSTEM ONE LINE DIAGRAM(S)	NOMINAL L-L VOLTS	LOWEST RATED DEVICE IN EQUIPMENT ENCLOSURE TYPE	AIC OR WCR	MAXIMUM AVAILABLE SCA OR DUTY	X/R RATIO	LINE SIDE MAXIMUM DEVICE	LINE SIDE SERIES RATING	NOTES EVALUATION	#
215	H21M1	480.0	EDB	18,000	9,258	0.682			Adequate	
216	H21U1	480.0	EDB	18,000	7,290	0.560			Adequate	
217	SDPL21	208.0	FH(3P)	65,000	13,877	2.387			Adequate	
218	L21U1	208.0	QOB(1P)/15-30A	10,000	6,532	0.859	QG	65,000	Adequate	
219	L21U2	208.0	QOB(1P)/15-30A	10,000	3,446	0.602	QG	65,000	Adequate	
220	L21U3	208.0	QOB(1P)/15-30A	10,000	5,557	0.770	QG	65,000	Adequate	
221	L21U4	208.0	QOB(1P)/15-30A	10,000	3,811	0.629	QG	65,000	Adequate	
222	L21U5	208.0	QOB(1P)/15-30A	10,000	6,931	0.899	QG	65,000	Adequate	
223	L21M1	208.0	QOB(1P)/15-30A	10,000	4,445	0.949	QG	65,000	Adequate	
224	L21M11	208.0	QOB(1P)/15-30A	10,000	3,905	0.816	QG	65,000	Adequate	
225	L21M2	208.0	QOB(1P)/15-30A	10,000	6,532	0.859	QG	65,000	Adequate	
226	L21M3	208.0	QOB(1P)/15-30A	10,000	5,113	1.002	QG	65,000	Adequate	
227	L21M4	208.0	QOB(1P)/15-30A	10,000	8,450	1.070	QG	65,000	Adequate	
228	L21B1	208.0	QOB-VH	22,000	10,685	1.131			Adequate	
229	SDPH22	480.0	FH(3P)	25,000	15,945	2.154			Adequate	
230	H22B1	480.0	EDB	18,000	12,178	1.072			Adequate	
231	H22M1	480.0	EDB	18,000	4,595	0.372			Adequate	
232	H22U1	480.0	EDB	18,000	8,900	0.888			Adequate	
233	SDPL22	208.0	FH(3P)	65,000	13,565	2.658			Adequate	
234	L22U1	208.0	QOB(1P)/15-30A	10,000	6,166	0.858	QG	65,000	Adequate	
235	L22U2	208.0	QOB(1P)/15-30A	10,000	5,554	0.798	QG	65,000	Adequate	
236	L22U3	208.0	QOB(1P)/15-30A	10,000	4,437	0.698	QG	65,000	Adequate	
237	L22U4	208.0	QOB(1P)/15-30A	10,000	5,845	0.826	QG	65,000	Adequate	
238	L22U5	208.0	QOB(1P)/15-30A	10,000	5,290	0.773	QG	65,000	Adequate	
239	L22M1	208.0	QOB(1P)/15-30A	10,000	6,166	0.858	QG	65,000	Adequate	
240	L22M2	208.0	QOB(1P)/15-30A	10,000	5,290	0.773	QG	65,000	Adequate	
241	L22M3	208.0	QOB(1P)/15-30A	10,000	5,290	0.773	QG	65,000	Adequate	
242	L22M4	208.0	QOB(1P)/15-30A	10,000	5,049	0.751	QG	65,000	Adequate	
243	L22M5	208.0	QOB(1P)/15-30A	10,000	5,787	1.101	QG	65,000	Adequate	
244	L22M6	208.0	QOB(1P)/15-30A	10,000	4,624	0.714	QG	65,000	Adequate	
245	L22B1	208.0	QOB	10,000	6,612	0.622			Adequate	
300	GEN SEC	480.0	SCCR35	35,000	2,325	12.400			Adequate	
301	ATS_E1B1	480.0	SCCR50	50,000	12,790	0.648			Adequate	
302	ATS_E2B1	480.0	SCCR50	50,000	22,152	1.597			Adequate	

#N/A = Number not available.

POWER SYSTEM ENGINEERING

SHORT-CIRCUIT EVALUATION TABLE

KELLY WALSH HIGH SCHOOL
Casper, WY
6.E501 & 6.E502

BUS NO.	EQUIP. DESCRIPTION PER SYSTEM ONE LINE DIAGRAM(S)	NOMINAL L-L VOLTS	LOWEST RATED DEVICE IN EQUIPMENT ENCLOSURE		MAXIMUM AVAILABLE SCA OR DUTY	X/R RATIO	LINE SIDE MAXIMUM DEVICE	LINE SIDE SERIES RATING	NOTES	
			TYPE	AIC OR WCR					EVALUATION	#
303	E1B1	480.0	EDB	18,000	10,773	0.564			Adequate	
304	E1L1	480.0	EDB	18,000	3,143	0.201			Adequate	
305	E1L2	480.0	EDB	18,000	2,885	0.296			Adequate	
306	E1BL1	208.0	QOB	10,000	1,787	0.783			Adequate	
307	E1BL2	208.0	QOB	10,000	1,618	0.705			Adequate	
308	E2B1	480.0	EGB	35,000	19,271	1.302			Adequate	
309	E2BL1	208.0	QOB	10,000	2,981	1.100			Adequate	
310	E2BL2	208.0	QOB	10,000	1,491	0.730			Adequate	
311	E2BL3	208.0	QOB	10,000	1,005	0.573			Adequate	
312	E2M1	480.0	EDB(1P)	18,000	3,716	0.222	EGB	35,000	Adequate	
313	E2B2	480.0	EDB(1P)	18,000	2,924	0.351	EGB	35,000	Adequate	
314	E2M3	480.0	EDB	18,000	1,911	0.250			Adequate	
315	E2U1	480.0	EDB	18,000	1,758	0.236			Adequate	
316	E2B3	480.0	EDB	18,000	1,786	0.295			Adequate	
317	E2M2	480.0	EDB	18,000	1,137	0.212			Adequate	
318	E2U2	480.0	EDB	18,000	1,080	0.205			Adequate	

#N/A = Number not available.

5 OVERCURRENT DEVICE COORDINATION ANALYSIS

5.1 General Procedure

An overcurrent device time-current coordination analysis is an organized effort to determine the settings and, where appropriate, the ampere ratings and types for the over-current protective devices in an electrical system. The objective of the coordination analysis is to effect a time-current coordination among the devices, thereby achieving the desired system protection and electrical service continuity goals.

Maximum protection requires that the overcurrent protective devices be rated, selected, and adjusted to allow the normal load currents to flow while instantaneously opening the circuit when abnormal currents flow.

However, maximum service continuity requires that the overcurrent protective devices be rated, selected, and adjusted so that only the overcurrent protective device nearest the fault opens and isolates the faulted circuit from the system, permitting the rest of the system to remain in operation. Protective devices farther from the fault location should therefore essentially act as backup protection for the devices nearer to the fault, allowing the fault to be cleared with a minimum of disruption to the system. This is referred to as “coordination” between the protective devices. This may allow longer duration faults when the fault point is nearer the service entrance; however, such faults are not as common, and setting the protective devices to operate in this manner is generally more desirable than deenergizing most or all of the system for a fault near one of the loads.

Selecting and setting the overcurrent devices is a procedure where the time-current characteristic curves of the various devices in series are compared with one another on a log-log graph. This procedure should take into account boundaries defined by load currents, short-circuit currents, and ANSI and NEC requirements.

Coordination usually will be obtained when the log-log plots of time-current characteristics show sufficient clear space or no overlap between the curves for the protective devices operating in series. Coordination will often stop short of complete selectivity when an acceptable compromise is reached between the various boundaries imposed on the selecting and setting procedure.

The CAPTOR module of the SKM Power*Tools software was used to complete the device coordination analysis. As shown on the one-line diagram, each overcurrent protective device or motor under consideration by the program has been assigned an identification number so that the computer output could be readily interpreted.

5.2 Specific Procedure

5.2.1 Short-Circuit Current Considerations

All protective device characteristic curves shown on the time-current graphs end at the calculated maximum short-circuit current at that device.

5.2.2 Molded Case Breaker Coordination

A molded case circuit breaker will trip with no intentional time delay for short-circuit currents above its instantaneous trip setting. Because of this, molded case breakers in series can only be selectively coordinated with each other if there is sufficient impedance between them so that the maximum available short-circuit current at the downstream breaker is less than the instantaneous trip setting of the upstream breaker. In **Figure 2**, breaker "C" illustrates this principle.

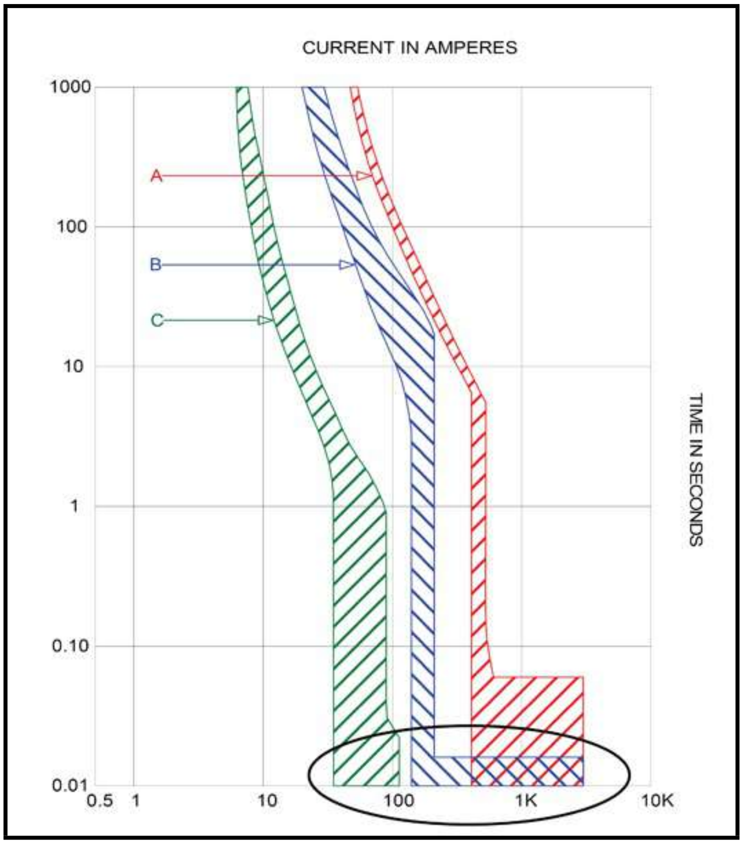


Figure 2: Example molded case breaker coordination.

There is enough cable impedance to limit the maximum available short-circuit current at "C" to less than the instantaneous trip setting of either "A" or "B". When molded case breakers are in series without sufficient impedance between them to permit complete coordination, e.g., a panel main breaker and one of the branch devices in the panel, the time-current curves will overlap in the high-current instantaneous trip region. This is illustrated by the overlap between the curves for devices “A” and “B” in **Figure 2**. Most molded case breakers exhibit some degree of current limitation that will often result in selective operation in the overlap region. Time-current coordination curves included in this report do not match the results from the latest edition of the Schneider Electric data bulletin 0100DB0501. The software used to generate the curves is incapable of accounting for the dynamic impedance the system has when two or more devices in series “see” a fault. The data bulletin takes the dynamic impedance introduced by the downstream device into account. Greater separation between the instantaneous settings may increase the likelihood that the two devices will operate selectively. The potential lack of coordination is generally not considered critical and can be avoided only by adopting a different and, in general, less economically practical design especially when the following are considered:

- Most faults occur in equipment such as motors, lighting panels, and process control panels which typically are located at the end of branch circuits, significantly reducing fault level and thereby reducing or eliminating the possibility of non-selective operation.
- Lower magnitude arcing faults in rotating machinery and lighting panels are statistically more common than bolted three-phase faults.
- Ground faults are more common than three-phase faults.
- Maximum fault current is a random event depending on point-on-wave of the fault occurrence and other factors.
- The device cutoff points on time-current coordination graphs are based on bolted fault current levels which correspond to zero impedance. Typical fault current impedance is usually greater than zero so the actual fault current seen by overcurrent devices can be less than what is shown on the time-current coordination graphs.

Recommended breaker trip settings are given in the "OVERCURRENT DEVICE SETTING TABLE – LV CIRCUIT BREAKERS". In addition, an illustration of the actual magnetic trip adjustment dials for Schneider Electric circuit breakers is included in the REFERENCES section to aid the setting process.

5.2.3 Low-Voltage Ground Fault Relay Settings

The main ground fault time setting was chosen to coordinate with the appropriate load side devices. The ground fault current pickup setting has been shown set both at minimum and at maximum.

Best equipment protection is achieved by a minimum current setting but best coordination with load side protective devices is achieved by a maximum current setting. However, it should be noted even with the ground fault current pickup set maximum, coordination with downstream breakers does not exist for any ground fault current exceeding this maximum pickup setting but less than the magnetic setting of the load side breaker. This is unavoidable because the load side protective devices are not equipped with ground fault protection. **Figure 3** illustrates this.

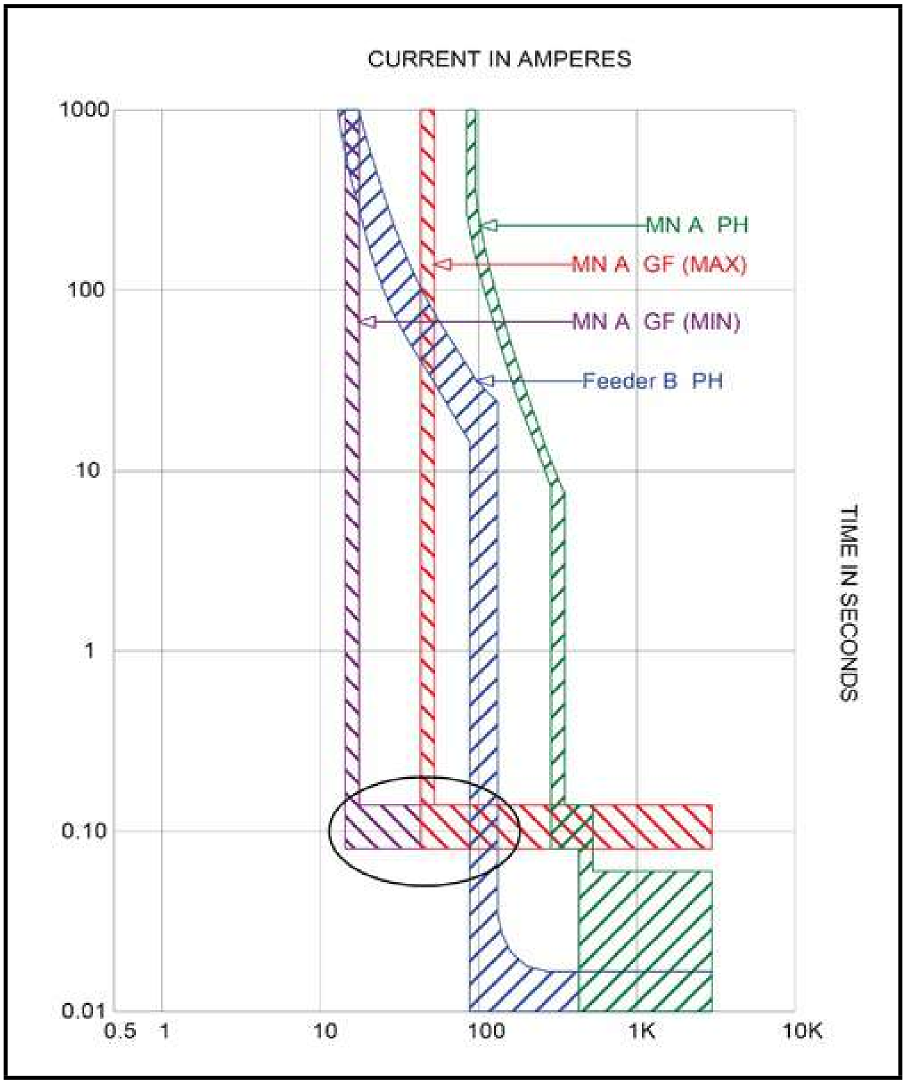


Figure 3: Example ground fault coordination (current scale X 10).

As shown in **Figure 3**, the main ground fault device A set at minimum does not coordinate with feeder breaker B for ground fault currents in the range of 140A - 1,310A as indicated. Even with

A set at maximum, it will not coordinate with breaker B for ground fault currents in the range of 425A - 1,310A as indicated.

All ground fault settings are tabulated in the appropriate overcurrent device setting tables.

5.2.4 Transformer Protective Devices

If in the project scope, medium- and/or low-voltage transformer primary overcurrent protective devices were checked for compliance with NEC Article 450. Also, medium voltage protective devices, primary, secondary and secondary feeder, were evaluated with respect to the applicable ANSI/IEEE Through Fault Guides (C57.12.59 for dry and cast resin type and C57.109 for liquid immersed type) and the Appendix for ANSI/IEEE C37.91. Transformer standards define low-voltage transformers as having a primary voltage less than or equal to 600V. Transformer full load currents and magnetizing inrush currents were also considered.

If a transformer is subject to a through fault, thermal damage occurs to conductors and insulation due to resistive heating. Mechanical damage occurs to windings and structural components due to large magnetic forces associated with the fault current. In general, smaller transformers are assigned a single damage characteristic that accounts for both thermal and mechanical damage. Larger transformers are assigned a two-part characteristic with a thermal characteristic and a more restrictive mechanical characteristic. For the most conservative protection, the thermal-mechanical limits should be used. In many cases, it may be acceptable to use only the thermal characteristic, especially if the transformer is not subject to frequent through faults. Transformers connected to overhead secondary feeders should be considered to be subject to frequent through faults.

To evaluate through fault protection according to the ANSI Guides, the applicable curve was plotted representing a transformer's projected damage threshold for the cumulative effects of through faults. However, this ANSI through fault curve must be reduced for certain unbalanced secondary faults, because even though full short-circuit current is flowing in one or more secondary windings, the primary overcurrent device experiences less current.

Secondary line-to-neutral faults on delta-wye connected transformers produce only 0.577 of the maximum 3-phase fault current in the primary overcurrent device while one secondary winding experiences the full short-circuit current as illustrated in **Figure 4** below. Therefore, to account for this fault condition, the ANSI through fault curve has been adjusted by a factor of 0.577. Both curves (three phase line-to-line and single phase line-to-neutral) are plotted on the time-current graphs.

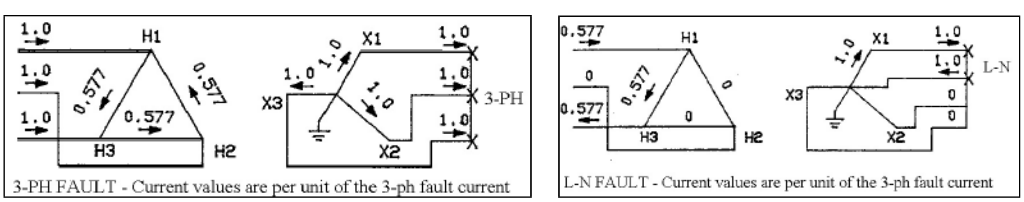


Figure 4: Delta–Wye 3-PH and L-N fault current per unit values.

Since the through fault curves represent a transformer's projected damage threshold for the cumulative mechanical and thermal effects of through faults, all applicable primary and secondary overcurrent devices were checked to ensure interruption before these through fault curves were reached.

Further, to avoid nuisance interruptions, the primary overcurrent devices were also checked to ensure they will carry the transformers rated full load and equivalent magnetic inrush currents which are plotted on the time-current graphs.

Because of the restrictions mentioned above, coordination between the transformer primary and secondary main devices may not exist for any transformers examined as shown by the overlapping of their characteristics on the time-current graphs. However, this is judged acceptable, because the opening of either device results in the same extent of service interruption.

5.2.5 Cable Protection

Feeder overcurrent protective devices were reviewed to verify the protection of their load side cables as shown on the one-line diagram in accordance with NEC Article 240. If the adjustable low-voltage protective devices are set as suggested in this report, then the cables reviewed will be properly protected.

It is not possible to damage the phase conductor during short-circuits below the AIC rating of the breaker protecting the phase conductor when a low-voltage phase conductor is properly sized per NEC 240. UL tests to verify the short-circuit rating of a circuit breaker are performed considering 75°C cable. The corresponding phase conductor is sized according to the NEC and must pass the fault tests without compromising its integrity. Therefore, the ICEA cable withstand curves have not been included on the time-current coordination graphs.

5.2.6 Selective Coordination and the National Electric Code

In some situations, even though individual devices are not coordinated, the system may still be considered to be well-coordinated. For example, where two devices are in series with no loads connected between them, operation of either/both devices interrupts power to the exact same portion of the power system. The system may be considered to be coordinated even though the two devices, strictly speaking, do not coordinate with one another.

Selective coordination, while always desirable, is not required by the NEC except in certain situations:

- In health-care facilities, per NEC 517.17(C): "Ground-fault protection for operation of the service and feeder disconnecting means shall be fully selective such that the feeder device, but not the service device, shall open on ground faults on the load side of the feeder device."

- In elevator circuits when more than one elevator motor is fed by a single feeder. See NEC 620.62.

- In emergency and legally-required standby power systems (including those in hospitals and other health-care facilities where so required), per NEC 700.27 and NEC 701.27.

- In critical operations power systems (COPS) such as, but not limited to, power systems, HVAC, fire alarm, security, communications, and signaling; refer NEC 708.54. Generally, these are facilities or parts of facilities that require continuous operation for reasons of public safety, emergency management, national security, or business continuity.

The requirements for selective coordination in emergency and legally-required standby systems, call for each overcurrent device to be “selectively coordinated with all supply side overcurrent protective devices.” This requirement can be problematic for system designers because it recognizes only device coordination and not system coordination. Special consideration of selective coordination (beyond the traditional coordination study) must be given when the system is initially designed, since for both fusible and circuit-breaker based systems, designs that are otherwise NEC compliant may not meet the selective coordination requirements of the NEC.

Time-current coordination curves included in this report do not match the results from the latest edition of the Schneider Electric data bulletin 0100DB0501. The software used to generate the curves is incapable of accounting for the dynamic impedance the system has when two or more devices in series “see” a fault. The data bulletin takes the dynamic impedance introduced by the downstream device into account.

Compliance with NEC articles 517.17 (Health Care Facilities), 700.27 (Emergency Systems), 701.27 (Legally Required Standby Systems), and 708.54 (Critical Operations Power Systems) may require interpretation and approval by the local authority having jurisdiction. The most common interpretations related to the extent of selective coordination have been either 0.1 seconds or total selectivity.

5.2.7 Assumptions and Estimates

Some assumptions, or estimates, were required and may affect the results of this study. In general, assumptions, or estimates, are needed because of limited access, safety concerns in obtaining equipment nameplate data, or lack of documentation. Significant differences between the assumptions, or estimates, listed here and actual values will require that this power system analysis be revised.

The following assumptions, or estimates, were made for the reasons given above:

1. MD/G low-voltage transformer the X/R and magnetic inrush was assumed.

5.3 Analysis of Results and Recommendations

The basic results of an overcurrent device coordination analysis are the time-current coordination graphs which are plotted to illustrate the degree of coordination achieved in the system. 28 graphs are included in this report. Settings for devices which have adjustable characteristics are summarized in the appropriate overcurrent device setting tables. Smaller devices with fixed time-current characteristics are not shown on the graphs unless they directly affect the setting of an adjustable upstream device.
It is assumed the impedance ground return path for the equipment grounding conductors (EGCs) and conduit for equipment rated 600V and less exhibit very low impedance levels—generally much less than 0.25 ohms for circuits 50A and larger; and can be in that range when larger sized EGCs are used. Although design and installation standards are intended to provide a ground return path with suitably low impedance, failure to maintain the ground return path with suitably low impedance will affect the ability for ground fault relays to operate as designed and intended. This impedance is not to be confused with the resistance to remote earth of a grounding electrode system, which is often specified in the 3-5 ohm range and does not impact whether ground fault devices operate properly. IEEE Std 1100 (Emerald Book) provides recommended maximum impedance values for EGCs and IEEE 81 provides test methods for measuring resistance to remote earth of a grounding electrode system. Field measurements may result in additional engineering and field work to correct the grounding system. Field testing and analysis are outside of the scope of work for this project.

To generate the time-current graphs, a computer program was used which allows the power system engineer to determine optimum coordination, after first insuring that loading and protection requirements are satisfied. The engineer's objective is to determine the best coordination for the entire system. This approach necessitates tradeoffs in selectivity for some parts of the system to achieve maximum coordination in more critical areas. Regions in which coordination has been sacrificed are as previously discussed involving transformer primary and secondary main devices, high current regions of molded case breakers, etc.

5.3.1 TCC Plot Remarks

The following comments refer to the graphs shown in the Time Current Coordination Graphs section of this report.

TCC-01 MDPH1:
Time-current coordination graph shows device numbers 101-08 MDPH1_XFMR_SDPL1 and 108-01 SDPL1 MCB as well as other devices. The equipment designations for the installed devices are: MDPH1 and SDPL1 As shown by the graph, these devices overlap. However, these devices are in series and the loss of selectivity is acceptable as operation of either device affects the same portion of the system and full coordination is not required. This allows better coordination between these devices and the ones upstream and downstream.

TCC-01 MDPH1:
Time-current coordination graph shows device numbers 108-04 SDPL1_L1L2 and 111-01 L1L2 MCB as well as other devices. The equipment designations for the installed devices are: SDPL1 and L1L2 As shown by the graph, these devices overlap. However, these devices are in series and the loss of selectivity is acceptable as operation of either device affects the same portion of the system and full coordination is not required. This allows better coordination between these devices and the ones upstream and downstream.

TCC-05 MDPH1:
Time-current coordination graph shows device numbers 101-05 and 103-02 as well as other devices. The equipment designations for the installed devices are: MDPH1 and H1L1. As shown by the graphs, these devices do not coordinate well; however, these are fixed devices and cannot be adjusted to improve coordination.

TCC-06 SDPL1:
Time-current coordination graph shows device numbers 108-03 SDPL1_L1L1 and 110-01 L1L1 MCB as well as other devices. The equipment designations for the installed devices are: SDPL1 and L1L1 As shown by the graph, these devices overlap. However, these devices are in series and the loss of selectivity is acceptable as operation of either device affects the same portion of the system and full coordination is not required. This allows better coordination between these devices and the ones upstream and downstream.

TCC-07 SDPL1:
Time-current coordination graph shows device numbers 108-05 SDPL1_L1L3 and 112-01 L1L3 MCB as well as other devices. The equipment designations for the installed devices are: SDPL1 and L1L3 As shown by the graph, these devices overlap. However, these devices are in series and the loss of selectivity is acceptable as operation of either device affects the same portion of the system and full coordination is not required. This allows better coordination between these devices and the ones upstream and downstream.

TCC-07 SDPL1:
Time-current coordination graph shows device numbers 112-02 and 113-02 as well as other devices. The equipment designations for the installed devices are: L1L3 and L1L31. As shown by the graphs, these devices do not coordinate well; however, these are fixed devices and cannot be adjusted to improve coordination.

TCC-10 SDPL1:
Time-current coordination graph shows device numbers 108-10 and 118-02 as well as other devices. The equipment designations for the installed devices are: SDPL1 and L1B2. As shown by the graphs, these devices do not coordinate well; however, these are fixed devices and cannot be adjusted to improve coordination.

TCC-11 SDPL1:
Time-current coordination graph shows device numbers 101-09 and 119-01 as well as other devices. The equipment designations for the installed devices are: SDPL1 and H1B1 As shown by the graph, these devices overlap. However, these devices are in series and the loss of selectivity is acceptable as operation of either device affects the same portion of the system and full coordination is not required. This allows better coordination between these devices and the ones upstream and downstream.

TCC-12 E1B1:
Time-current coordination graph shows device numbers 303-01 and 303-02 as well as other devices. The equipment designations for the installed devices are: MDPH1 and E1B1. As shown by the graph, these devices do not coordinate well; however, these are fixed devices and cannot be adjusted to improve coordination. If improving selective coordination is required for this particular circuit and we recommend to upgrading device 303-01, ED thermal magnetic to JD LI 3.2.

TCC-13 E1B1:
Time-current coordination graph shows device numbers 306-01 and 306-02 as well as other devices. The equipment designations for the installed devices are: E1BL1. As shown by the graph, these devices do not coordinate well; however, these are fixed devices and cannot be adjusted to improve coordination. If improving selective coordination is required for this particular circuit and we recommend to upgrading device 306-01, QOB thermal magnetic to JD LI 3.2 and 306-02, QOB thermal magnetic to HD LI 3.2.

TCC-14 MDPH2:
Time-current coordination graph shows device numbers 229-02 SDPH22_SDPL22 and 233-01 SDPL22 MCB as well as other devices. The equipment designations for the installed devices are: SDPH22 and SDPL22 As shown by the graph, these devices overlap. However, these devices are in series and the loss of selectivity is acceptable as operation of either device affects the same portion of the system and full coordination is not required. This allows better coordination between these devices and the ones upstream and downstream.

TCC-15 SDPL21:
Time-current coordination graph shows device numbers 217-07 and 223-02 as well as other devices. The equipment designations for the installed devices are: SDPL21 and L21M1. As shown by the graphs, these devices do not coordinate well; however, these are fixed devices and cannot be adjusted to improve coordination.

TCC-20 SDPL2:
Time-current coordination graph shows device numbers 205-02 and 206-01 as well as other devices. The equipment designations for the installed devices are: L2M2 and L2M21. As shown by the graph, these devices overlap. However, these devices are in series and the loss of selectivity is acceptable as operation of either device affects the same portion of the system and full coordination is not required. This allows better coordination between these devices and the ones upstream and downstream.

TCC-21 MDPH2:
Time-current coordination graph shows device numbers 308-01 E2B1 MCB and 308-04 as well as other devices. The equipment designations for the installed devices are: E2B1. As shown by the graph, these devices do not selectively coordinate well. DPB2_L1E device has been adjusted to obtain the highest level of selectivity possible for the protection level required. If improving selective coordination is required for this particular circuit and we recommend to upgrading device 308-01 E2B1 MCB, JG thermal magnetic to JG LI 3.2 and 308-04, EG thermal magnetic to HG LI 3.2.

TCC-22 E2B1:
Time-current coordination graph shows device numbers 313-04 and 316-03 as well as other devices. The equipment designations for the installed devices are: E2B1 and E2B2. As shown by the graph, these devices do not coordinate well; however, these are fixed devices and cannot be adjusted to improve coordination. If improving selective coordination is required for this particular circuit and we recommend to upgrading device 313-01, ED thermal magnetic to HD LI 3.2.

TCC-23 E2B1:
Time-current coordination graph shows device numbers 308-02 and 309-02 as well as other devices. The equipment designations for the installed devices are: E2B1 and E2BL1. As shown by the graph, these devices do not coordinate well; however, these are fixed devices and cannot be adjusted to improve coordination. If improving selective coordination is required for this particular circuit and we recommend to upgrading device 308-02, EG thermal magnetic to HG LI 3.2.

TCC-23 E2B1:
Time-current coordination graph shows device numbers 309-01 E2BL1 MCB and 309-02 as well as other devices. The equipment designations for the installed devices are: E2B1. As shown by the graph, these devices do not selectively coordinate well. 309-01 E2BL1 MCB device has been adjusted to obtain the highest level of selectivity possible for the protection level required. If improving selective coordination is required for this particular circuit and we recommend to upgrading device 309-01 E2BL1 MCB, JD thermal magnetic to JD LI 3.2.

TCC-23 E2B1:
Time-current coordination graph shows device numbers 309-02 and 310-02 as well as other devices. The equipment designations for the installed devices are: E2BL1 and E2BL2. As shown by the graph, these devices do not coordinate well; however, these are fixed devices and cannot be adjusted to improve coordination. If improving selective coordination is required for this particular circuit and we recommend to upgrading device 309-02, QO-VH thermal magnetic to HD LI 3.2 and 310-02, QOB to EDB thermal magnetic.

TCC-24 MDPH1:
Time-current coordination graph shows device numbers 101-07 MDPH1_H1L4 and 105-02 H1L4_XFMR_MD/G as well as other devices. The equipment designations for the installed devices are: MDPH1 and H1L4. As shown by the graph, these devices do not coordinate well. These devices have been adjusted to obtain the highest level of selectivity possible for the protection level required.

TCC-25 MDPH1:
Time-current coordination graph shows device numbers 106-03 MD/G_G/GA and 107-02 as well as other devices. The equipment designations for the installed devices are: MD/G and G/GA. As shown by the graph, these devices do not selectively coordinate well. 106-03 MD/G_G/GA device has been adjusted to obtain the highest level of selectivity possible for the protection level required.

EMER TCC-01:
Time-current coordination graph shows device numbers 300-02 GEN SEC_ATS_E1B1 and 303-03 as well as other devices. The equipment designations for the installed devices are: GEN SEC and E1B1. As shown by the graph, these devices do not coordinate well; however, these are fixed devices and cannot be adjusted to improve coordination. If improving selective coordination is required for this particular circuit and we recommend to upgrading device 300-02 GEN SEC_ATS_E1B1, JGE thermal magnetic to FDE 310+ LS.

EMER TCC-02:
Reference selective coordination comment on time-current coordination graph **TCC-21 MDPH2:**

5.4 Overcurrent Device Setting Tables

DEVICE		DESCRIPTION			SETTINGS						
BUS NUMBER & NAME	DEVICE NUMBER & NAME	MANUFACTURER & TYPE	BUS VOLTAGE	FRAME SENSOR PLUG	LONG TIME		SHORT TIME		INST	GROUND	
					PICKUP	DELAY	PICKUP	DELAY (I^2T)		PICKUP	DELAY (I^2T)
100 UTC_MDPH1	100-02 UTC_MDPH1	SQUARE D Masterpact NW, 5.0 & 6.0 A/P/H LSI, 400-6000AS, UL	480.0V	3000.0A 3000.0A	1	8	5 (15000A)	0.1 (I^2t Off)	15 (45000A)	D (800A)	0.2 (I^2t Off)
101 MDPH1	101-02 MDPH1_ACC-3	SQUARE D JG 150-250A	480.0V	250.0A 175.0A					LO (875A)		
101 MDPH1	101-03 MDPH1_ACC-2	SQUARE D PowerPact L-Frame, 3.3 LI, 600AS	480.0V	600.0A 600.0A 600.0A	450 (450A)	16 sec			5 (3000A)		
101 MDPH1	101-04 MDPH1_H1L1	SQUARE D PowerPact L-Frame, 3.3 LI, 400AS	480.0V	400.0A 400.0A 400.0A	400 (400A)	16 sec			4 (1600A)		
101 MDPH1	101-06 MDPH1_H1L3	SQUARE D JG 150-250A	480.0V	250.0A 225.0A					LO (1125A)		
101 MDPH1	101-07 MDPH1_H1L4	SQUARE D PowerPact L-Frame, 3.3 LI, 600AS	480.0V	600.0A 600.0A 600.0A	500 (500A)	16 sec			8 (4800A)		
101 MDPH1	101-08 MDPH1_XFMR_SDPL1	SQUARE D Powerpact R/P-Frame, 1.0I LI, 250-2500A, UL	480.0V	1200.0A 1000.0A	1	Fixed			10 (10000A)		
102 H1L1	102-02 H1L1 FEEDER	SQUARE D JG 150-250A	480.0V	250.0A 200.0A					LO (1000A)		
105 H1L4	105-02 H1L4_XFMR_MD/G	SQUARE D LA (10/04) 125-400A, 2-3 poles	480.0V	400.0A 300.0A					HI (3000A)		

Frame, Sensor and Plug types must be verified to agree with this list prior to installing settings. I2t dial settings follow In = On and Out = Off.

DEVICE		DESCRIPTION			SETTINGS						
BUS NUMBER & NAME	DEVICE NUMBER & NAME	MANUFACTURER & TYPE	BUS VOLTAGE	FRAME SENSOR PLUG	LONG TIME		SHORT TIME		INST	GROUND	
					PICKUP	DELAY	PICKUP	DELAY (I^2T)		PICKUP	DELAY (I^2T)
106 MD/G	106-02 MD/G Feeder	GE TJK 125-600A	208.0V	400.0A 400.0A					HI (4000A)		
106 MD/G	106-03 MD/G_G/GA	GE TFJ 70-225A	208.0V	225.0A 200.0A					HI (2000A)		
108 SDPL1	108-01 SDPL1 MCB	SQUARE D Powerpact R/P-Frame, 1.0I LI, 250-2500A, UL	208.0V	2500.0A 2000.0A	1	Fixed			5 (10000A)		
108 SDPL1	108-03 SDPL1_L1L1	SQUARE D PowerPact L-Frame, 3.3 LI, 600AS	208.0V	600.0A 600.0A 600.0A	600 (600A)	2 sec			8 (4800A)		
108 SDPL1	108-04 SDPL1_L1L2	SQUARE D PowerPact L-Frame, 3.3 LI, 600AS	208.0V	600.0A 600.0A 600.0A	600 (600A)	8 sec			8 (4800A)		
108 SDPL1	108-05 SDPL1_L1L3	SQUARE D PowerPact L-Frame, 3.3 LI, 400AS	208.0V	400.0A 400.0A 400.0A	400 (400A)	2 sec			8 (3200A)		
110 L1L1	110-01 L1L1 MCB	SQUARE D PowerPact L-Frame, 3.3 LI, 600AS	208.0V	600.0A 600.0A 600.0A	600 (600A)	2 sec			8 (4800A)		
111 L1L2	111-01 L1L2 MCB	SQUARE D PowerPact L-Frame, 3.3 LI, 600AS	208.0V	600.0A 600.0A 600.0A	600 (600A)	8 sec			8 (4800A)		
112 L1L3	112-01 L1L3 MCB	SQUARE D PowerPact L-Frame, 3.3 LI, 400AS	208.0V	400.0A 400.0A 400.0A	400 (400A)	2 sec			8 (3200A)		

Frame, Sensor and Plug types must be verified to agree with this list prior to installing settings. I2t dial settings follow In = On and Out = Off.

DEVICE		DESCRIPTION			SETTINGS						
					LONG TIME		SHORT TIME		INST	GROUND	
BUS NUMBER & NAME	DEVICE NUMBER & NAME	MANUFACTURER & TYPE	BUS VOLTAGE	FRAME SENSOR PLUG	PICKUP	DELAY	PICKUP	DELAY (I^2T)		PICKUP	DELAY (I^2T)
200 UTC2_MDPH2	200-02 UTC2_MDPH2	SQUARE D Masterpact NW, 5.0 & 6.0 A/P/H LSI, 400-6000AS, UL	480.0V	3000.0A 3000.0A	1	8	5 (15000A)	0.1 (I^2t Off)	15 (45000A)	D (800A)	0.2 (I^2t Off)
201 MDPH2	201-03 MDPH2_XFMR_SDPL2	SQUARE D PowerPact L-Frame, 3.3 LI, 600AS	480.0V	600.0A 600.0A 600.0A	600 (600A)	8 sec			11 (6600A)		
201 MDPH2	201-04 MDPH2_ACC-1	SQUARE D PowerPact L-Frame, 3.3 LI, 600AS	480.0V	600.0A 600.0A 600.0A	450 (450A)	16 sec			8 (4800A)		
201 MDPH2	201-05 MDPH2_H2M1	SQUARE D JG 150-250A	480.0V	250.0A 225.0A					LO (1125A)		
201 MDPH2	201-06 MDPH2_H2M2	SQUARE D PowerPact L-Frame, 3.3 LI, 400AS	480.0V	400.0A 400.0A 400.0A	400 (400A)	0.5 sec			3 (1200A)		
201 MDPH2	201-07 MDPH2_H2B2	SQUARE D PowerPact L-Frame, 3.3 LI, 400AS	480.0V	400.0A 400.0A 400.0A	400 (400A)	0.5 sec			3 (1200A)		
201 MDPH2	201-09 MDPH2_SDPH21	SQUARE D Powerpact R/P-Frame, 1.0I LI, 250-2500A, UL	480.0V	1200.0A 1000.0A	1	Fixed			8 (8000A)		
201 MDPH2	201-10 MDPH2_SDPH22	SQUARE D Powerpact R/P-Frame, 1.0I LI, 250-2500A, UL	480.0V	1200.0A 1000.0A	1	Fixed			10 (10000A)		
202 SDPL2	202-01 SDPL2 MCB	SQUARE D Powerpact R/P-Frame, 1.0I LI, 250-2500A, UL	208.0V	1200.0A 1200.0A	1	Fixed			4 (4800A)		

Frame, Sensor and Plug types must be verified to agree with this list prior to installing settings. I2t dial settings follow In = On and Out = Off.

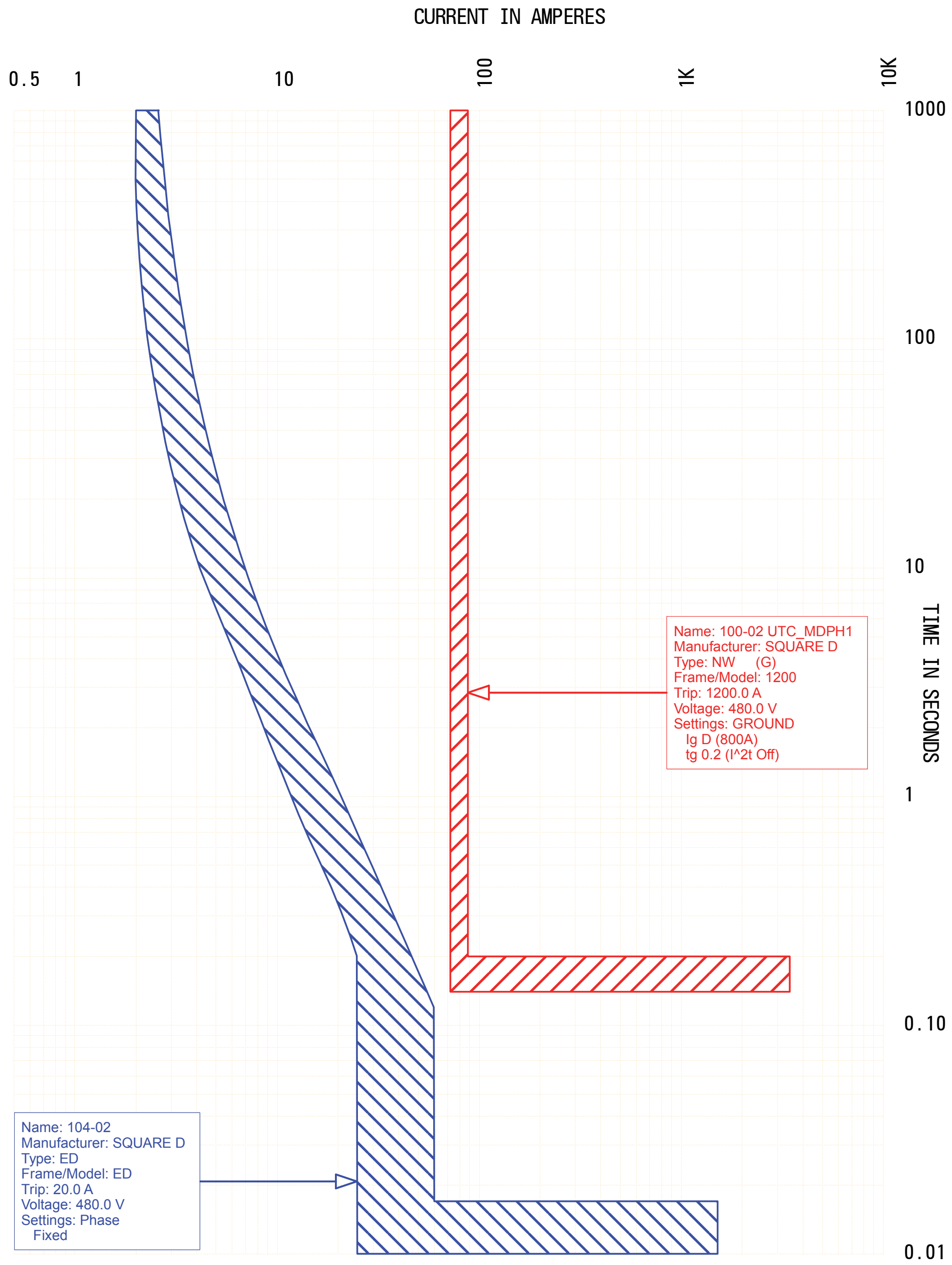
DEVICE		DESCRIPTION			SETTINGS						
					LONG TIME		SHORT TIME			GROUND	
BUS NUMBER & NAME	DEVICE NUMBER & NAME	MANUFACTURER & TYPE	BUS VOLTAGE	FRAME SENSOR PLUG	PICKUP	DELAY	PICKUP	DELAY (I^2T)	INST	PICKUP	DELAY (I^2T)
202 SDPL2	202-02 SDPL2_L2M1	SQUARE D PowerPact L-Frame, 3.3 LI, 600AS	208.0V	600.0A 600.0A 600.0A	600 (600A)	1 sec			5 (3000A)		
202 SDPL2	202-03 SDPL2_L2M2	SQUARE D PowerPact L-Frame, 3.3 LI, 400AS	208.0V	400.0A 400.0A 400.0A	400 (400A)	8 sec			8 (3200A)		
203 L2M1	203-02 L2M1_L2M11	SQUARE D PowerPact L-Frame, 3.3 LI, 400AS	208.0V	400.0A 400.0A 400.0A	300 (300A)	0.5 sec			4 (1600A)		
213 SDPH21	213-02 SDPH21_SDPL21	SQUARE D PowerPact L-Frame, 3.3 LI, 600AS	480.0V	600.0A 600.0A 600.0A	600 (600A)	8 sec			11 (6600A)		
217 SDPL21	217-01 SDPL21 MCB	SQUARE D Powerpact R/P-Frame, 1.0I LI, 250-2500A, UL	208.0V	1200.0A 1200.0A	1	Fixed			4 (4800A)		
229 SDPH22	229-02 SDPH22_SDPL22	SQUARE D PowerPact L-Frame, 3.3 LI, 600AS	480.0V	600.0A 600.0A 600.0A	600 (600A)	8 sec			11 (6600A)		
233 SDPL22	233-01 SDPL22 MCB	SQUARE D Powerpact R/P-Frame, 1.0I LI, 250-2500A, UL	208.0V	1200.0A 1200.0A	1	Fixed			4 (4800A)		
300 GEN SEC	300-02 GEN SEC_ATS_E1B1 REC	CUTLER-HAMMER FDE/FDCE/HFDE, 310+ LS, 80-225AS, I2T	480.0V	225.0A 160.0A 125.0A	F (125) (125A)	7	12 (1500A)	Fixed (I^2t Off)	Fixed (1920A)		
300 GEN SEC	300-02 GEN SEC_ATS_E1B1	CUTLER-HAMMER JG, Series G 80-250A, Adj. Mag, IEC	480.0V	100.0A 100.0A					10X (1000A)		

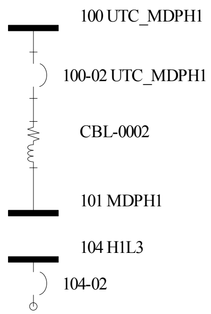
Frame, Sensor and Plug types must be verified to agree with this list prior to installing settings. I2t dial settings follow In = On and Out = Off.

DEVICE		DESCRIPTION			SETTINGS						
BUS NUMBER & NAME	DEVICE NUMBER & NAME	MANUFACTURER & TYPE	BUS VOLTAGE	FRAME SENSOR PLUG	LONG TIME		SHORT TIME		INST	GROUND	
					PICKUP	DELAY	PICKUP	DELAY (I^2T)		PICKUP	DELAY (I^2T)
300 GEN SEC	300-03 GEN SEC_ATS_E2B1	CUTLER-HAMMER JG, Series G 80-250A, Adj. Mag, IEC	480.0V	250.0A 225.0A					10X (2250A)		
308 E2B1	308-01 E2B1 MCB REC	SQUARE D PowerPact J-Frame, 3.2 LI, 70-250A	480.0V	250.0A 250.0A 250.0A	150 (150A)	16 sec			10 (2500A)		
308 E2B1	308-01 E2B1 MCB	SQUARE D JG 150-250A	480.0V	250.0A 150.0A					HI (1500A)		
308 E2B1	308-02 REC	SQUARE D PowerPact H-Frame, 3.2 LI, 100AS	480.0V	150.0A 100.0A 100.0A	100 (100A)	8 sec			12 (1200A)		
309 E2BL1	309-01 E2BL1 MCB	SQUARE D JD 150-250A	208.0V	250.0A 200.0A					HI (2000A)		
313 E2B2	313-04 REC	SQUARE D PowerPact H-Frame, 3.2 LI, 150AS	480.0V	150.0A 150.0A 150.0A	60 (60A)	4 sec			12 (1800A)		

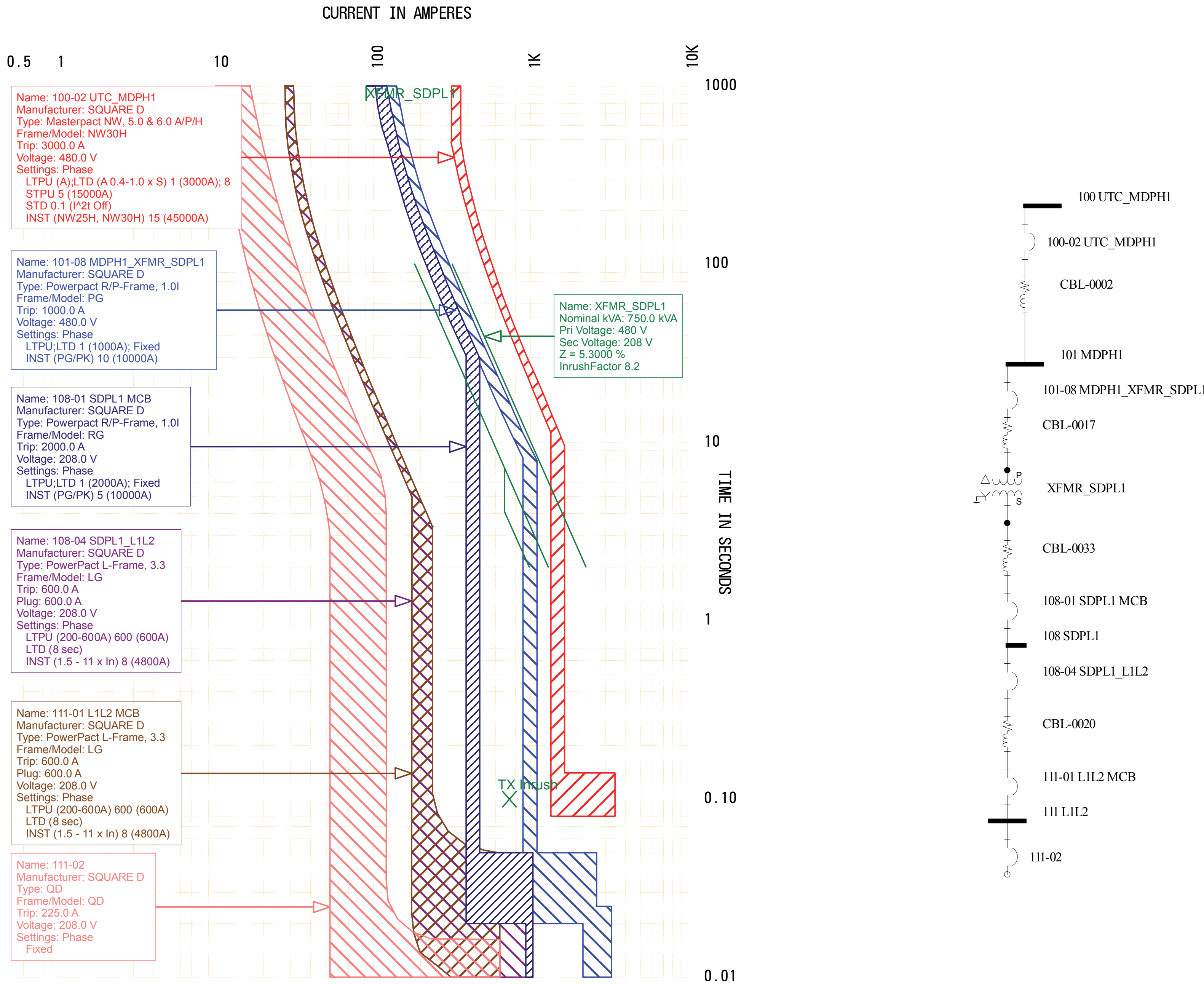
Frame, Sensor and Plug types must be verified to agree with this list prior to installing settings. I2t dial settings follow In = On and Out = Off.

5.5 Time-Current Coordination Graphs - Recommended Settings





TCC: GROUND 1 | Current Scale x 10 | Reference Voltage: 480 | July 21, 2014



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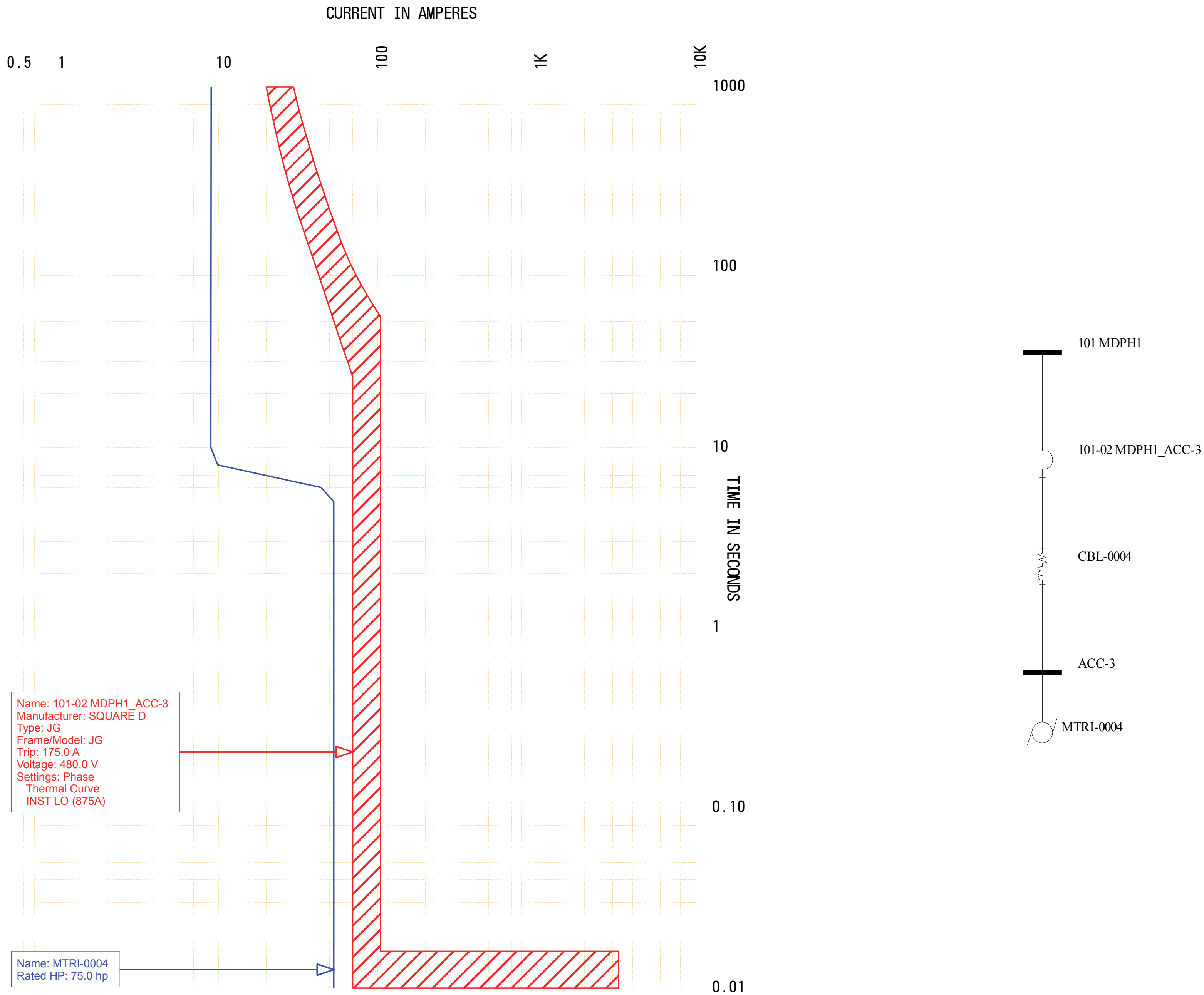

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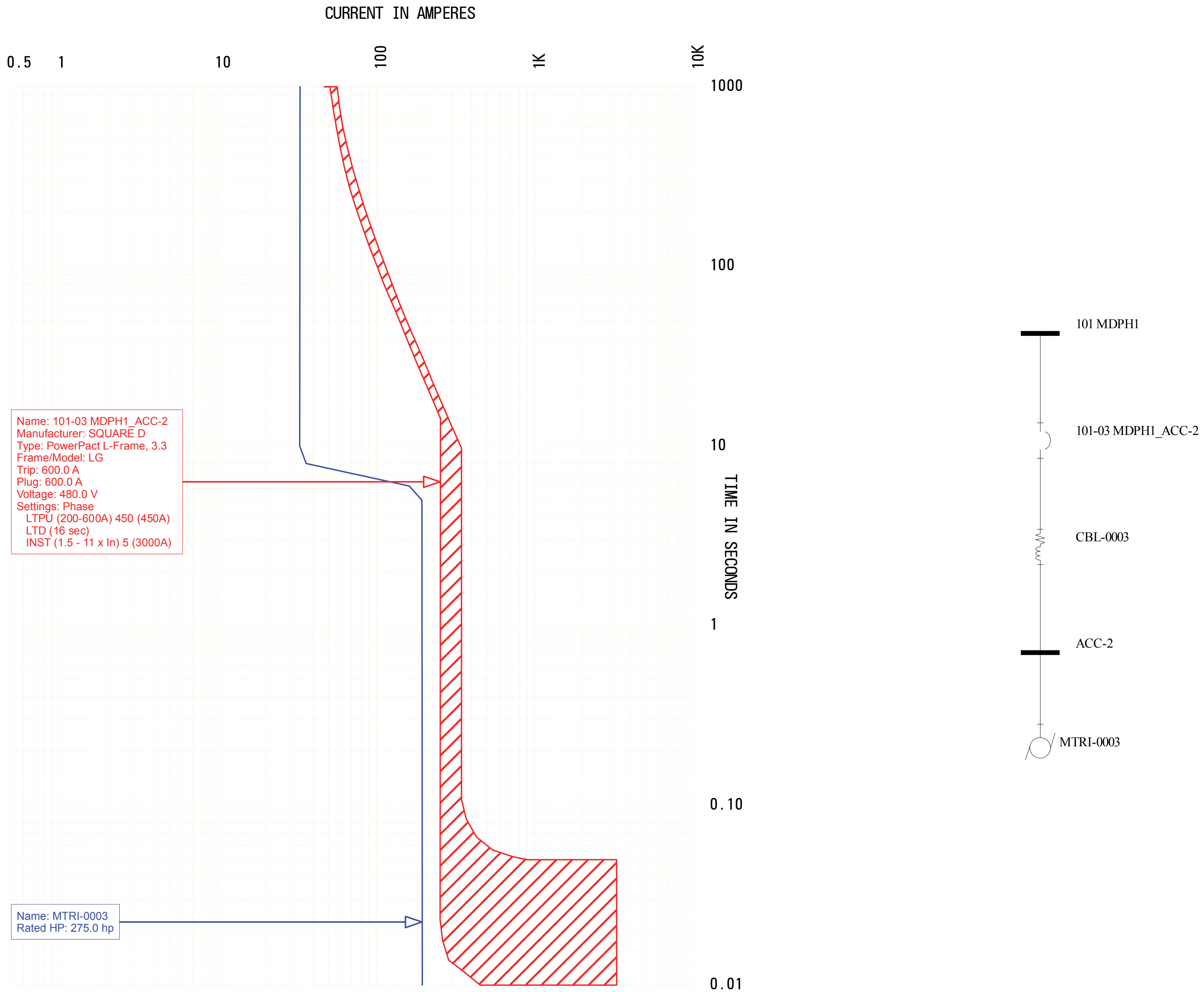

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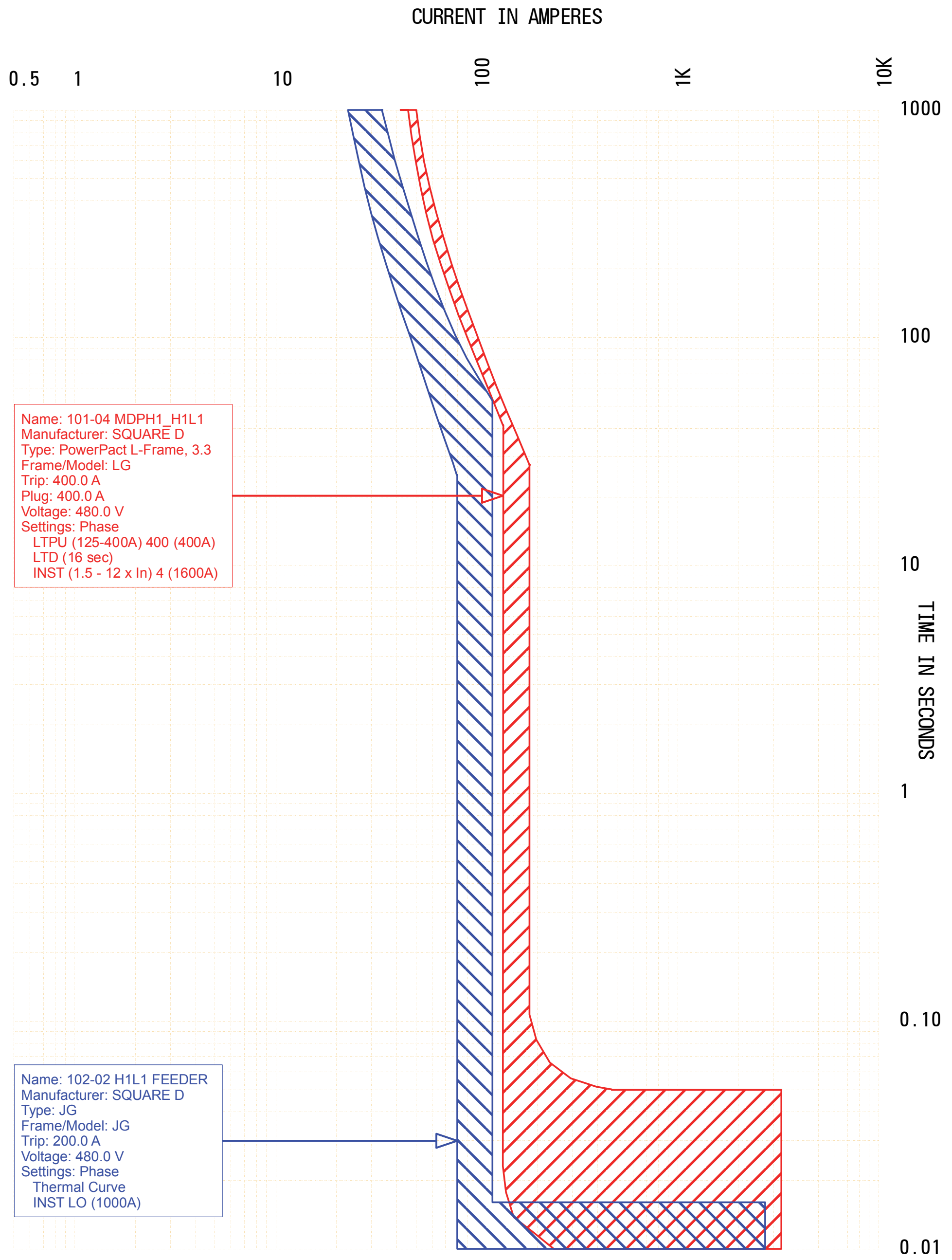
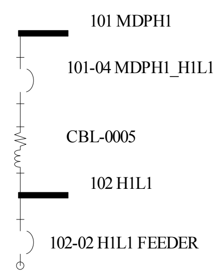


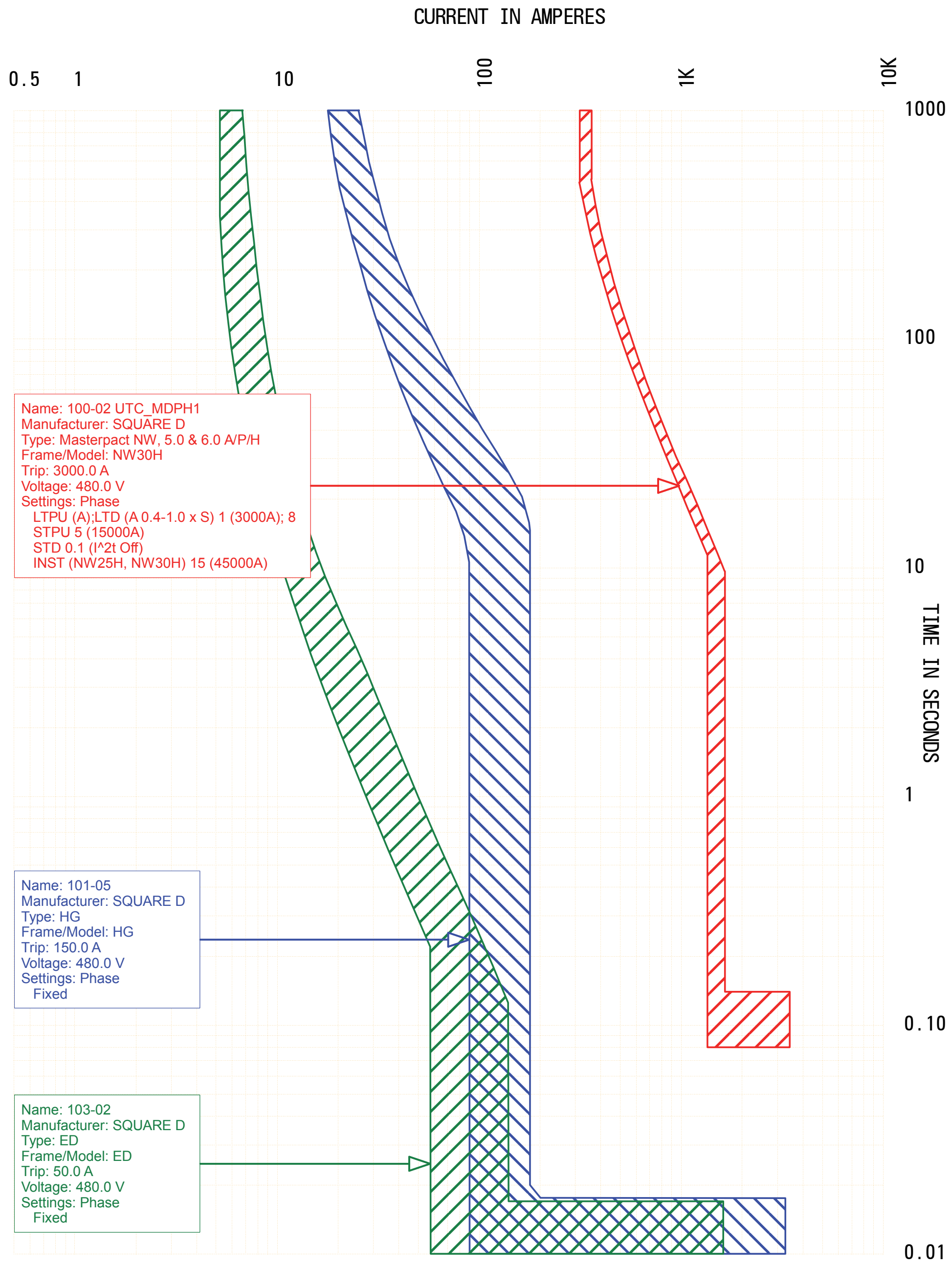


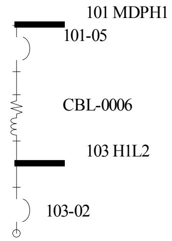
TCC: TCC-04 MDPH1

Current Scale x 10

Reference Voltage: 480

July 21, 2014





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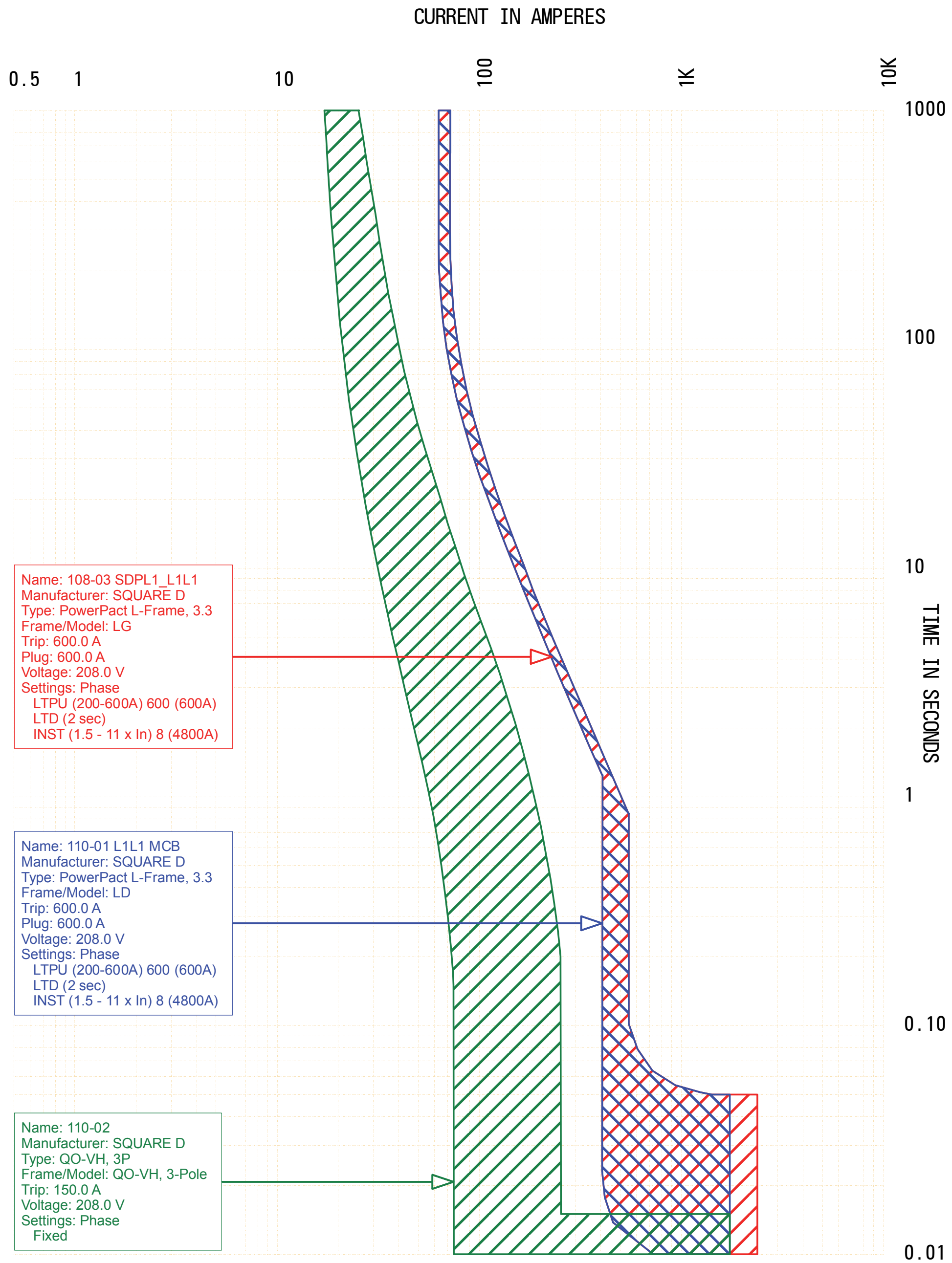
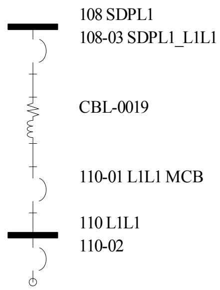


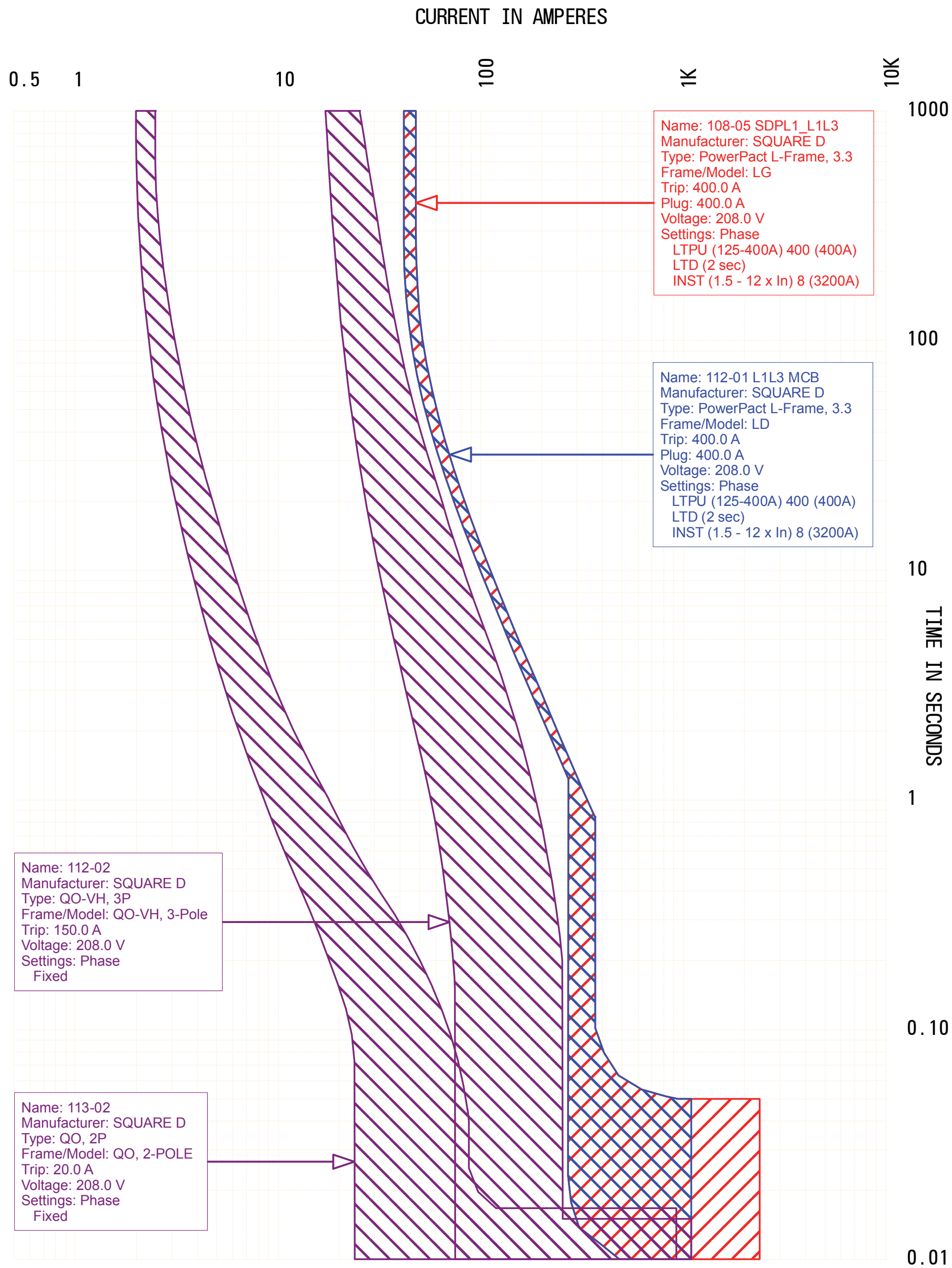


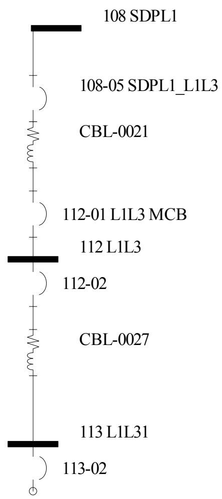
TCC: TCC-06 SDPL1

Current Scale x 10

Reference Voltage: 208

July 21, 2014





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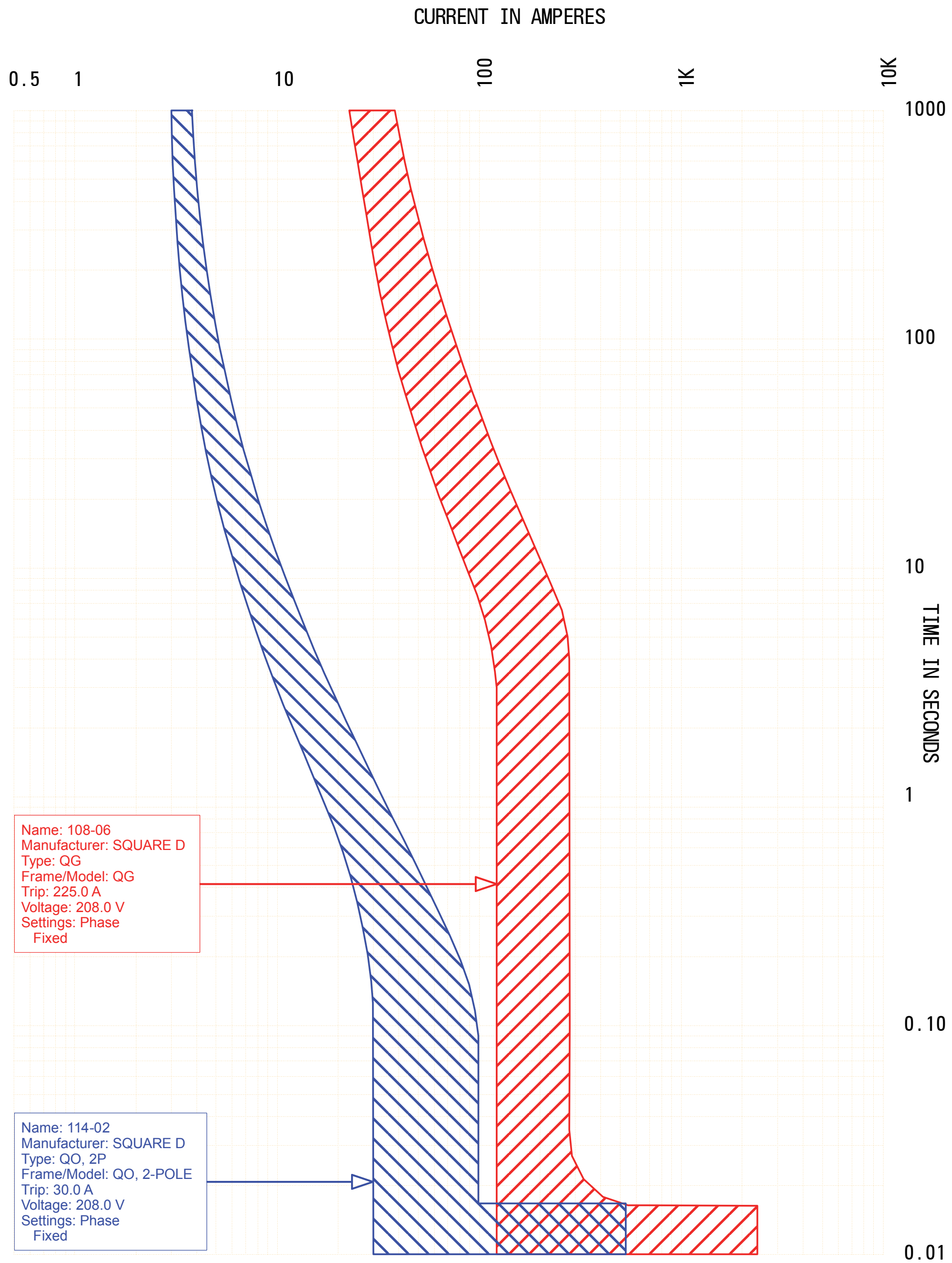

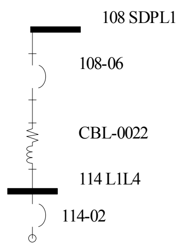

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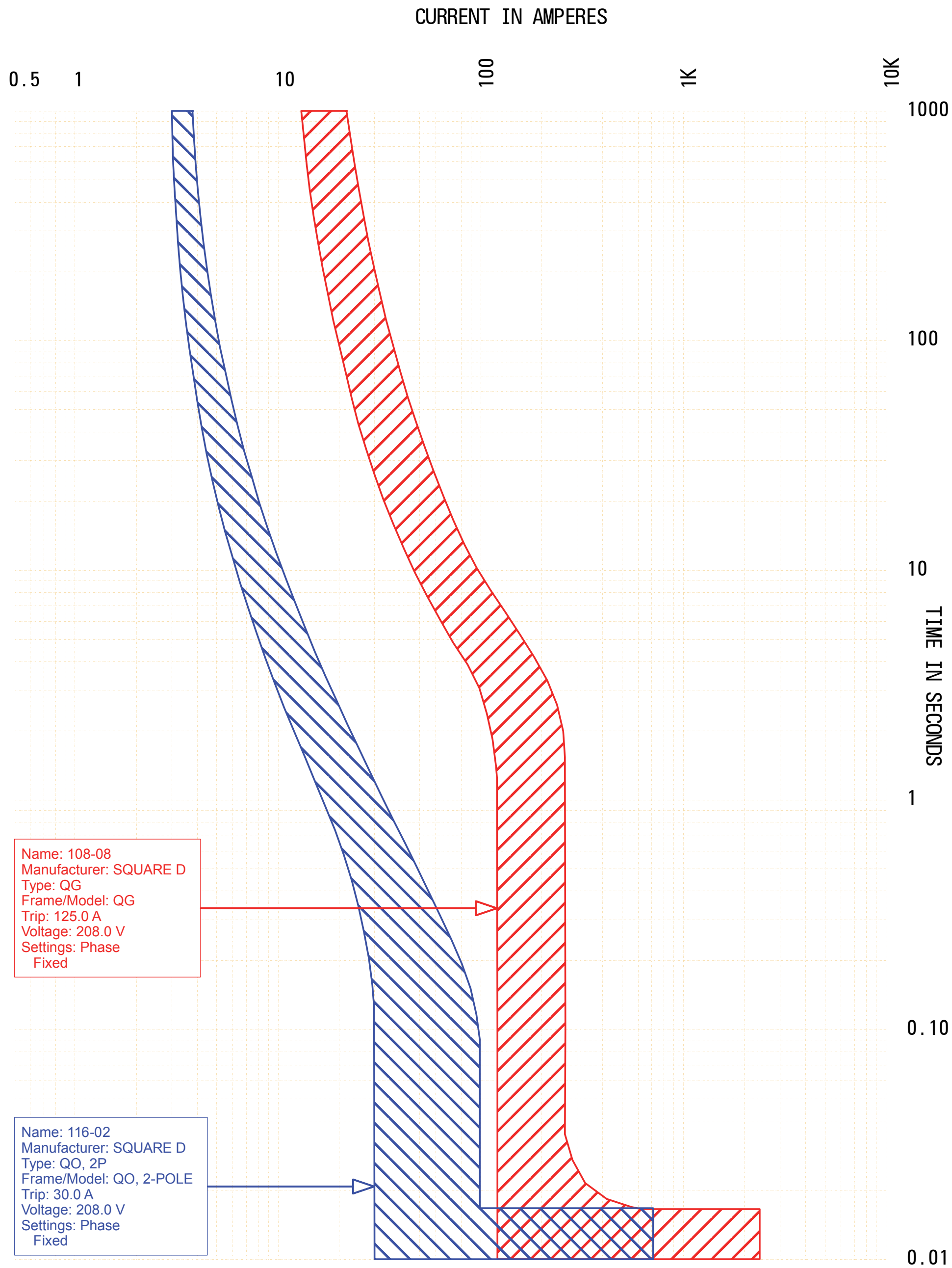

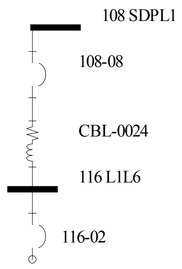

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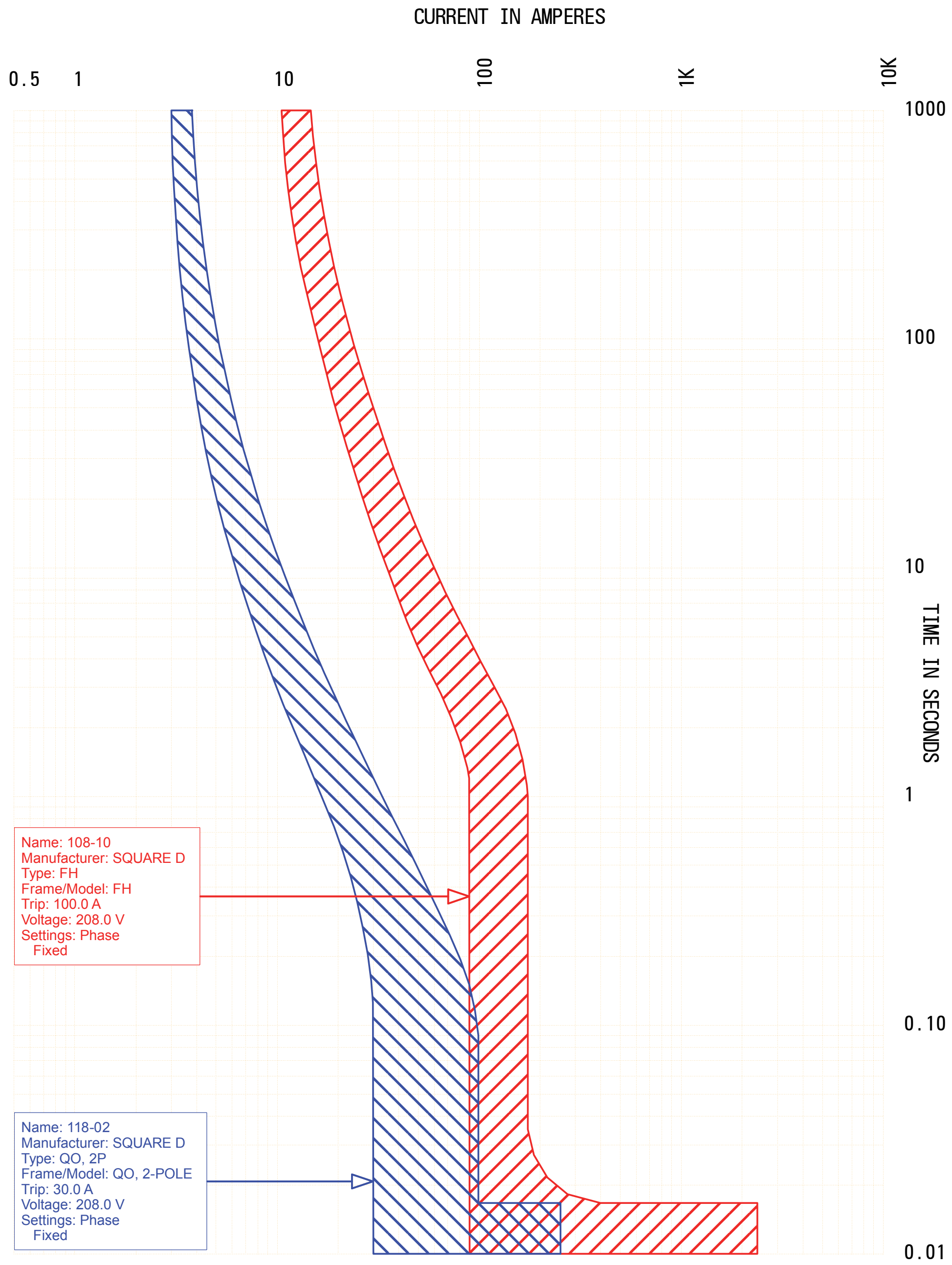

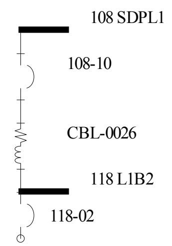

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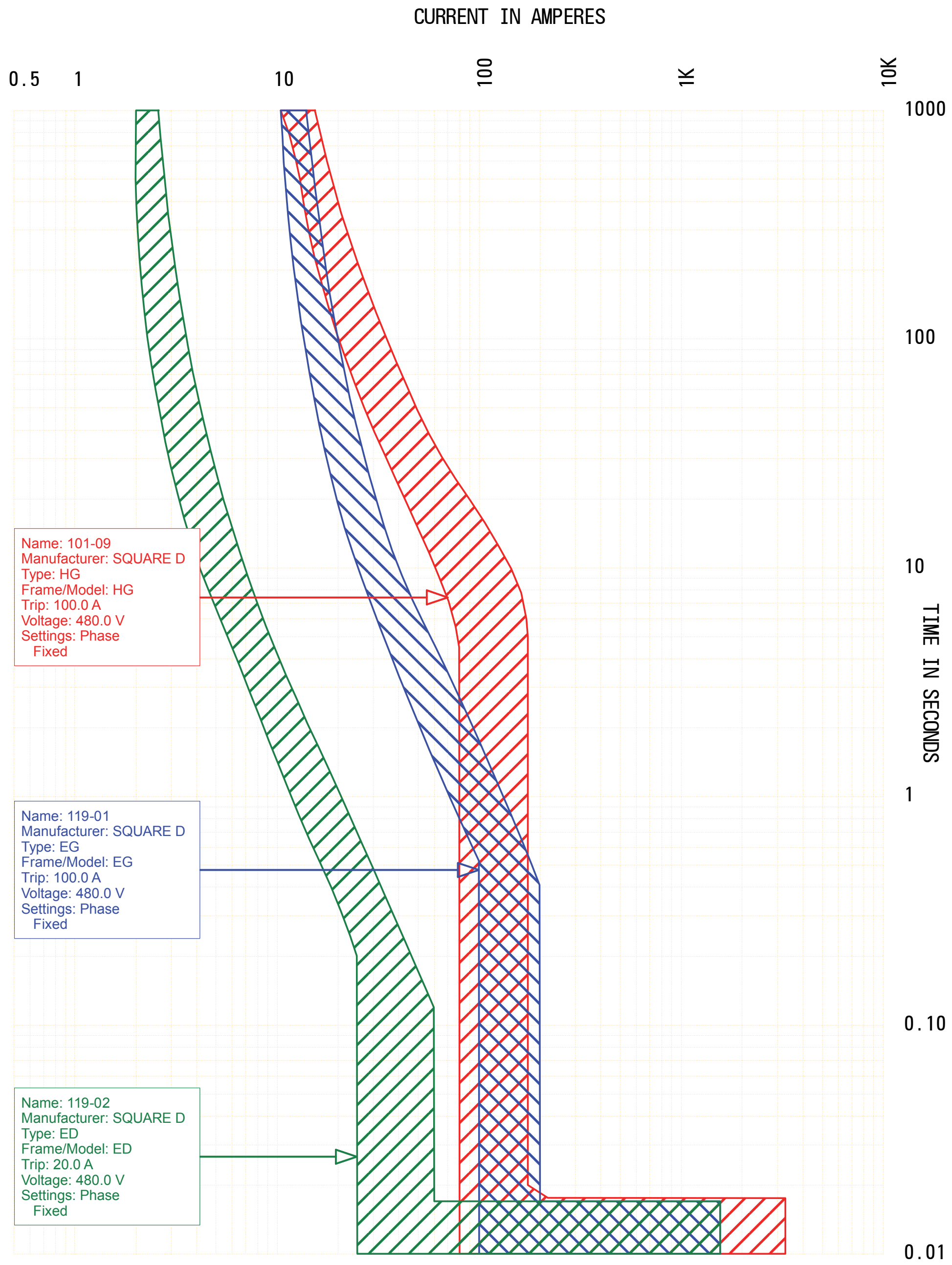

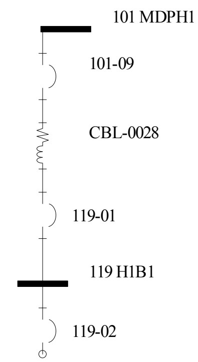

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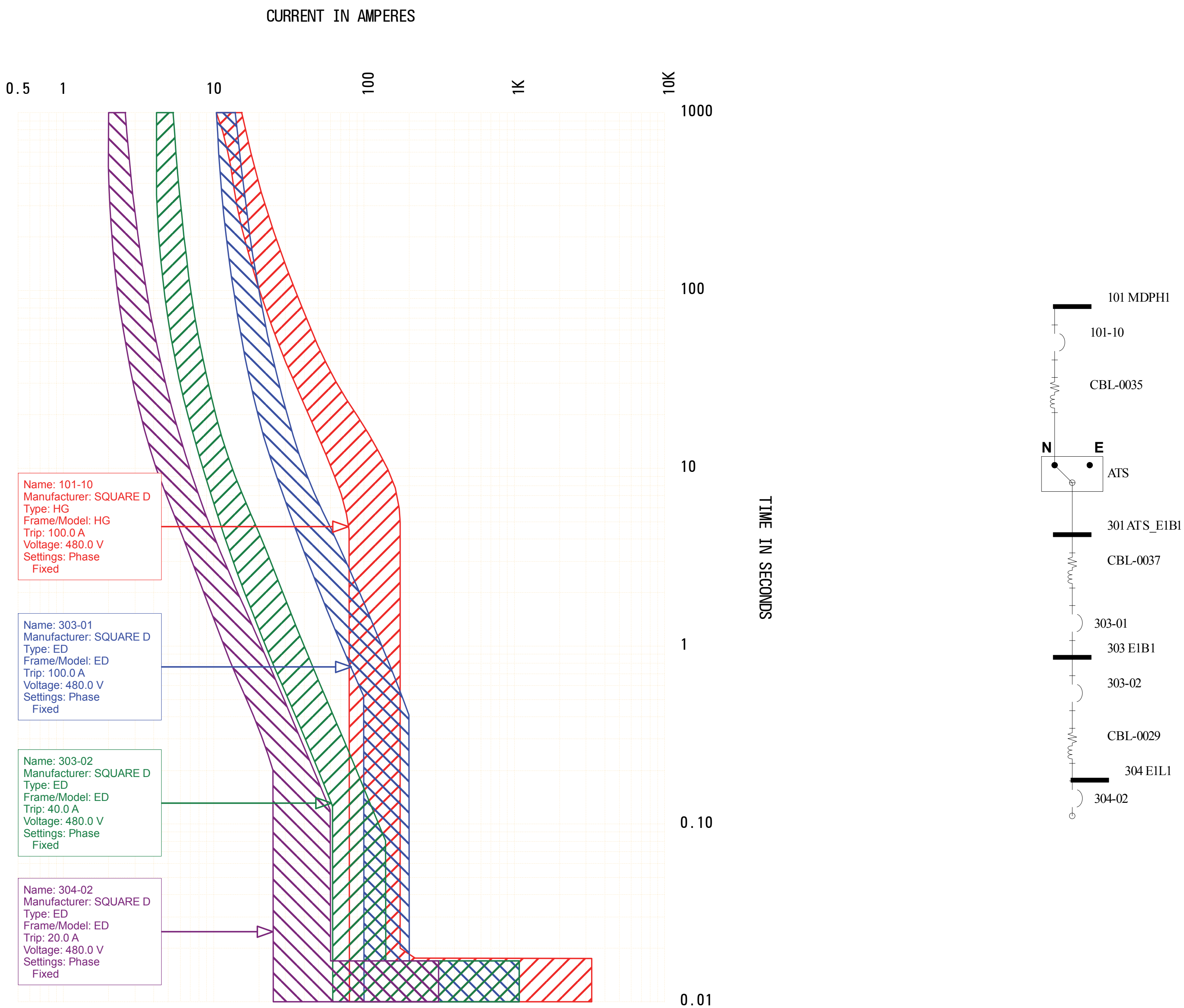

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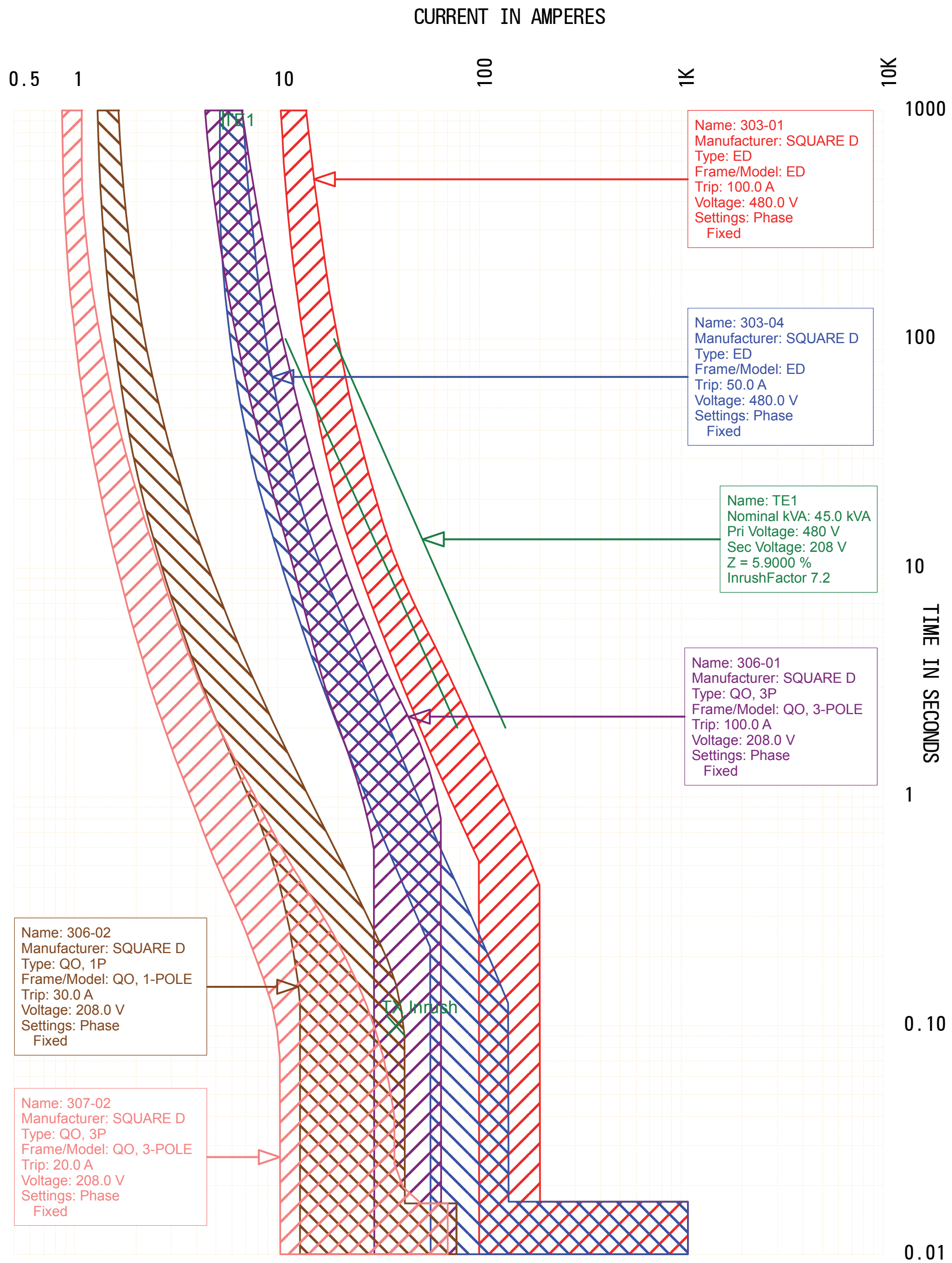

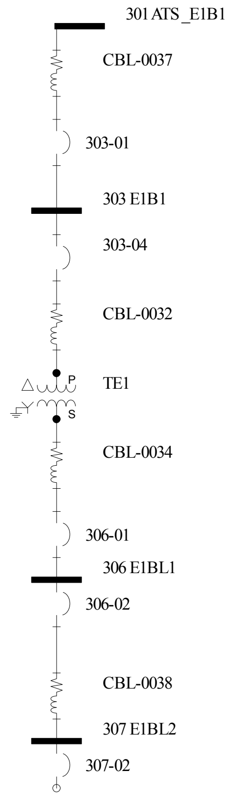

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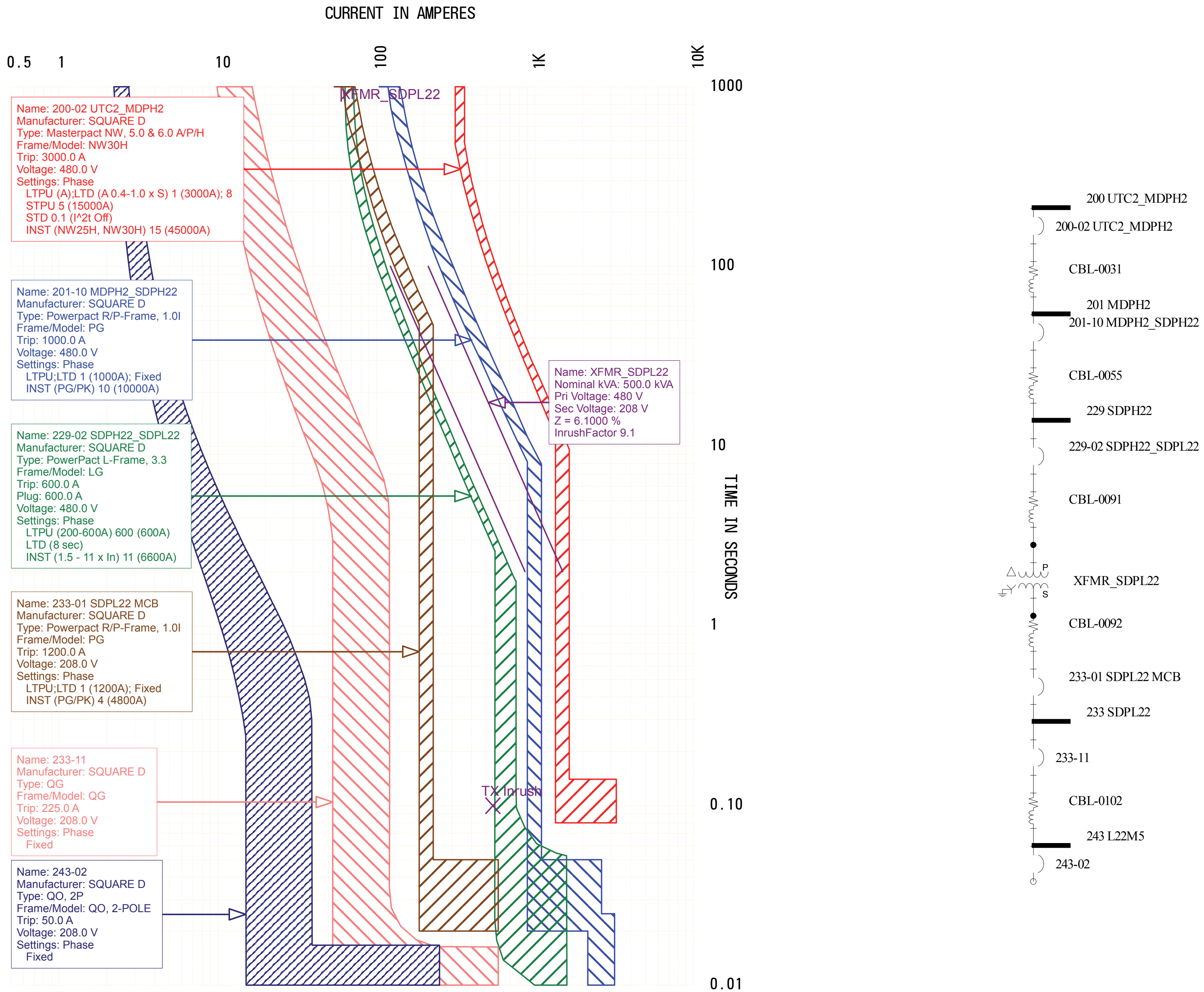

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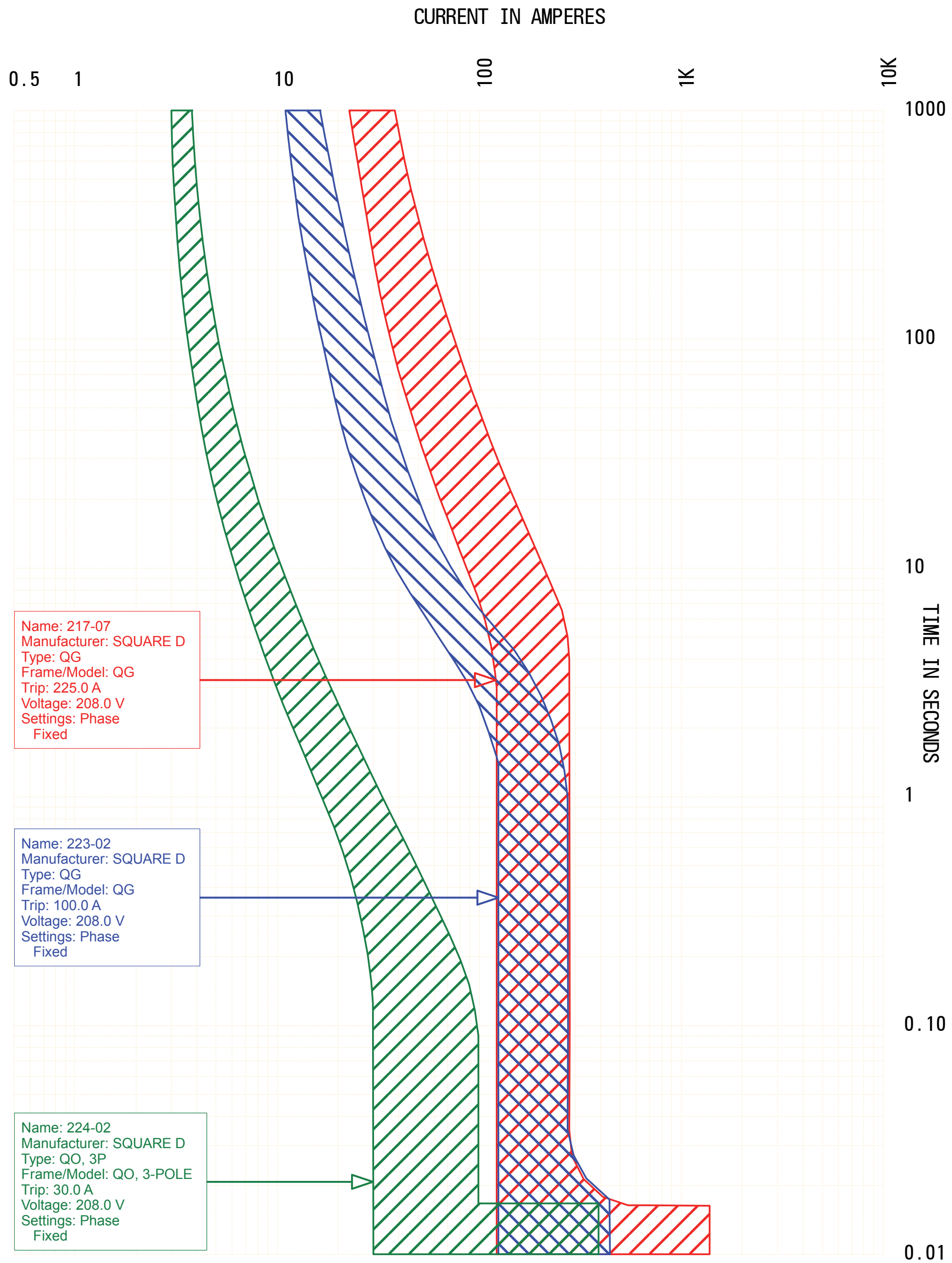

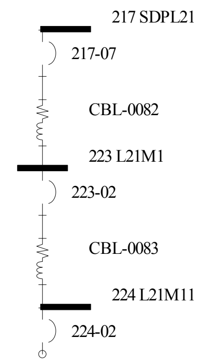

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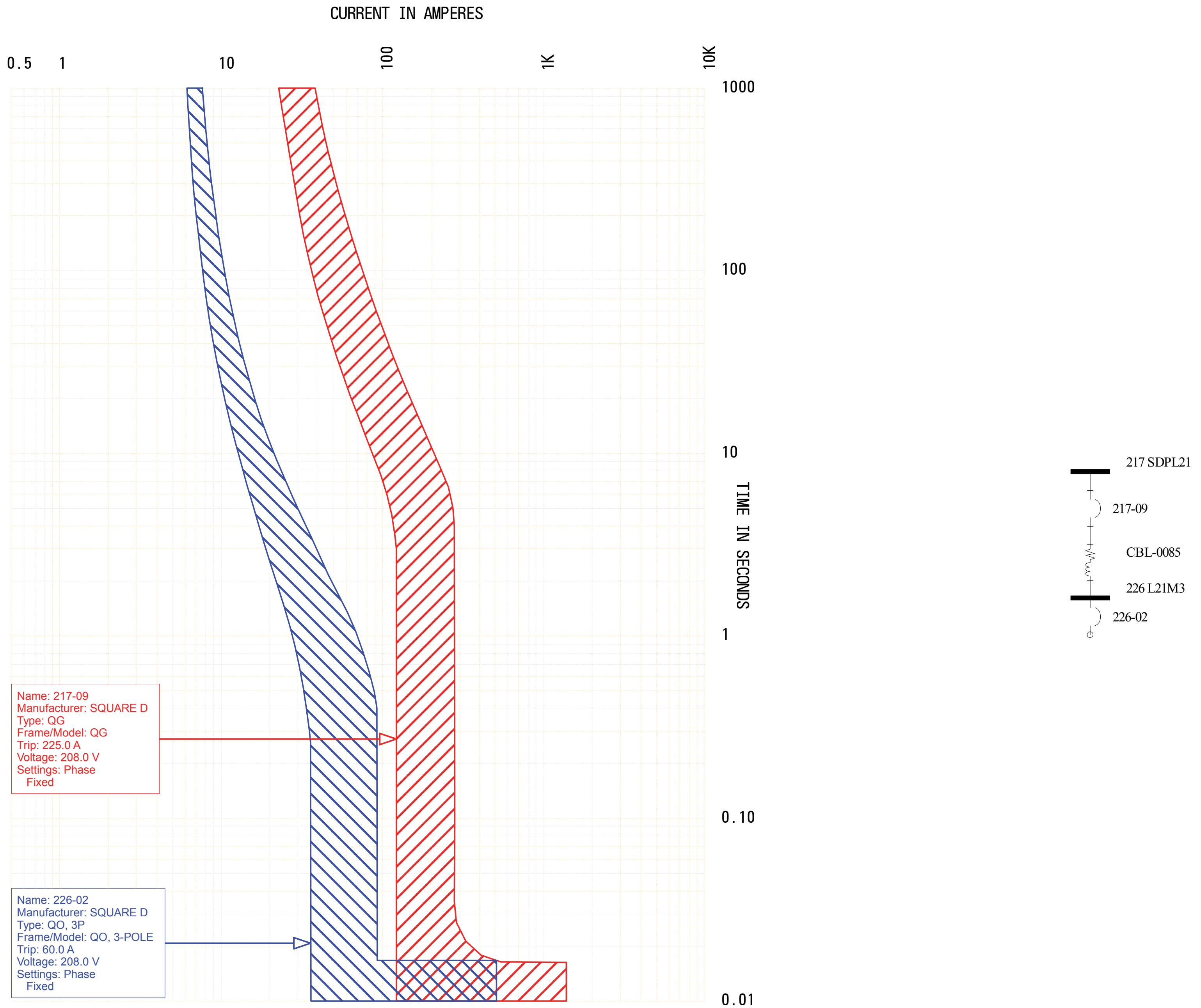
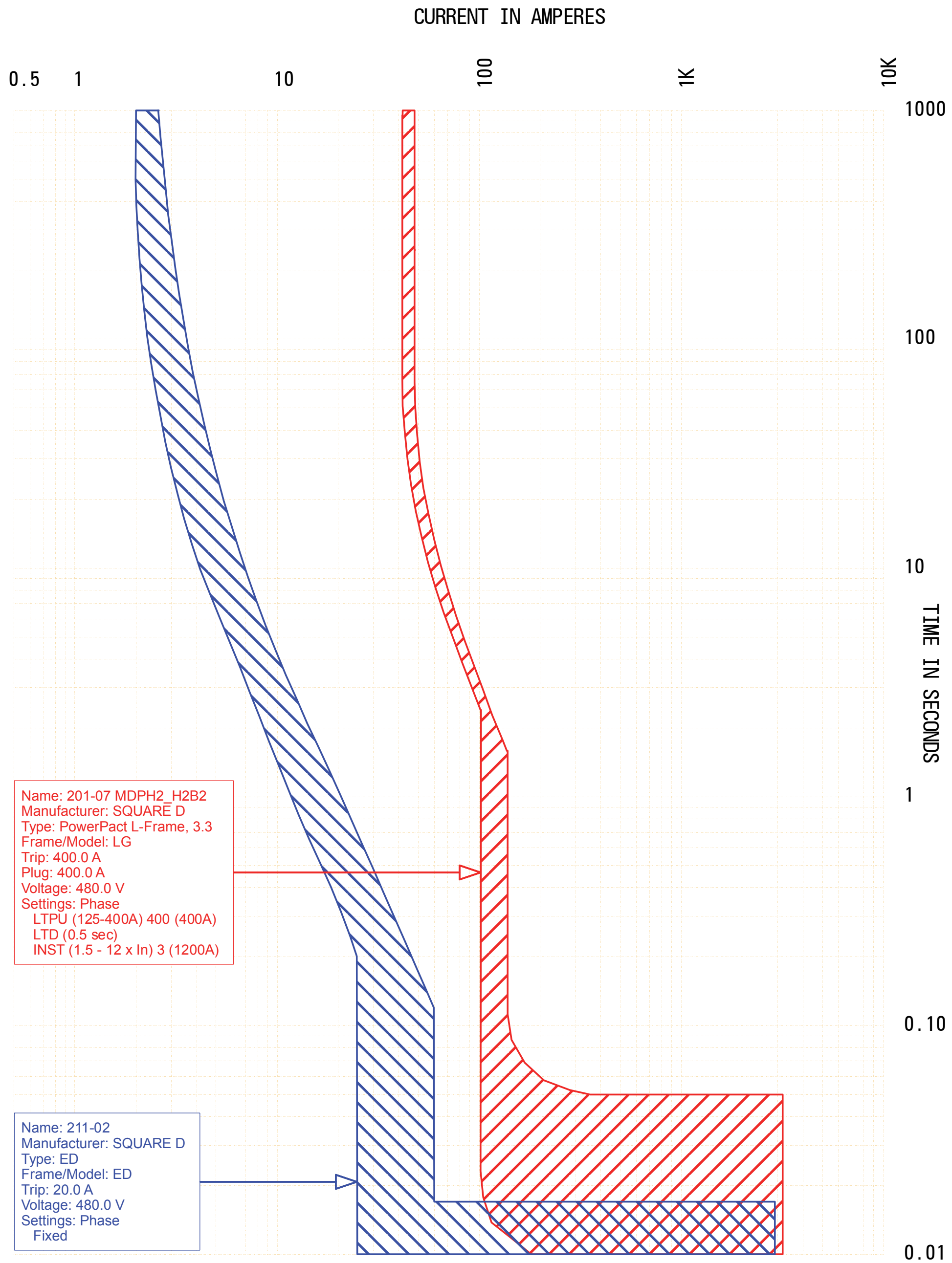
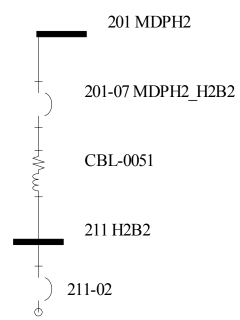
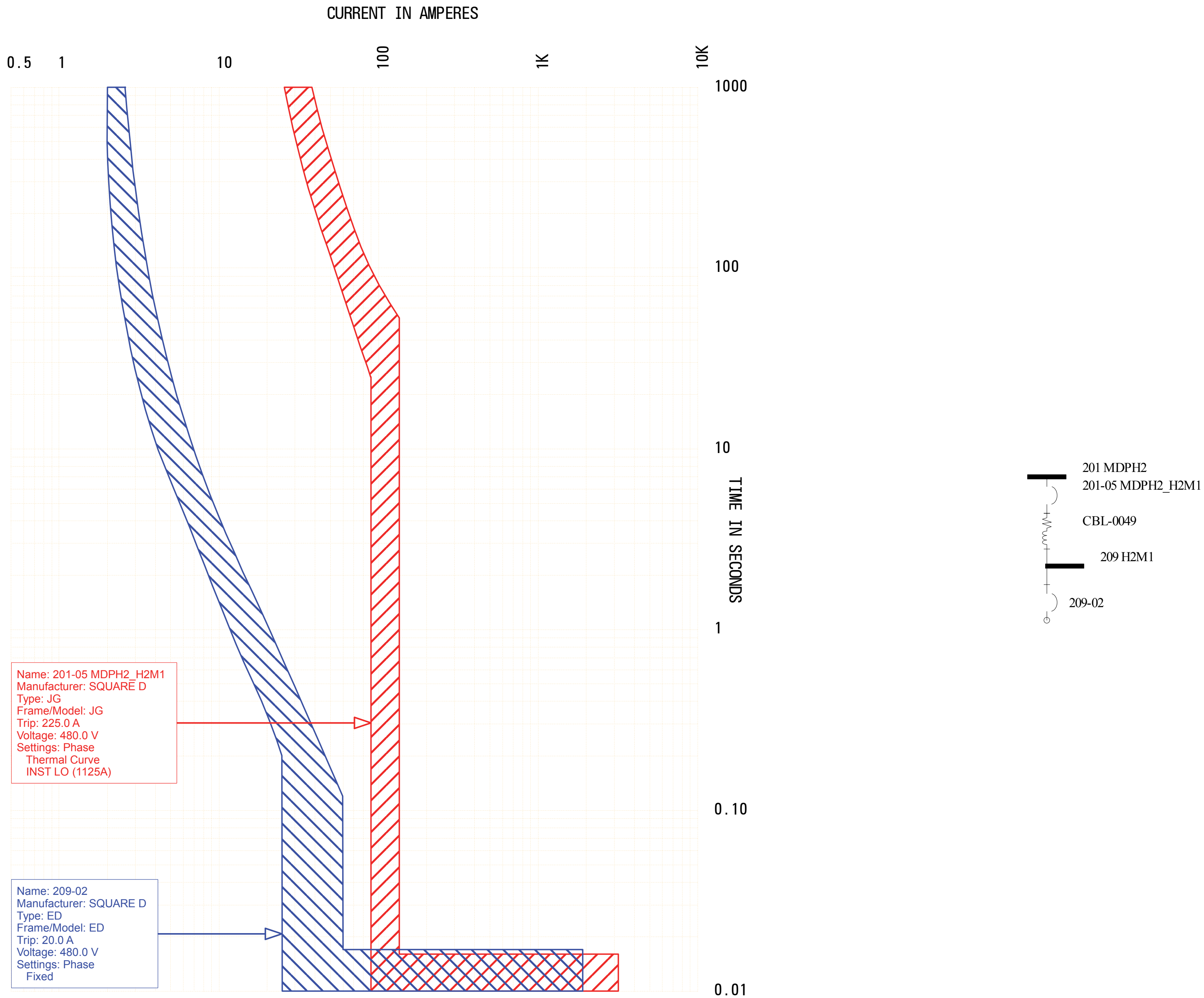


TCC: TCC-16 SDPL21 | Current Scale x 10 | Reference Voltage: 208 | July 21, 2014





TCC: TCC-17 MDPH2 Current Scale x 10 Reference Voltage: 480 July 21, 2014



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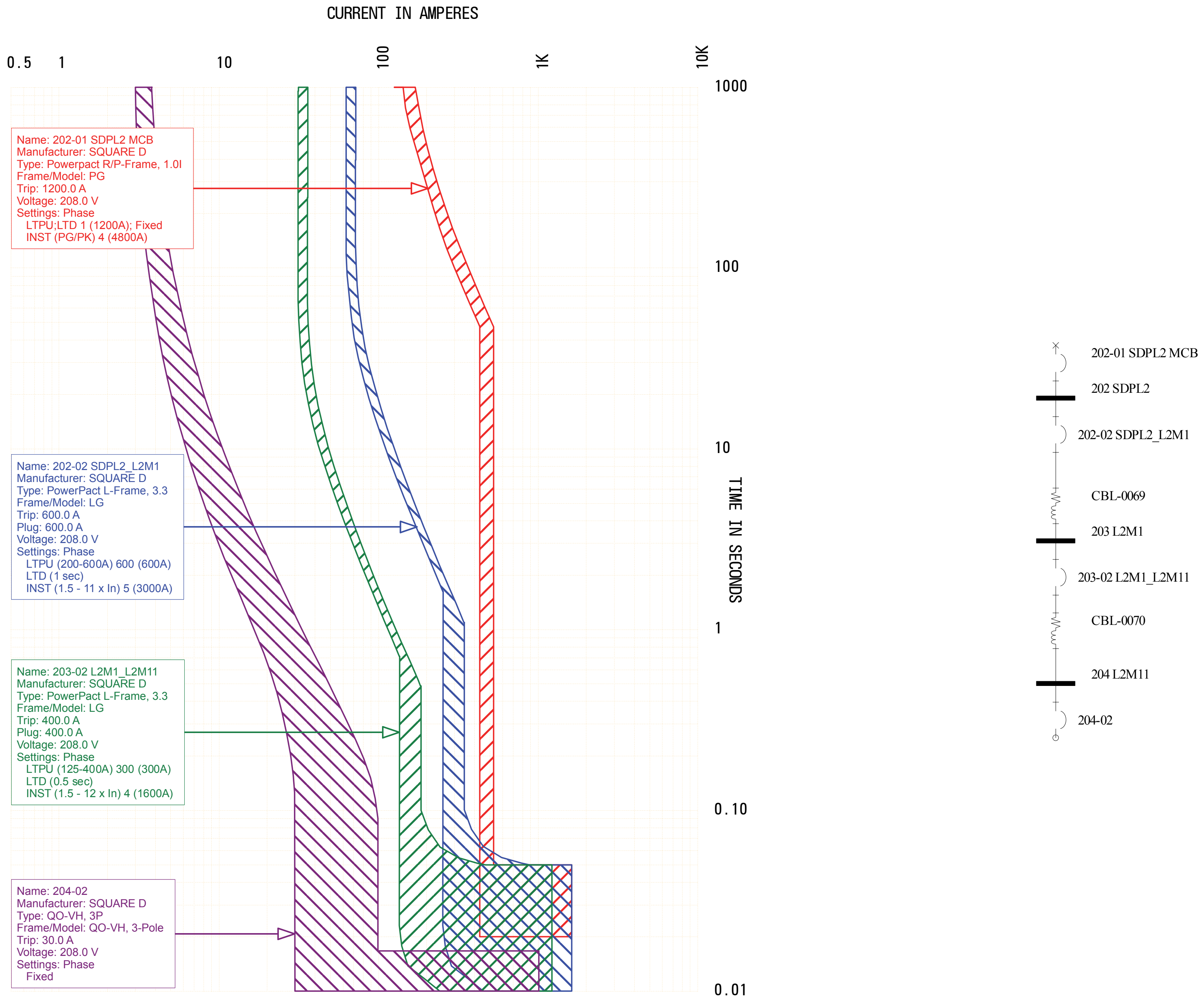
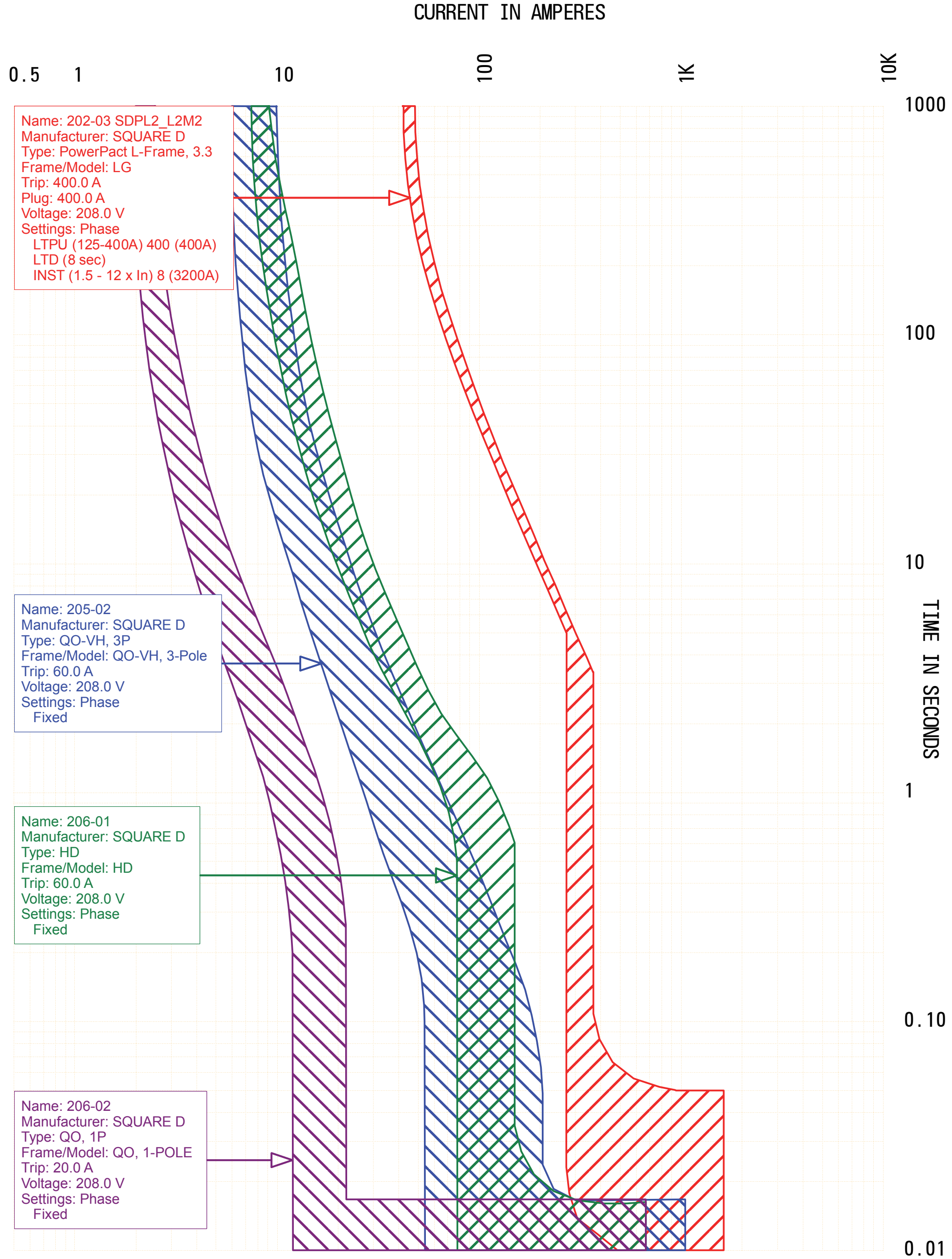
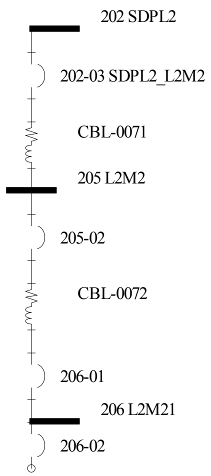


TCC: TCC-19 SDPL2 | Current Scale x 10 | Reference Voltage: 208 | July 21, 2014





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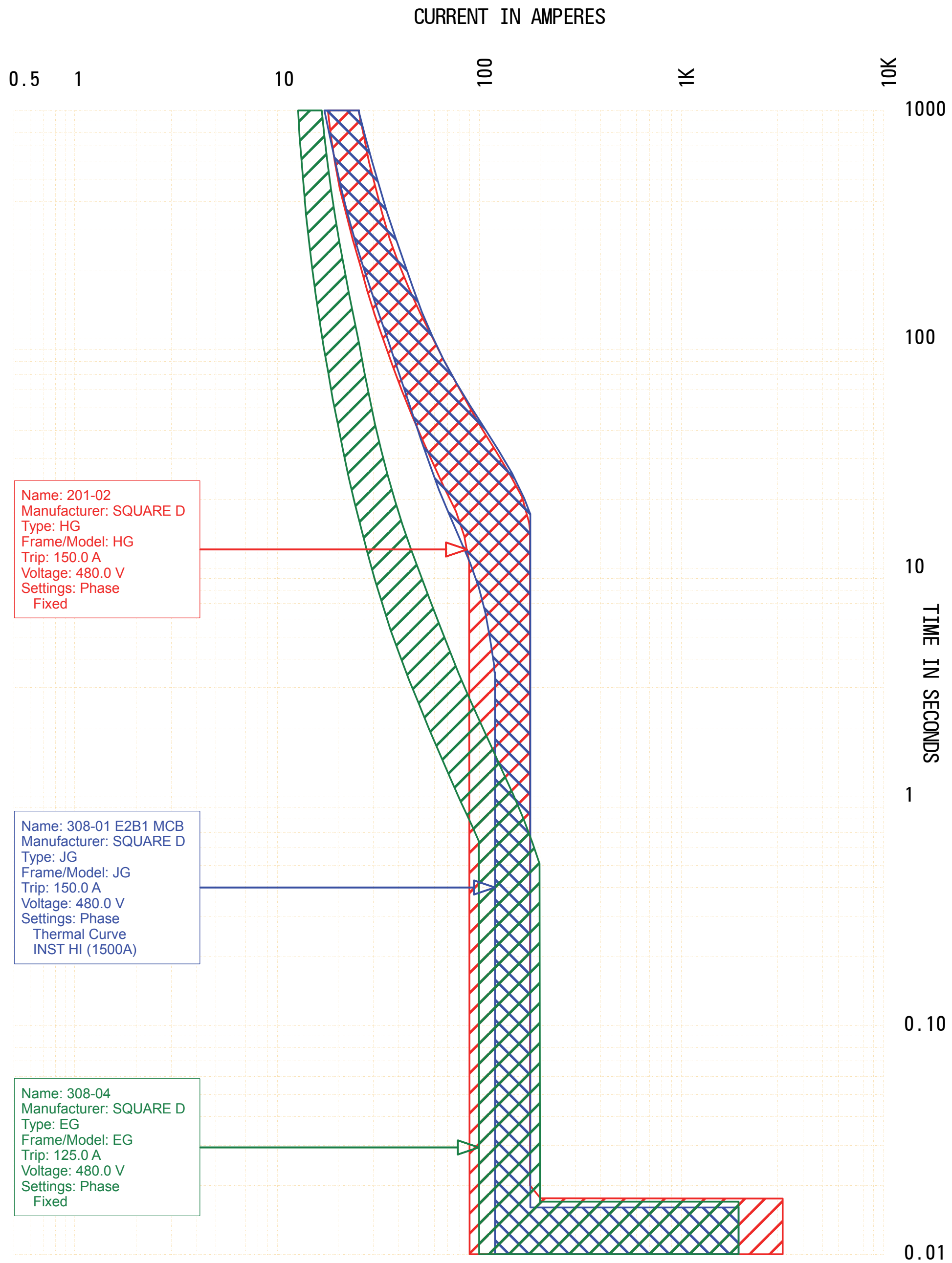
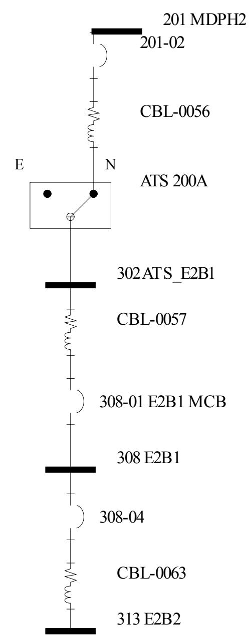
Current Scale x 10

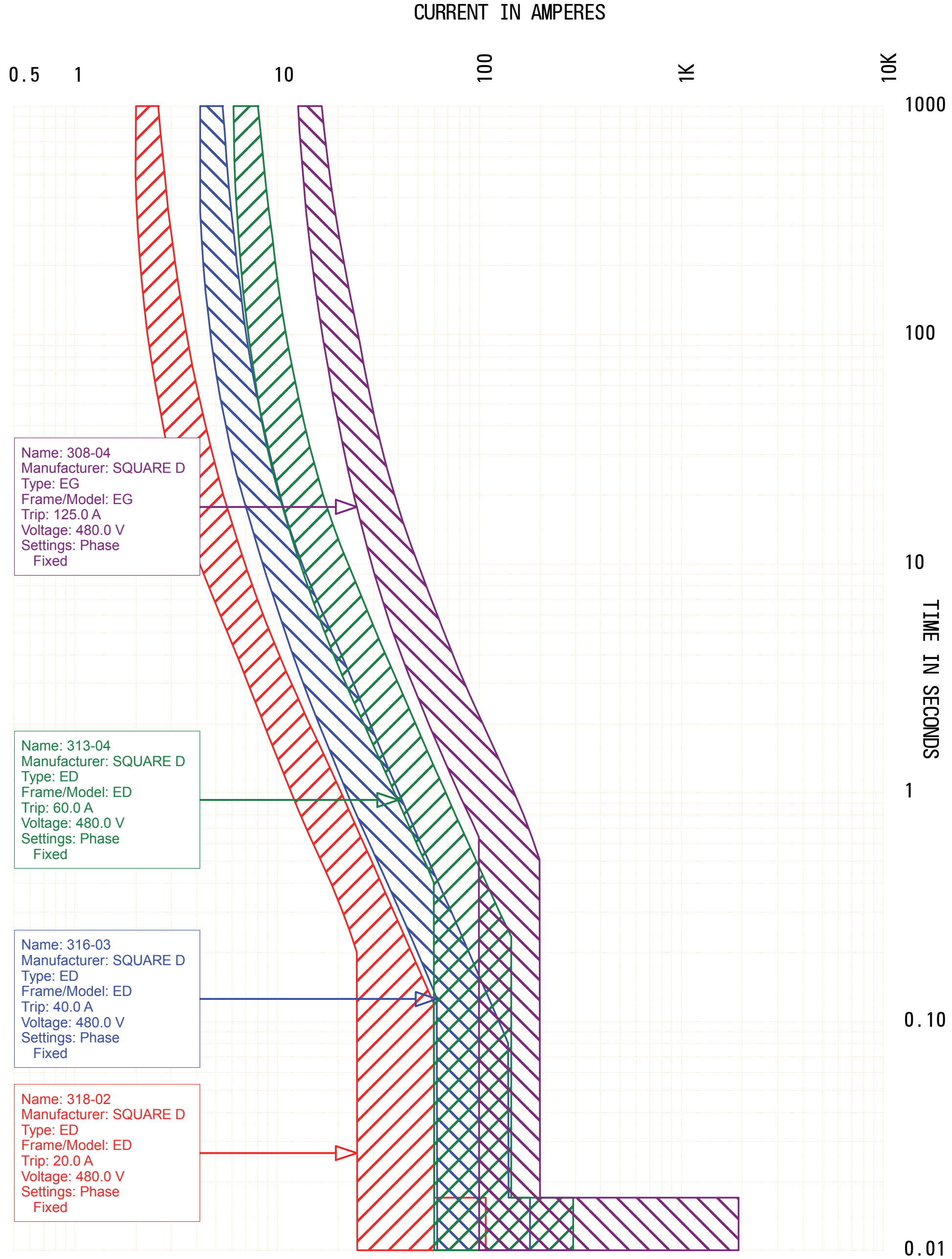
Reference Voltage: 208

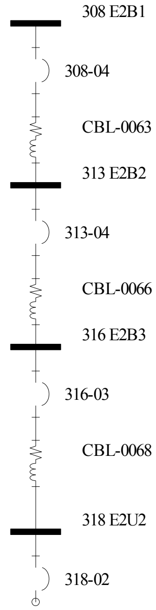
July 21, 2014





TCC: TCC-21 MDPH2 | Current Scale x 10 | Reference Voltage: 480 | July 21, 2014



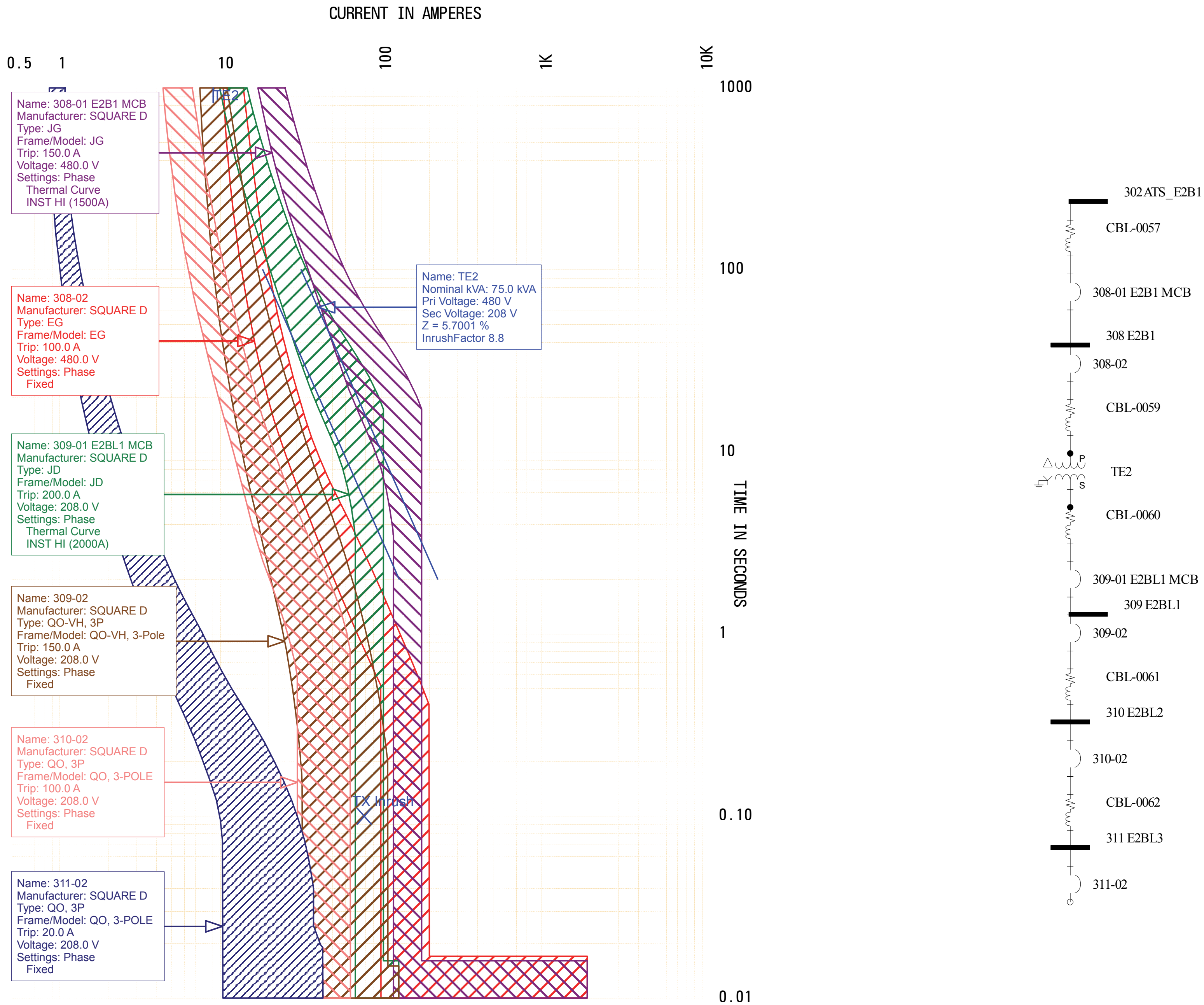


TCC: TCC-22 E2B1

Current Scale x 10

Reference Voltage: 480

July 21, 2014



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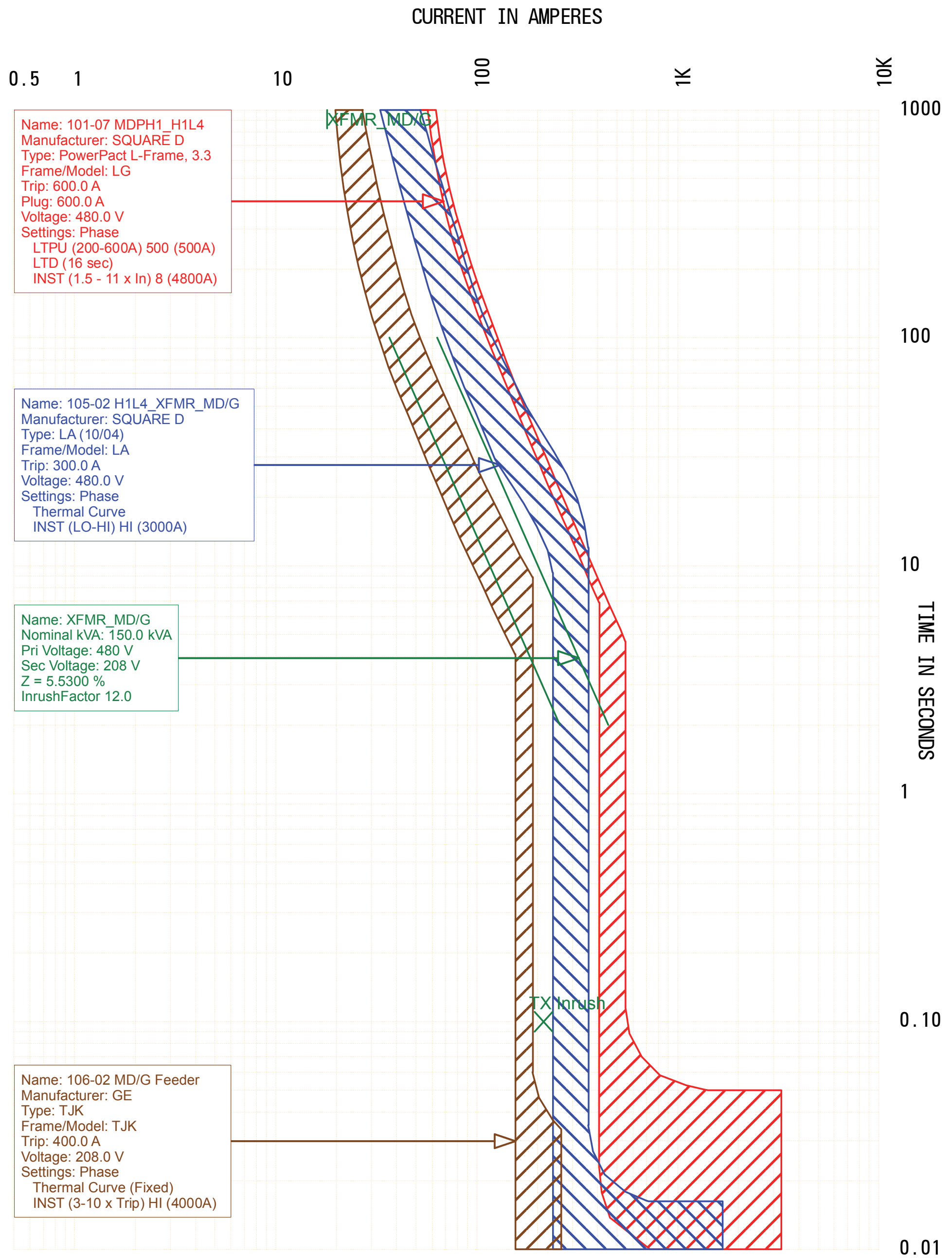
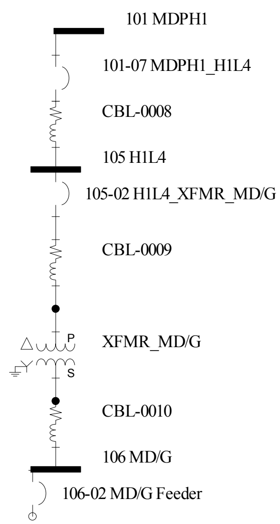
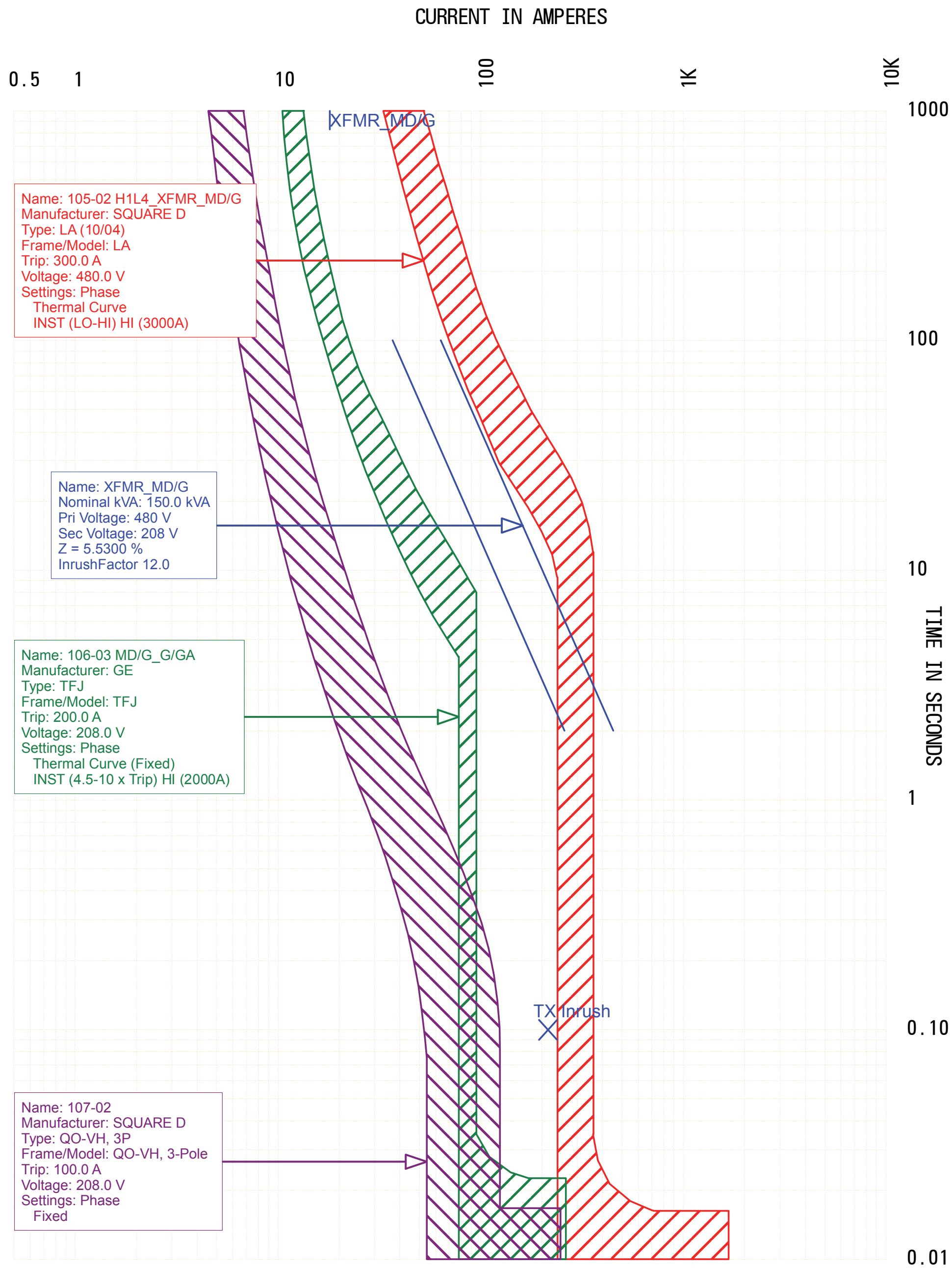
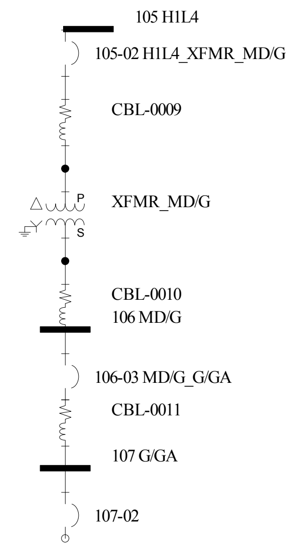


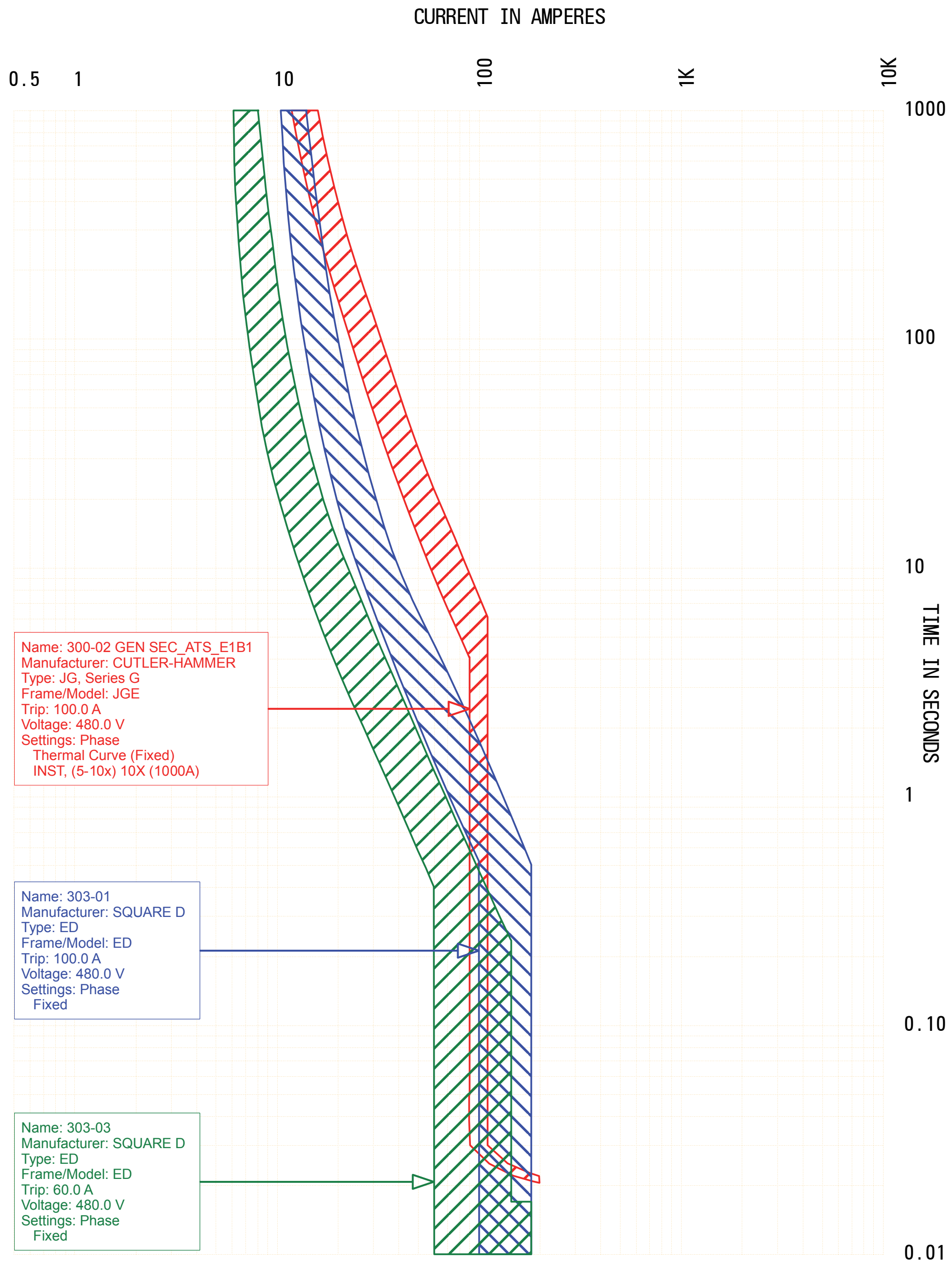


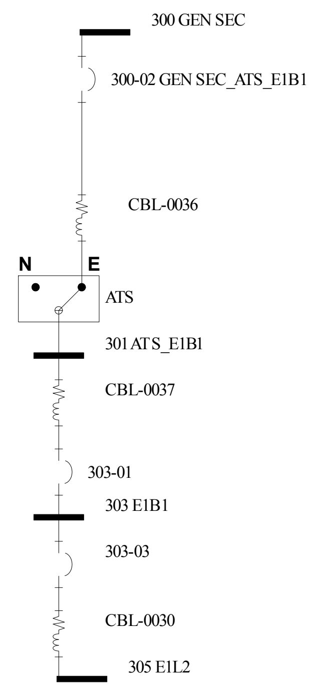
TCC: TCC-24 MDPH1 | Current Scale x 10 | Reference Voltage: 480 | July 21, 2014



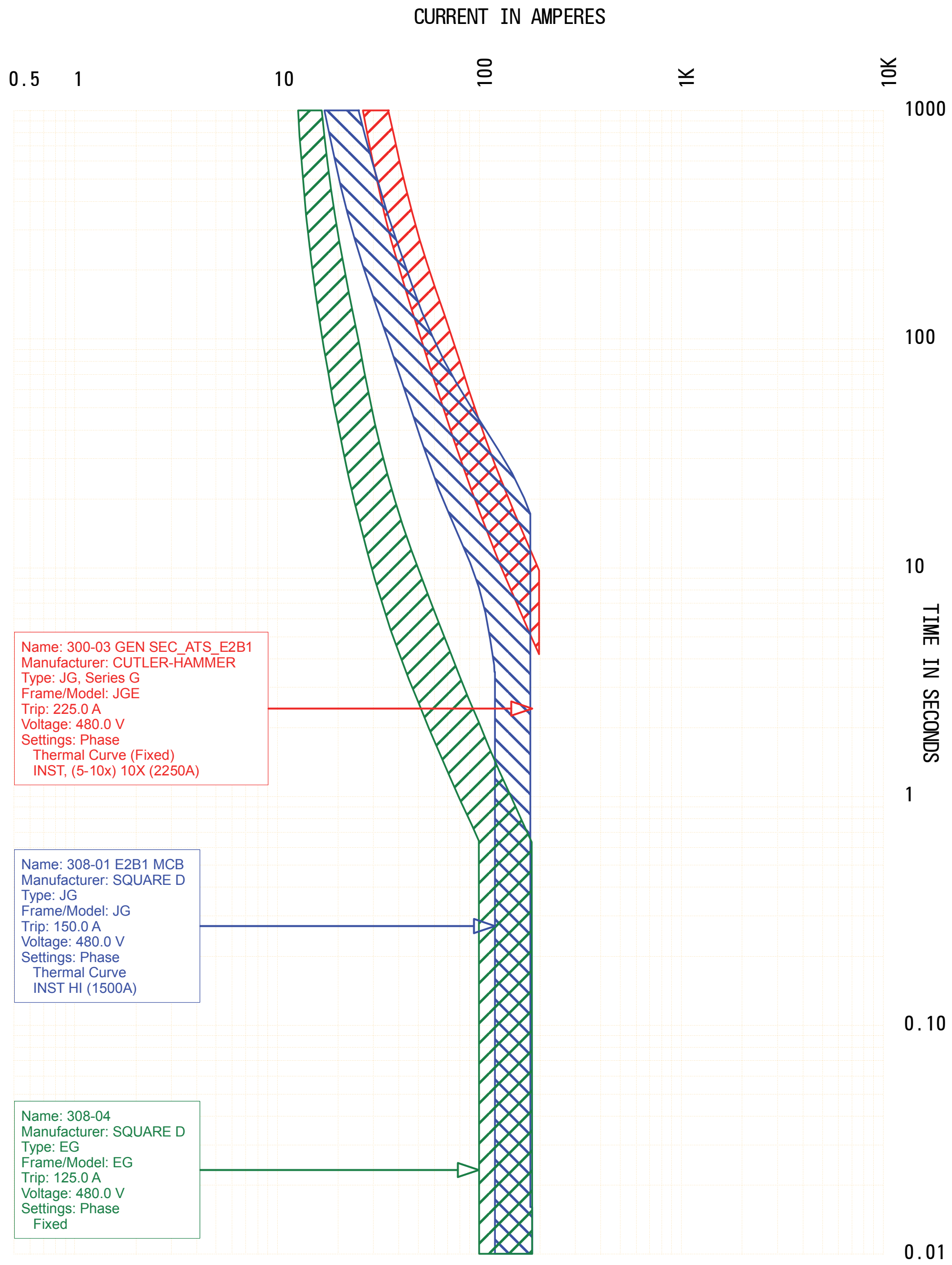


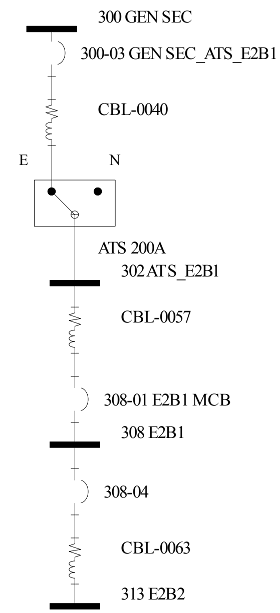
TCC: TCC-25 MDPH1 Current Scale x 10 Reference Voltage: 480 July 21, 2014





TCC: EMER TCC-01 Current Scale x 10 Reference Voltage: 480 July 18, 2014





TCC: EMER TCC-02

Current Scale x 10

Reference Voltage: 480

July 18, 2014

6 ARC FLASH HAZARD ANALYSIS

6.1 General Procedure

Over the past two decades, the electrical industry has begun to recognize arc flash as a safety hazard for personnel working near exposed, energized conductors. Ralph Lee is credited with raising the awareness of this hazard in a technical paper entitled "The Other Electrical Hazard: Electric Arc Blast Burns," *IEEE Transactions on Industry Applications*, Vol. 1A-18, No. 3, May-June 1982. Lee's paper presented a theoretical model for calculating the distance-energy relationship for electrical arc exposure. The hazard was later further quantified through controlled testing on 600V systems which included the effect of an enclosure in reflecting heat from the arc toward the opening of the enclosure. Curve fitting was applied to the test data and the resulting algorithms were published in a technical paper by R. L. Doughty, T. E. Neal, and H. L. Floyd, entitled "Predicting Incident Energy to Better Manage the Electric Arc Hazard on 600V Power Distribution Systems," Proceedings of *the IEEE Petroleum and Chemicals Industry Conference*, Paper No. 98-36, 1998. These models provide the basis for performing flash hazard analysis per NFPA 70E-2012, *Standard for Electrical Safety in the Workplace*.

IEEE Std. 1584-2002, *IEEE Guide for Performing Arc-Flash Hazard Calculations*, presents a more comprehensive methodology for arc flash hazard analysis. This standard, based on extensive testing carried out on low-voltage and medium-voltage systems (to 15kV), is applicable to a wider range of systems than previous calculation methods. For systems above 15kV, where sufficient test data is not yet available, IEEE 1584 relies on the Lee method for calculation of arcing energy levels. The results presented in this report are based solely on the IEEE 1584 calculation procedures. IEEE 1584 is applicable only to three-phase arcing faults (though single-phase or phase-phase arcing faults are generally expected to quickly escalate to three-phase faults), and it does not consider the effects of arc blast or other by-products of an arcing fault (sound levels, molten metal droplets, toxic vapors, and so on).

NFPA 70B and 70E address the issue of equipment maintenance and its potential effect on the arc flash boundary and the selection of personal protective equipment. The results of this study assume that protective devices considered are in working order and will operate within their specified tolerances to clear faults from the system. Non-functioning overcurrent protective devices can allow arcing faults to persist for much longer than normal, producing a very significant arc flash hazard beyond the results of the calculations presented in this report. Failure to properly maintain equipment per manufacturers' requirements and intervals may invalidate these results. Protection from arc flash hazards can best be provided by working only on circuits or equipment that have been placed in an electrically safe work condition.

The results of the arc flash analysis show both the calculated arc flash incident energy (AFIE) and arc flash boundary distances at each bus under study. In some locations, more than one value for AFIE levels and/or the arc flash boundary are given (e.g., one for the main section and one for the feeder sections of a switchgear lineup) to reflect different zones of protection for a given piece of equipment. Equipment warning labels or safety programs should take these variations in energy levels and arc flash boundaries into account.

For buses that represent low-voltage switchboards, panelboards, or motor control centers, the values shown in the Arc Flash Hazard Analysis – Summary Tables assume that the fault is cleared by the upstream protective device, even if the equipment contains a main overcurrent protective device. This assumption is intended to produce conservative results and therefore cover the case where faults originating in such equipment may propagate to the line side of the local main. See the Arc Flash Specific Procedure for additional details regarding the analysis procedure.

Additional discussion of buses with incident energy greater than 40 cal/cm^2 is given in the Arc Flash Analysis of Results, if applicable. Note that while PPE with arc ratings of up to 112 cal/cm^2 is commercially available, NFPA 70E-2012 does not define protective clothing classes or intend for work to be performed at locations having incident energies above 40 cal/cm^2 (Category 4). Due to the increased risk of non-burn injuries (e.g., concussions, hearing damage, or other internal injuries) at such high-energy locations, *Power Systems Engineering does not recommend energized work at any location with an available AFIE greater than 40 cal/cm^2.*

The arc flash hazard analysis and recommended PPE levels are no substitutes for safe work practices. As stated in 130.7(A), Informational Note No. 1 of NFPA 70E-2012, burn injuries can occur even when adequate PPE is employed, and the recommended PPE may provide little or no protection against arc blast and its effects. Protection from arc flash can best be provided by working only on circuits or equipment that have been placed in an electrically safe work condition.

6.2 Specific Procedure

SKM Power*Tools software includes an Arc Flash Hazard Analysis study module that contains equations based on both NFPA 70E and IEEE 1584. Calculations presented in this report are based on the IEEE 1584 calculation procedure. The program calculates the three-phase arcing fault current at each bus in the system based on the available three-phase bolted fault current determined during the short-circuit analysis and the equations in IEEE 1584. The duration of the arc is determined from the time-current characteristics of the applicable phase overcurrent devices and the calculated arc fault current. Once the arcing fault current and fault duration are known, equations from IEEE 1584 are used to calculate the available incident energy and arc flash boundary for each location under study. Per IEEE 1584, for low voltage (less than 1000V) buses, a second arcing fault current value is calculated to be equal to 85% of the arcing fault value originally calculated. From this second calculation, a second device operating time is determined. The incident energy and arc flash boundaries are calculated using both sets of values, and the worst case result is reported in this analysis. IEEE 1584 also contains equations specifically for buses protected by Class RK1 or Class L (through 2000A) current-limiting fuses, and these equations were used when appropriate.

The calculated incident energy levels are also based on the "working distance" from the fault, which is the distance from the head and torso of the worker to the source of arcing energy. A working distance of 36 inches was assumed for medium-voltage equipment, 24 inches for low-voltage switchgear, and 18 inches for motor control centers and panelboards, per the IEEE 1584 recommendations. In addition to the incident energy levels at the given working distance, the arc flash boundary at each location is provided. This distance corresponds to the distance from the equipment that the incident energy equals 1.2 cal/cm^2, which is generally accepted to be the energy level sufficient to cause the onset of a 2nd degree burn on bare skin. When working inside the arc flash boundary, proper personal protective equipment (PPE) is required.

For buses that represent low-voltage switchboards, panelboards, and MCCs the values shown in the Flash Hazard tables assume that the fault is cleared by the upstream protective device, even if the equipment contains a main overcurrent protective device. Since this equipment typically lacks the internal barriers or compartments that are typical of switchgear construction, it may be possible for arcing faults—particularly those that originate close to the main section and that are not cleared instantaneously—to propagate to the line side of the main overcurrent protective device. If this happens, then the fault can no longer be cleared by the local main, but rather by the next upstream overcurrent protective device. In cases where the next upstream device is a fuse or relay on the primary side of a step-down transformer, the fault clearing time and resulting AFIE level can increase significantly. Specific equipment testing has not been performed to assess the risk of such fault propagation, but the assumption that the upstream device clears the fault produces conservative results.

Motor contribution to the arcing fault current is considered in the analysis. For this study, induction motor contribution for motors 50HP and larger was assumed to go to zero after 5 cycles if not already cleared by the opening/clearing of a breaker/fuse. Contribution from induction motors is generally not considered to last for more than a few cycles, so this 5-cycle contribution time is believed to produce rational results when motor contribution is considered.

For buses with more than one source of fault current, the SKM software continues to accumulate incident energy until the *Fault Clear Threshold* is reached. The Fault Cleared Threshold is the percent of the total bus arcing fault current that must be interrupted by protective devices in order to consider the fault cleared. The assumption is; after the threshold is reached the remaining arcing fault current is not sufficient to maintain the arc and should not be included as accumulated incident energy. The result of this study option is that incident energy will be accumulated until either the Fault Cleared Threshold or the Maximum Protection Trip Time is reached, whichever occurs first. There are no recommendations in NFPA 70E or IEEE 1584 for determining a fault cleared threshold; a value of 99% was used in the analysis and is the maximum allowed value in the SKM software.

The SKM software, when calculating trip times for use in the arc flash hazard analysis, checks the upstream devices to determine which actually trips first rather than simply considering the characteristics of the next upstream device. In cases where the next upstream device was not the one that trips the fastest, the software flags this as “miscoordination” between the devices.

Ingress/egress should always be reviewed as part of the overall safety program as it cannot be solely determined by this analysis. However, some maximum arcing durations are cut off at 2.0 seconds. Annex B.1.2 of IEEE 1584 recognizes that it is likely a worker exposed to an arcing fault will quickly move away from the source of the arc if physically possible, and states under such conditions, “*...two seconds is a reasonable maximum time for calculations.*” Situations where such a cutoff might not be appropriate include workers in a lift bucket inspecting or operating overcurrent devices in elevated plug-in busway, or in other locations where clear ingress/egress is not available.

Neither the calculated incident energy levels nor the arc flash boundaries calculated as part of this analysis are relevant to the shock hazard that exists near all energized equipment. Shock hazard analyses may also be required before qualified employees are able to work on or near energized equipment. NFPA 70E-2012 defines *shock hazard* as “A dangerous condition associated with the possible release of energy caused by contact or approach to energized electrical conductors or circuit parts.” The standard also defines the *Limited Approach Boundary* as “An approach limit at a distance from an exposed energized electrical conductor or circuit part within which a shock hazard exists.” Only qualified employees can cross the Limited Approach Boundary and enter the limited space in order to perform a given task. A shock hazard analysis shall determine the voltage to which the personnel will be exposed, boundary requirements, and the personal protective equipment necessary in order to minimize the possibility of electric shock. In addition to the Limited Approach Boundary, the Restricted and Prohibited Approach Boundaries are also applicable to situations in which qualified personnel are exposed to live parts. See NFPA 70E Tables 130.4(C)(a) and 130.4(C)(b) for the boundary distances associated with various system voltages.

6.3 AF Hazard Analysis Results and Recommendations

The results of the arc flash hazard analysis are presented in the "ARC FLASH HAZARD ANALYSIS TABLES." The parameters that the analysis is based upon—fault current, arc duration, and working distance—are presented along with the incident energy, arc flash boundary, and minimum PPE class required for each bus.

As discussed previously, the calculations are cut off at a maximum arcing duration of 2.0 seconds.

Arc Flash labels or procedures should not be based on the AFIE levels shown in Arc Flash Hazard Analysis until after the recommended settings have been implemented.

Overly conservative available fault current values should not be used solely for an arc flash analysis. Therefore, three arc flash fault current scenarios were considered. The first consisted of a high utility source 80,000 Amps at 13.2kV, based on maximum fault current. The second considered a minimum utility source 1,531Amps at 13.2kV, available fault current assumed. The third was a generator source for equipment fed by the emergency generator. All arc flash scenarios were considered with motor loads turned off and on to find the worst case. The results of all the scenarios were combined into one composite table showing the worst case results for each piece of equipment evaluated.

IEEE 1584 states that during testing, arcs on 208V systems were difficult to sustain, and arc flash levels on systems operating below 240V and fed by transformers sized below 125 kVA are "not a concern". NFPA 70E-2012 article 130.5 Informational Note No. 5 refers to IEEE 1584 for more information regarding arc flash hazards for three-phase systems rated less than 240 volts. Based on this guidance from the standards, for buses operating less than 240V, the PPE level was assumed to be Category 0 (1.2 cal/cm^2 or less) as long as the transformer size is less than 125 kVA. The arc flash boundary at these locations is a maximum of 18 inches.

For some buses, more than one AFIE value and arc flash boundary distance are provided. This is the case when various parts of a single piece of equipment may actually be in different arc flash "zones of protection." For example, consider a lineup of low-voltage drawout switchgear containing both a main breaker and several feeder breakers. The compartmentalized switchgear construction would be expected to reduce the chance that faults in the feeder sections would propagate to the line-side of the main, so any fault occurring in a feeder section would be considered to be cleared by the main breaker. However, an arcing fault in the main section could either occur on the load side or the line side of the main, so such faults must be considered to be cleared by the next upstream protective device (e.g., the transformer primary overcurrent protective device). This results in different values for AFIE and for the arc flash boundary for such locations, possibly requiring different levels of PPE for workers depending on which section they are working on or near. In such cases, the results of both calculations are presented in the tables.

There are no personal protective equipment categories given for locations with energy levels exceeding 40 cal/cm^2, even though protective clothing capable of providing flash protection at incident energy levels of up to 112 cal/cm^2 is commercially available. **The ARC FLASH HAZARD ANALYSIS TABLES makes use of the term "Dangerous" to identify when the Hazard/Risk Category (PPE) is greater than 40cal/cm^2.** While NFPA 70E-2012 does not explicitly prohibit work at locations with energy levels above 40 cal/cm^2, research into the potential for non-burn injuries (internal injuries, hearing damage, etc.) indicates that these other injuries become a significant concern at such high-energy locations. *Power System Engineering does not recommend work at locations with energy levels greater than 40 cal/cm^2, unless the equipment has been placed into an electrically safe work condition.*

After the initial breaker coordination work was performed, a review of settings affecting locations with energy levels greater than 40 cal/cm^2 was conducted to determine whether adjustment of device settings could be performed to reduce the flash hazard level. In many some cases, the settings could be adjusted with no significant loss of coordination, as discussed in Overcurrent Device Coordination Analysis Results and Recommendations.

In other cases, devices were either nonadjustable or their settings could not be reduced without a significant loss of selectivity between devices, as discussed in the following paragraphs:

> KWHS Power company owned fuse is the primary overcurrent protective device for the 1,500 kVA transformer and cannot be reduced in size enough causing this situation to be unavoidable.

There were seven locations where the arc flash incident energy level is greater than 40 cal/cm^2 which is considered the upper limit defined by NFPA 70E. Flash hazard levels at (100 UTC_MDPH1, 101 MDPH1, 108 SDPL1, 200 UTC2_MDPH2, 201 MDPH2, 213 SDPH21 and 229 SDPH22) exceeded 40 cal/cm2, and this equipment is reported as “Dangerous” in the Flash Hazard Table. The arcing fault current must be cleared by the upstream utility transformer primary fuse. Equipment protected by a transformer primary overcurrent device generally results in long trip delay times which cannot be adjusted lower because of the load and/or transformer inrush, or due to limitations or non-adjustability of the protective device. Knowing the actual device information for this project is not likely to result in any improvement at this equipment location.

- Work should not be performed on 100 UTC_MDPH1 and 200 UTC2_MDPH2 without first opening and locking out power on the primary side of the Utilities service transformer.
- Work should not be performed on 101 MDPH1, 108 SDPL1, 201 MDPH2, 213 SDPH21 and 229 SDPH22 without first opening and locking out power on the protective device that feeds each equipment.

6.3.1 Arc Flash Hazard Table Headings Guide and PPE Table

The arc flash hazard table summarizes the results of the arc flash hazard analysis. The calculations are based on the protective relay and low voltage circuit breaker settings developed in previous sections. Following is a brief description of the arc flash hazard analysis table headings.

- Protective Device Name: The designation for the overcurrent protective device that clears the arcing fault. In cases where several sources are connected to a single bus (e.g., multiple mains, motor contribution to an MCC, etc.), the main device to operate is reported.
- Bus Bolted Fault (kA): The calculated three-phase bolted fault current, RMS symmetrical amperes.
- Prot. Dev. Bolted Fault (kA): The portion of the bolted fault current through the protective device.
- Prot. Dev. Arcing Fault (kA): The calculated arcing fault current associated with the bolted fault current.
- Trip/Delay Time (sec.): This is the time for the main protective device to react to the arcing current. For fuses, it is the total clearing time. For circuit breakers, it is the relay or trip unit time delay. The time is taken from a time-current curve using the arcing current or the reduced (85%) arcing current, unless the maximum tripping time of 2.0 seconds is used.

- Breaker Opening Time (sec.): This is the time for the circuit breaker mechanism to open the contacts and interrupt the current. The time is in addition to the trip or delay time. For low-voltage breakers, the opening time is included in the trip/delay time.
- Ground: This indicates whether the system is grounded or ungrounded (including ungrounded or impedance grounded).
- Equip. Type: This indicates the type of equipment in which the arc is assumed to occur: switchgear, panelboard, cable, or open air.
- Gap: This is the gap between conductors and defines the length of the arc. Standard bus gap distances are defined in IEEE 1584.
- Arc Flash Hazard Boundary: This is the working distance at which incident energy equals 1.2 cal/cm^2, considered to be the level which can produce second-degree burns on exposed skin. Any approach closer than the arc flash boundary requires use of personal protective equipment.
- Working Distance: The assumed distance from the arc point to the head and body of the worker positioned in place to perform the assigned task.
- Incident Energy: The thermal energy density to which a person at the working distance is exposed.
- Required Protective Arc Rated (AR) Clothing Characteristics: The information is intended to provide a convenient classification of hazard levels in the system to allow for selection of PPE. The requirements for protective clothing and other protective equipment are based on the hazard/risk categories 0-4 in 70E. If the incident energy is greater than 40 cal/cm^2 (Category 4), work should not be performed on or near the equipment unless the equipment has been placed in an electrically safe condition. For such hazard levels, the description “Dangerous” is used. The required AR clothing characteristics reported in the table are based on Table 130.7(C)(16) of NFPA 70E, as shown in the **Table 2** on the following page. The descriptions in the arc flash summary table are typical—consult NFPA 70E and manufacturers’ Arc Rating information for further information and additional requirements on other required protective clothing, including hearing, face, and eye protection. The latest edition of NFPA 70E should also be reviewed regarding limitations and requirements for working on energized equipment. Requirements related to energized work, including mandatory energized work permits, are much more restrictive than in previous versions of NFPA 70E.

Table 2: Protective Clothing Characteristics from Table 130.7(C)(16) of NFPA 70E.

Hazard/Risk Category	Clothing Description	Minimum Required ATPV
0	Protective Clothing, Nonmelting or Untreated Natural Fiber (i.e., untreated cotton, wool, rayon, or silk, or blends of these materials) with a Fabric Weight of at Least 4.5 oz/yd^2 Shirt (long sleeve); Pants (long)	N/A
1	Arc-Rated Clothing Arc-rated long-sleeve shirt and pants or arc-rated coverall; Arc-rated face shield or arc flash suit hood; Arc-rated jacket, parka, rainwear, or hard hat liner (AN)	4
2	Arc-Rated Clothing Arc-rated long-sleeve shirt and pants or arc-rated coverall; Arc-rated flash suit hood or arc-rated face shield and arc-rated balaclava; Arc-rated jacket, parka, rainwear, or hard hat liner (AN)	8
3	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating Arc-rated long-sleeve shirt (AR); Arc-rated pants (AR); Arc-rated coverall (AR); Arc-rated arc flash suit jacket (AR); Arc-rated arc flash suit pants (AR); Arc-rated arc flash suit hood; Arc-rated gloves; Arc-rated jacket, parka, rainwear, or hard hat liner (AN)	25
4	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating Arc-rated long-sleeve shirt (AR); Arc-rated pants (AR); Arc-rated coverall (AR); Arc-rated arc flash suit jacket (AR); Arc-rated arc flash suit pants (AR); Arc-rated arc flash suit hood; Arc-rated gloves; Arc-rated jacket, parka, rainwear, or hard hat liner (AN)	40

While using categories 0-4 is a convenient way to determine the arc-rated clothing and other personal protective equipment (PPE), for a given location, Informative Annex H in 70E is a suggested simplified approach to select PPE when an incident energy analysis is performed. That analysis is a component of a broader arc flash hazard analysis used to predict the incident energy of an arc flash for a specified set of conditions. Selection of PPE is always left up to the worker and the safety policy of the worker's facility based on the type of exposure for a given task.

6.3.2 Arc Flash Hazard Analysis Table – Recommended Settings

POWER SYSTEM ENGINEERING

ARC FLASH HAZARD
ANALYSIS TABLE

KELLY WALSH HIGH SCHOOL
Casper, WY
6.E501 & 6.E502
BASED ON RECOMMENDED SETTINGS

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 ARC RATED (AR) CLOTHING CHARACTERISTICS**
100 UTC_MDPH1	UTILITY FUSE	0.480	34.44	30.62	16.77	2.000	0.000	Yes	PNL	25	297	18	119	Dangerous! (*N9) High Utility Source
101 MDPH1	100-02 UTC_MDPH1	0.480	32.77	28.93	15.96	2.000	0.000	Yes	PNL	25	288	18	113	Dangerous! (*N9) High Utility Source
102 H1L1	101-04 MDPH1_H1L1	0.480	27.26	27.26	15.45	0.050	0.000	Yes	PNL	25	29	18	2.66	Category 1 High Utility Source
103 H1L2	101-05	0.480	16.15	16.15	9.87	0.018	0.000	Yes	PNL	25	12	18	0.57	Category 0 High Utility Source
104 H1L3	101-06 MDPH1_H1L3	0.480	15.16	15.16	9.36	0.016	0.000	Yes	PNL	25	11	18	0.49	Category 0 High Utility Source
105 H1L4	101-07 MDPH1_H1L4	0.480	16.75	16.75	10.19	0.054	0.000	Yes	PNL	25	23	18	1.83	Category 1 High Utility Source
106 MD/G	105-02 H1L4_XFMR_MD/G	0.208	6.10	6.10	3.05	2.000	0.000	Yes	PNL	25	95	18	18.40	Category 3 (*N9) (*N16) High Utility Source
107 G/GA	101-07 MDPH1_H1L4	0.208	6.55	6.55	2.75	0.074	0.000	Yes	PNL	25	12	18	0.61	Category 0 (*N3) (*N5) Low Utility Source
108 SDPL1	101-08 MDPH1_XFMR_SDPL1	0.208	23.91	23.91	7.79	2.000	0.000	Yes	PNL	25	177	18	51	Dangerous! (*N9) (*N16) High Utility Source
109 L1M1	108-02	0.208	2.69	2.69	1.73	2.000	0.000	Yes	PNL	25	65	18	9.93	Category 3 (*N9) (*N16) High Utility Source
110 L1L1	108-03 SDPL1_L1L1	0.208	15.48	15.48	4.79	1.119	0.000	Yes	PNL	25	90	18	16.84	Category 3 (*N3) (*N16) Low Utility Source
111 L1L2	108-04 SDPL1_L1L2	0.208	13.37	13.37	5.12	2.000	0.000	Yes	PNL	25	134	18	32.27	Category 4 (*N9) (*N16) Low Utility Source
112 L1L3	108-05 SDPL1_L1L3	0.208	10.27	10.27	3.77	0.092	0.000	Yes	PNL	25	17	18	1.06	Category 0 (*N3) Low Utility Source
113 L1L31	112-02	0.208	9.24	9.24	4.12	0.015	0.000	Yes	PNL	25	6	18	0.19	Category 0 High Utility Source
114 L1L4	108-06	0.208	5.33	5.33	2.78	2.000	0.000	Yes	PNL	25	90	18	16.66	Category 3 (*N9) (*N16) High Utility Source
115 L1L5	108-07	0.208	5.25	5.25	2.73	2.000	0.000	Yes	PNL	25	89	18	16.31	Category 3 (*N9) (*N16) Low Utility Source
116 L1L6	108-08	0.208	6.87	6.87	2.84	0.028	0.000	Yes	PNL	25	7	18	0.24	Category 0 (*N3) Low Utility Source
117 L1B1	108-09	0.208	13.18	13.18	5.28	0.017	0.000	Yes	PNL	25	8	18	0.28	Category 0 High Utility Source
118 L1B2	108-10	0.208	2.53	2.53	1.41	2.000	0.000	Yes	PNL	25	57	18	7.97	Category 2 (*N3) (*N9) (*N16) High Utility Source
119 H1B1	101-09	0.480	15.63	15.63	9.60	0.018	0.000	Yes	PNL	25	11	18	0.56	Category 0 High Utility Source
200 UTC2_MDPH2	UTILITY FUSE 2	0.480	32.64	29.31	16.18	2.000	0.000	Yes	PNL	25	290	18	114	Dangerous! (*N9) High Utility Source
201 MDPH2	200-02 UTC2_MDPH2	0.480	31.85	28.51	15.79	2.000	0.000	Yes	PNL	25	285	18	111	Dangerous! (*N9) High Utility Source
202 SDPL2	201-03 MDPH2_XFMR_SDPL2	0.208	16.27	16.27	6.01	2.000	0.000	Yes	PNL	25	149	18	38.34	Category 4 (*N9) (*N16) High Utility Source
203 L2M1	202-02 SDPL2_L2M1	0.208	12.23	12.23	5.01	0.059	0.000	Yes	PNL	25	15	18	0.93	Category 0 High Utility Source
204 L2M11	203-02 L2M1_L2M11	0.208	10.15	10.15	4.39	0.051	0.000	Yes	PNL	25	13	18	0.69	Category 0 High Utility Source
205 L2M2	202-03 SDPL2_L2M2	0.208	9.79	9.79	3.55	2.000	0.000	Yes	PNL	25	105	18	21.69	Category 3 (*N3) (*N9) (*N16) Low Utility Source
206 L2M21	205-02	0.208	6.70	6.70	3.28	0.017	0.000	Yes	PNL	25	5	18	0.17	Category 0 High Utility Source
207 L2B2	202-04	0.208	8.77	8.77	3.97	0.018	0.000	Yes	PNL	25	7	18	0.23	Category 0 High Utility Source
208 L2B1	202-05	0.208	10.10	10.10	4.38	0.018	0.000	Yes	PNL	25	7	18	0.24	Category 0 High Utility Source
209 H2M1	201-05 MDPH2_H2M1	0.480	19.07	19.07	11.38	0.016	0.000	Yes	PNL	25	12	18	0.61	Category 0 High Utility Source
210 H2M2	201-06 MDPH2_H2M2	0.480	20.65	20.65	12.18	0.050	0.000	Yes	PNL	25	25	18	2.05	Category 1 High Utility Source
211 H2B2	201-07 MDPH2_H2B2	0.480	29.14	29.14	16.35	0.050	0.000	Yes	PNL	25	30	18	2.82	Category 1 High Utility Source
212 H2B1	201-08	0.480	13.49	13.49	8.47	0.016	0.000	Yes	PNL	25	10	18	0.45	Category 0 High Utility Source
213 SDPH21	201-09 MDPH2_SDPH21	0.480	17.80	17.80	10.19	2.000	0.000	Yes	PNL	25	211	18	68	Dangerous! (*N9) (*N16) High Utility Source
214 H21B1	213-05	0.480	11.10	11.10	7.17	0.017	0.000	Yes	PNL	25	9	18	0.39	Category 0 High Utility Source
215 H21M1	213-04	0.480	9.26	9.26	6.14	0.017	0.000	Yes	PNL	25	8	18	0.33	Category 0 High Utility Source
216 H21U1	213-03	0.480	7.29	7.29	5.01	0.017	0.000	Yes	PNL	25	7	18	0.26	Category 0 High Utility Source

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 ARC RATED (AR) CLOTHING CHARACTERISTICS**
217 SDPL21	213-02 SDPH21_SDPL21	0.208	13.88	13.88	5.39	2.000	0.000	Yes	PNL	25	139	18	34.08	Category 4 (*N9) (*N16) High Utility Source
218 L21U1	217-02	0.208	6.53	6.53	2.73	2.000	0.000	Yes	PNL	25	88	18	16.29	Category 3 (*N3) (*N9) (*N16) High Utility Source
219 L21U2	217-03	0.208	3.45	3.45	2.05	2.000	0.000	Yes	PNL	25	73	18	11.99	Category 3 (*N9) (*N16) High Utility Source
220 L21U3	217-04	0.208	5.56	5.56	2.44	2.000	0.000	Yes	PNL	25	82	18	14.43	Category 3 (*N3) (*N9) (*N16) High Utility Source
221 L21U4	217-05	0.208	3.81	3.81	2.20	2.000	0.000	Yes	PNL	25	77	18	12.94	Category 3 (*N9) (*N16) High Utility Source
222 L21U5	217-06	0.208	6.66	6.66	2.78	0.035	0.000	Yes	PNL	25	8	18	0.29	Category 0 (*N3) Low Utility Source
223 L21M1	217-07	0.208	4.45	4.45	2.45	2.000	0.000	Yes	PNL	25	82	18	14.53	Category 3 (*N9) (*N16) High Utility Source
224 L21M11	223-02	0.208	3.91	3.91	2.24	2.000	0.000	Yes	PNL	25	78	18	13.18	Category 3 (*N9) (*N16) High Utility Source
225 L21M2	217-08	0.208	6.53	6.53	2.73	2.000	0.000	Yes	PNL	25	88	18	16.29	Category 3 (*N3) (*N9) (*N16) High Utility Source
226 L21M3	217-09	0.208	5.11	5.11	2.70	2.000	0.000	Yes	PNL	25	88	18	16.14	Category 3 (*N9) (*N16) High Utility Source
227 L21M4	217-10	0.208	8.03	8.03	3.17	0.025	0.000	Yes	PNL	25	7	18	0.24	Category 0 (*N3) Low Utility Source
228 L21B1	217-11	0.208	10.69	10.69	4.56	0.017	0.000	Yes	PNL	25	7	18	0.24	Category 0 High Utility Source
229 SDPH22	201-10 MDPH2_SDPH22	0.480	15.94	15.94	9.32	2.000	0.000	Yes	PNL	25	199	18	62	Dangerous! (*N9) (*N16) High Utility Source
230 H22B1	229-05	0.480	12.18	12.18	7.76	0.017	0.000	Yes	PNL	25	10	18	0.42	Category 0 High Utility Source
231 H22M1	229-04	0.480	4.60	4.60	3.38	0.017	0.000	Yes	PNL	25	6	18	0.17	Category 0 High Utility Source
232 H22U1	229-03	0.480	8.90	8.90	5.94	0.018	0.000	Yes	PNL	25	8	18	0.33	Category 0 High Utility Source
233 SDPL22	229-02 SDPH22_SDPL22	0.208	13.57	13.57	5.31	2.000	0.000	Yes	PNL	25	137	18	33.51	Category 4 (*N9) (*N16) High Utility Source
234 L22U1	233-02	0.208	6.17	6.17	2.62	2.000	0.000	Yes	PNL	25	86	18	15.60	Category 3 (*N3) (*N9) (*N16) High Utility Source
235 L22U2	233-03	0.208	5.55	5.55	2.44	2.000	0.000	Yes	PNL	25	82	18	14.42	Category 3 (*N3) (*N9) (*N16) High Utility Source
236 L22U3	233-04	0.208	4.44	4.44	2.45	2.000	0.000	Yes	PNL	25	82	18	14.51	Category 3 (*N9) (*N16) High Utility Source
237 L22U4	233-05	0.208	5.85	5.85	2.52	2.000	0.000	Yes	PNL	25	84	18	14.99	Category 3 (*N3) (*N9) (*N16) High Utility Source
238 L22U5	233-06	0.208	5.14	5.14	2.70	2.000	0.000	Yes	PNL	25	88	18	16.11	Category 3 (*N9) (*N16) Low Utility Source
239 L22M1	233-07	0.208	6.17	6.17	2.62	2.000	0.000	Yes	PNL	25	86	18	15.60	Category 3 (*N3) (*N9) (*N16) High Utility Source
240 L22M2	233-08	0.208	5.14	5.14	2.70	2.000	0.000	Yes	PNL	25	88	18	16.11	Category 3 (*N9) (*N16) Low Utility Source
241 L22M3	233-09	0.208	5.14	5.14	2.70	2.000	0.000	Yes	PNL	25	88	18	16.11	Category 3 (*N9) (*N16) Low Utility Source
242 L22M4	233-10	0.208	5.05	5.05	2.68	2.000	0.000	Yes	PNL	25	87	18	16.00	Category 3 (*N9) (*N16) High Utility Source
243 L22M5	233-11	0.208	5.79	5.79	2.50	2.000	0.000	Yes	PNL	25	84	18	14.86	Category 3 (*N3) (*N9) (*N16) High Utility Source
244 L22M6	233-12	0.208	4.62	4.62	2.52	2.000	0.000	Yes	PNL	25	84	18	14.97	Category 3 (*N9) (*N16) High Utility Source
245 L22B1	233-13	0.208	6.61	6.61	3.25	0.017	0.000	Yes	PNL	25	5	18	0.17	Category 0 High Utility Source
300 GEN SEC	MaxTripTime @2.0s	0.480	2.00	2.00	1.66	2.000	0.000	Yes	PNL	25	43	18	4.98	Category 2 (*N2) (*N9) High Utility Source
301 ATS_E1B1	101-10	0.480	12.79	12.79	8.09	0.018	0.000	Yes	PNL	25	10	18	0.46	Category 0 High Utility Source
302 ATS_E2B1	300-03 GEN SEC_ATS_E2B1	0.480	1.85	1.85	0.82	2.000	0.000	Yes	PNL	25	42	18	4.81	Category 2 (*N9) (*N16) Generator Source

Schneider Electric

POWER SYSTEM ENGINEERING

ARC FLASH HAZARD
ANALYSIS TABLE

KELLY WALSH HIGH SCHOOL
Casper, WY
6.E501 & 6.E502
BASED ON RECOMMENDED SETTINGS

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 ARC RATED (AR) CLOTHING CHARACTERISTICS**
303 E1B1	101-10	0.480	10.77	10.77	6.99	0.018	0.000	Yes	PNL	25	9	18	0.39	Category 0 High Utility Source
304 E1L1	303-02	0.480	1.48	1.48	1.09	0.133	0.000	Yes	PNL	25	9	18	0.40	Category 0 (*N3) Generator Source
305 E1L2	303-03	0.480	1.40	1.40	0.64	1.161	0.000	Yes	PNL	25	26	18	2.17	Category 1 (*N3) (*N16) Generator Source
306 E1BL1	303-04	0.208	1.79	1.79	1.30	0.793	0.000	Yes	PNL	25	18	18	1.20	Category 0 (*N5) (*N15) (*N16) High Utility Source
307 E1BL2	306-02	0.208	1.28	1.28	0.87	0.158	0.000	Yes	PNL	25	9	18	0.38	Category 0 (*N3) (*N15) Generator Source
308 E2B1	300-03 GEN SEC_ATS_E2B1	0.480	1.83	1.83	0.82	2.000	0.000	Yes	PNL	25	42	18	4.79	Category 2 (*N9) (*N16) Generator Source
309 E2BL1	308-02	0.208	2.98	2.98	1.85	2.000	0.000	Yes	PNL	25	18	18	1.20	Category 0 (*N5) (*N9) (*N15) (*N16) High Utility Source
310 E2BL2	309-02	0.208	1.49	1.49	1.14	2.000	0.000	Yes	PNL	25	18	18	1.20	Category 0 (*N9) (*N15) (*N16) High Utility Source
311 E2BL3	310-02	0.208	1.01	1.01	0.87	2.000	0.000	Yes	PNL	25	18	18	1.20	Category 0 (*N9) (*N15) (*N16) High Utility Source
312 E2M1	308-03	0.480	1.53	1.53	1.12	0.126	0.000	Yes	PNL	25	9	18	0.39	Category 0 (*N3) Generator Source
313 E2B2	308-04	0.480	1.37	1.37	0.74	2.000	0.000	Yes	PNL	25	39	18	4.22	Category 2 (*N9) (*N16) Generator Source
314 E2M3	313-02	0.480	1.16	1.16	0.60	0.448	0.000	Yes	PNL	25	15	18	0.85	Category 0 (*N3) (*N16) Generator Source
315 E2U1	313-03	0.480	1.12	1.12	0.59	0.461	0.000	Yes	PNL	25	15	18	0.85	Category 0 (*N3) (*N16) Generator Source
316 E2B3	313-04	0.480	1.11	1.11	0.58	1.398	0.000	Yes	PNL	25	27	18	2.28	Category 1 (*N3) (*N16) Generator Source
317 E2M2	316-02	0.480	0.86	0.86	0.52	0.585	0.000	Yes	PNL	25	15	18	0.88	Category 0 (*N3) (*N16) Generator Source
318 E2U2	316-03	0.480	0.83	0.83	0.51	0.605	0.000	Yes	PNL	25	15	18	0.88	Category 0 (*N3) (*N16) Generator Source

Notes Section (The following default note numbers from the software have been used in this analysis.)

(*N2) - Percentage of fault current cleared is less than the Cleared Fault Threshold specified in the study options.

(*N3) - Arcing Fault Current Low Tolerances Used.

(*N5) - Mis-coordinated, Upstream Device Tripped.

(*N9) - Max. Arcing Duration Reached. The time taken for the protective device to clear the fault is longer than the Max. Arcing Duration as specified in the study options.

(*N15) - Fed by Transformer Size < 125 kVA, on bus voltage level < 240V; Report as Category 0.

(*N16) - Trip Time Recalculated.

6.4 Power System Engineering Arc Flash Labeling Practice

The Power System Engineering arc flash labeling practice will be used for this job. Labels for each piece of equipment, or for each section of multi-section equipment will consist of two labels: (1) An Arc Flash Information label and (2) a general safety label. The Arc Flash Information label is printed with values produced by the arc flash hazard analysis and is field installed. The general safety label is factory installed on new Schneider Electric, Square D brand, equipment and will be provided for field installation on any electrical equipment (Square D or other) lacking these labels, or having existing safety labels not meeting the intent of these general safety labels.

6.4.1 Arc Flash Information Labels

The Arc Flash Information labels are printed with black letters on Brady B-423 glossy white polyester label stock (2 mil) using a thermal transfer printer. The labels have a pressure sensitive permanent acrylic adhesive backing (1 mil) and are 4.0-inches by 4.0-inches. Clear polyvinyl chloride overlaminates (2.6 mil) are available for outdoor application where UV resistance is required. These clear overlaminates use Brady B-649 material and are 4.5-inches by 4.5-inches. Technical data sheets for each Brady material are available on-line at www.bradyid.com. The following information is included on each label:

a. "Arc Flash Information" banner on the top of the label
b. Arc Flash Boundary in inches
c. Incident Energy in cal/cm^2
d. Working Distance in inches
e. PPE Category per NFPA 70E (also repeated in large font in the upper left corner)
f. Shock hazard when cover is open
g. Limited Approach in inches
h. Restricted Approach in inches
i. Prohibited Approach in inches
j. Equipment name (optional)
k. Arc Flash Analysis study number
l. Arc Flash Analysis study date

The standard Arc Flash Information label will report the maximum incident energy and arc flash boundary for each PPE category number and equipment type, unless voltage is greater than 15kV, or if incident energy is above 40 cal/cm^2 (refer to Figure 5 and Figure 6 for typical labels). Generally no equipment name is printed on the label, unless the voltage is greater than 15kV, or if incident energy is greater than 40 cal/cm^2. This type of Arc Flash Information label may reduce the need to replace arc flash labels due to changes in the electrical system that change the incident energy and arc flash boundary values but do not affect the PPE category at a given piece of equipment.

For this project, standard Arc Flash Information labels will be supplied.

Multiple labels for one piece of equipment are sometimes sent for a variety of reasons which may include, but are not limited to the following: multiple sections of equipment, side/rear accessible equipment, equipment built to low-voltage Metal-Enclosed Switchgear or medium-voltage Metal-Clad Switchgear standards, and so on.

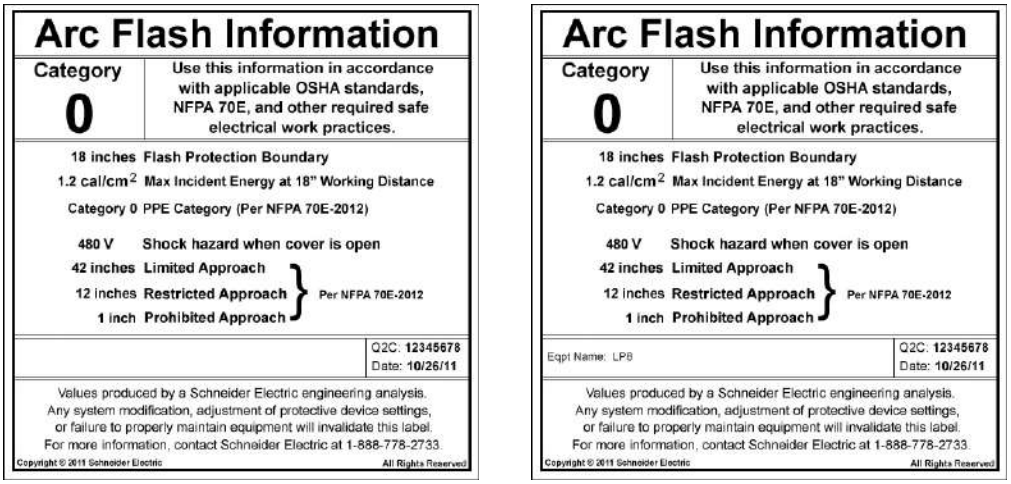


Figure 5: Typical Standard Arc Flash Information Labels – Actual sizes are 4" x 4".
Without Equipment Name (shown left); With Equipment Name (shown right).

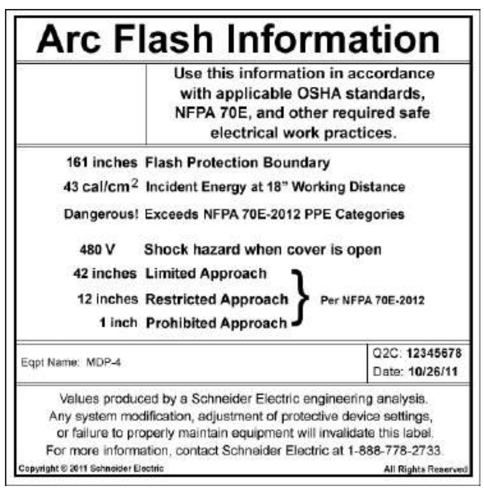


Figure 6: Typical Standard Arc Flash Information Label – Actual size is 4" x 4".
Exceeds NFPA 70E-2012 PPE Categories (shown above).

6.4.2 General Safety Labels

General safety labels (typical label shown in Figure 7) are applied to power distribution equipment to warn of general electrical hazards associated with shock, arc flash, and explosions, and to instruct workers to turn off power prior to work. The labels remind workers to de-energize equipment prior to work.

New Schneider Electric, Square D brand, factory installed general safety labels vary in size, wording and physical characteristics, but convey the safety message outlined below. General safety labels provided for field installation are printed with black letters (unless otherwise noted below) on white polyester label stock (2 mil) with UV resistant lamination (3 mil). The labels have a pressure sensitive permanent acrylic adhesive backing (1 mil) and are 3.6-inches by 3.6-inches. The following information is printed on each label:

a. A safety symbol/pictorial (ANSIMan - figure of a person contacting an energized conductor) in the upper left corner of the label.
b. A header in ANSI “Safety Red” with white lettering consisting of a safety alert symbol (an “!” inside a triangle) preceding the signal word “DANGER”.
c. HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH
d. Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See NFPA 70E.
e. This equipment must be installed and serviced only by qualified electrical personnel.
f. Turn off all power supplying this equipment before working on or inside equipment.
g. Always use a properly rated voltage sensing device to confirm power is off.
h. Replace all devices, doors and covers before turning on power to this equipment.
i. **Failure to follow these instructions will result in death or serious injury.**

For Square D brand equipment manufactured in 2006 or more recently, general safety labels do not need to be affixed. General safety labels prior to 2006 lack the words “OR ARC FLASH” in the warning statement.

For older Square D brand equipment lacking appropriate general safety labels, or for equipment manufactured by others, affix Schneider Electric general safety labels (Figure 7) as close as possible to the Arc Flash Information labels – DO NOT REMOVE OR COVER UP EXISTING SAFETY LABELS (ONES HAVING THE WORDS: DANGER, WARNING, OR CAUTION).

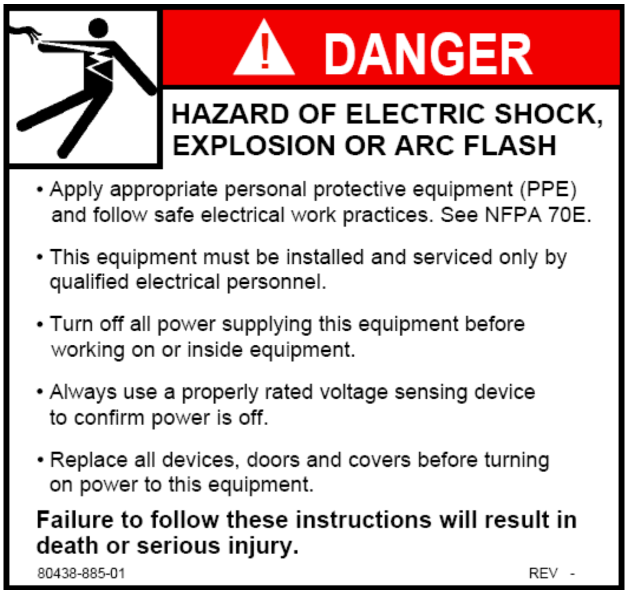


Figure 7: Typical General Safety Label for Electrical Equipment (Actual size is 3.6” x 3.6”).

APPENDIX A: ABBREVIATIONS AND TRADEMARKS

Organizations and Standards

ANSI	- American National Standards Institute
IEEE	- Institute of Electrical and Electronics Engineers
ICEA	- Insulated Cable Engineers Association
NEC	- National Electrical Code (NFPA No. 70)
NEMA	- National Electrical Manufacturers Association
UL	- Underwriters' Laboratories, Inc.

Other Abbreviations

A	- Amperes (RMS symmetrical)
AFIE	- Arc Flash Incident Energy (cal/cm^2)
AIC	- Amperes Interrupting Capacity (Three-Phase RMS sym.)
ASD	- Adjustable Speed ac Drive
ATPV	- Protective Clothing Arc Rating
ATS	- Automatic Transfer Switch
C/B	- Circuit Breaker
CHP	- Combined Horsepower
CFLA	- Combined Full Load Amperes
CT	- Current Transformer
FLA	- Full Load Amperes
AFB / FPB	- Arc Flash Boundary / Flash Protection Boundary
HP	- Horsepower
I_L	- Max. Demand Load Current at PCC
I_{SC}	- Short-Circuit Current at PCC
kVA	- Kilovolt-Ampere
kVAm	- Kilovolt-Amperes of Motor Short Circuit contribution
kW	- Kilowatt
L-L	- Line-To-Line
LRA	- Locked-Rotor Amperes
L.V.	- Low Voltage
LSIG.	- L = Long Time, S = Short time, I = Instantaneous, G = Ground fault protection
MCC	- Motor Control Center
MCS	- Molded Case Switch
Mohms	- Milliohms
M.V.	- Medium Voltage
OCPD	- Overcurrent Protective Device
O.L.	- Overload
PCC	- Point of Common Coupling
PF	- Power Factor
PPE	- Personal Protective Equipment
PWM	- Pulse Width Modulated
R	- Resistance
RMS	- Root-Mean-Square
SCA	- Short-Circuit Amperes
SCAm	- Short-Circuit Amperes of Motor Contribution
SCCR	- Short-Circuit Current Rating
S.F.	- Service Factor
sym.	- Symmetrical
TCC.	- Time Current Coordination graph
TCR	- Trip Current Rating
TDD	- Total Demand Distortion
THD	- Total Harmonic Distortion
V	- Line-To-Line Volts (RMS sym.)
WCR	- Withstand Current Rating
X	- Reactance
Z	- Impedance
%Z	- Percent Impedance

Trademarks
BOLT-LOC, ECONOPAK, EZ METER-PAK, GROUND CENSOR, I-LIMITER, I-LINE, ISO-FLEX, MAG-GARD, MICROLOGIC, MINI POWER-ZONE, OMEGAPAK, POWER-CAST, POWER STYLE, POWER ZONE, QF, QO, QWIK-GARD, SORGEL, SPEED-D, SQUARE D, VACARC and WATCHDOG are registered trademarks of Schneider Electric North America. I-75,000, METER-PAK, and PZ-8 are trademarks of Schneider Electric North America.

Company Abbreviations

Allen-Bradley	A-B
Allis-Chalmers	A-C
ASEA Brown Boveri	ABB
Automatic Switch Co	ASCO
Basler	BAS
Bussmann	BUSS
Challenger	CHA
Cooper	COOP
Cutler – Hammer	C-H
Economy Fuse	ECON
Federal Pacific Electric	FPE
G & W Electric	G&W
General Electric	GE
Gould Shawmut	GS
I-T-E Imperial	ITE
Kearney	KEA
Klockner	KLO
Littelfuse	LIT
McGraw Edison	ME
Merlin Gerin	MG
Powell	POW
Reliance	REL
RTE Corp.	RTE
Russelectric	RUSS
S & C Electric	S&C
Schweitzer Engr. Labs	SEL
Siemens	SIE
Square D	SQD
Thomas Betts	T-B
Toshiba	TOS
Westinghouse	WEST
Zenith	Z

APPENDIX B: SHORT CIRCUIT INPUT TABULATIONS

ALL PU VALUES ARE EXPRESSED ON A 100 MVA BASE.

FEEDER INPUT DATA

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=============================================================================================================================
CABLE                     FEEDER FROM                   FEEDER TO                     QTY  VOLTS   LENGTH          FEEDER
NAME                      NAME                          NAME                          /PH  L-L                SIZE       TYPE
=============================================================================================================================
CBL-0001                  BUS-0002                      100 UTC_MDPH1                  8   480      9.0  FEET   600     Copper
            Duct Material:    Magnetic    Insulation Type:      THWN    Insulation Class:
            +/-  Impedance: 0.0209 + J  0.0382  Ohms/1000 ft      0.0102 + J  0.0187  PU
            Z0   Impedance: 0.0659 + J  0.0941  Ohms/1000 ft      0.0322 + J  0.0459  PU

CBL-0002                  100 UTC_MDPH1                 101 MDPH1                      8   480  100.0  FEET   700   Aluminum
            Duct Material: Non-Magnetic   Insulation Type:      XLPE    Insulation Class:   XHHW-2
            +/-  Impedance: 0.0340 + J  0.0380  Ohms/1000 ft      0.1845 + J  0.2062  PU
            Z0   Impedance: 0.0540 + J  0.0967  Ohms/1000 ft      0.2930 + J  0.5246  PU

CBL-0003                  101 MDPH1                     ACC-2                          2   480  250.0  FEET   250     Copper
            Duct Material: Non-Magnetic   Insulation Type:      THHN    Insulation Class:
            +/-  Impedance: 0.0457 + J  0.0319  Ohms/1000 ft        2.48 + J    1.73  PU
            Z0   Impedance: 0.0727 + J  0.0812  Ohms/1000 ft        3.94 + J    4.41  PU

CBL-0004                  101 MDPH1                     ACC-3                          1   480  180.0  FEET   4/0     Copper
            Duct Material: Non-Magnetic   Insulation Type:      THHN    Insulation Class:
            +/-  Impedance: 0.0534 + J  0.0314  Ohms/1000 ft        4.17 + J    2.45  PU
            Z0   Impedance: 0.0849 + J  0.0799  Ohms/1000 ft        6.63 + J    6.24  PU

CBL-0005                  101 MDPH1                     102 H1L1                       2   480   60.0  FEET   250   Aluminum
            Duct Material:    Magnetic    Insulation Type:      THHN    Insulation Class:
            +/-  Impedance: 0.0722 + J  0.0399  Ohms/1000 ft      0.9401 + J  0.5195  PU
            Z0   Impedance: 0.2275 + J  0.0983  Ohms/1000 ft        2.96 + J    1.28  PU

CBL-0006                  101 MDPH1                     103 H1L2                       1   480  100.0  FEET   3/0   Aluminum
            Duct Material:    Magnetic    Insulation Type:      THHN    Insulation Class:
            +/-  Impedance: 0.1060 + J  0.0400  Ohms/1000 ft        4.60 + J    1.74  PU
            Z0   Impedance: 0.3341 + J  0.0985  Ohms/1000 ft       14.50 + J    4.28  PU

CBL-0007                  101 MDPH1                     104 H1L3                       1   480  160.0  FEET   300   Aluminum
            Duct Material:    Magnetic    Insulation Type:      THHN    Insulation Class:
            +/-  Impedance: 0.0602 + J  0.0393  Ohms/1000 ft        4.18 + J    2.73  PU
            Z0   Impedance: 0.1897 + J  0.0968  Ohms/1000 ft       13.17 + J    6.72  PU

CBL-0008                  101 MDPH1                     105 H1L4                       2   480  290.0  FEET   350   Aluminum
            Duct Material:    Magnetic    Insulation Type:      THHN    Insulation Class:
            +/-  Impedance: 0.0520 + J  0.0388  Ohms/1000 ft        3.27 + J    2.44  PU
            Z0   Impedance: 0.1639 + J  0.0956  Ohms/1000 ft       10.31 + J    6.02  PU

CBL-0009                  105 H1L4                      BUS-0011                       1   480   20.0  FEET   4/0     Copper
            Duct Material:    Magnetic    Insulation Type:      THHN    Insulation Class:
            +/-  Impedance: 0.0534 + J  0.0393  Ohms/1000 ft      0.4635 + J  0.3411  PU
            Z0   Impedance: 0.1683 + J  0.0968  Ohms/1000 ft        1.46 + J  0.8403  PU
```

```
                                 FEEDER  INPUT  DATA
==================================================================================================================
CABLE                FEEDER FROM                 FEEDER TO                   QTY  VOLTS   LENGTH          FEEDER
NAME                 NAME                        NAME                        /PH  L-L                 SIZE      TYPE
==================================================================================================================
CBL-0010             BUS-0012                    106 MD/G                     2   208    20.0  FEET    350     Copper
         Duct Material:   Magnetic    Insulation Type:     THHN    Insulation Class:
         +/-  Impedance: 0.0333 + J  0.0388  Ohms/1000 ft    0.7697 + J  0.8968  PU
         Z0   Impedance: 0.1050 + J  0.0956  Ohms/1000 ft      2.43 + J    2.21  PU

CBL-0011             106 MD/G                    107 G/GA                     1   208    20.0  FEET    300   Aluminum
         Duct Material:   Magnetic    Insulation Type:     THHN    Insulation Class:
         +/-  Impedance: 0.0602 + J  0.0393  Ohms/1000 ft      2.78 + J    1.82  PU
         Z0   Impedance: 0.1897 + J  0.0968  Ohms/1000 ft      8.77 + J    4.47  PU

CBL-0017             101 MDPH1                   BUS-0036                     4   480    40.0  FEET    350   Aluminum
         Duct Material:   Magnetic    Insulation Type:     THHN    Insulation Class:
         +/-  Impedance: 0.0520 + J  0.0388  Ohms/1000 ft    0.2257 + J  0.1684  PU
         Z0   Impedance: 0.1639 + J  0.0956  Ohms/1000 ft    0.7114 + J  0.4149  PU

CBL-0018             108 SDPL1                   109 L1M1                     1   208   500.0  FEET    250   Aluminum
         Duct Material:   Magnetic    Insulation Type:     THHN    Insulation Class:
         +/-  Impedance: 0.0722 + J  0.0399  Ohms/1000 ft     83.44 + J   46.11  PU
         Z0   Impedance: 0.2275 + J  0.0983  Ohms/1000 ft    262.92 + J  113.60  PU

CBL-0019             108 SDPL1                   110 L1L1                     2   208    80.0  FEET    500   Aluminum
         Duct Material:   Magnetic    Insulation Type:     THHN    Insulation Class:
         +/-  Impedance: 0.0375 + J  0.0379  Ohms/1000 ft      3.47 + J    3.50  PU
         Z0   Impedance: 0.1182 + J  0.0933  Ohms/1000 ft     10.93 + J    8.63  PU

CBL-0020             108 SDPL1                   111 L1L2                     2   208   130.0  FEET    500   Aluminum
         Duct Material:   Magnetic    Insulation Type:     THHN    Insulation Class:
         +/-  Impedance: 0.0375 + J  0.0379  Ohms/1000 ft      5.63 + J    5.69  PU
         Z0   Impedance: 0.1182 + J  0.0933  Ohms/1000 ft     17.76 + J   14.02  PU

CBL-0021             108 SDPL1                   112 L1L3                     2   208   170.0  FEET    250   Aluminum
         Duct Material:   Magnetic    Insulation Type:     THHN    Insulation Class:
         +/-  Impedance: 0.0722 + J  0.0399  Ohms/1000 ft     14.19 + J    7.84  PU
         Z0   Impedance: 0.2275 + J  0.0983  Ohms/1000 ft     44.70 + J   19.31  PU

CBL-0022             108 SDPL1                   114 L1L4                     1   208   260.0  FEET    300   Aluminum
         Duct Material:   Magnetic    Insulation Type:     THHN    Insulation Class:
         +/-  Impedance: 0.0602 + J  0.0393  Ohms/1000 ft     36.18 + J   23.62  PU
         Z0   Impedance: 0.1897 + J  0.0968  Ohms/1000 ft    114.00 + J   58.17  PU

CBL-0023             108 SDPL1                   115 L1L5                     1   208   300.0  FEET    400   Aluminum
         Duct Material:   Magnetic    Insulation Type:     THHN    Insulation Class:
         +/-  Impedance: 0.0460 + J  0.0385  Ohms/1000 ft     31.90 + J   26.70  PU
         Z0   Impedance: 0.1450 + J  0.0948  Ohms/1000 ft    100.55 + J   65.74  PU
```

FEEDER INPUT DATA

CABLE NAME		FEEDER FROM NAME	FEEDER TO NAME	QTY /PH	VOLTS L-L	LENGTH	FEEDER SIZE	FEEDER TYPE
CBL-0024		108 SDPL1	116 L1L6	1	208	100.0 FEET	2/0	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:					
	+/- Impedance: 0.1330 + J 0.0409 Ohms/1000 ft	30.74 + J 9.45 PU						
	Z0 Impedance: 0.4192 + J 0.1007 Ohms/1000 ft	96.89 + J 23.28 PU						
CBL-0025		108 SDPL1	117 L1B1	1	208	40.0 FEET	2/0	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:					
	+/- Impedance: 0.1330 + J 0.0409 Ohms/1000 ft	12.30 + J 3.78 PU						
	Z0 Impedance: 0.4192 + J 0.1007 Ohms/1000 ft	38.76 + J 9.31 PU						
CBL-0026		108 SDPL1	118 L1B2	1	208	260.0 FEET	1/0	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:					
	+/- Impedance: 0.1680 + J 0.0417 Ohms/1000 ft	100.96 + J 25.06 PU						
	Z0 Impedance: 0.5295 + J 0.1027 Ohms/1000 ft	318.21 + J 61.72 PU						
CBL-0027		112 L1L3	113 L1L31	1	208	20.0 FEET	3/0	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:					
	+/- Impedance: 0.1060 + J 0.0400 Ohms/1000 ft	4.90 + J 1.85 PU						
	Z0 Impedance: 0.3341 + J 0.0985 Ohms/1000 ft	15.44 + J 4.55 PU						
CBL-0028		101 MDPH1	119 H1B1	1	480	60.0 FEET	1	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:					
	+/- Impedance: 0.2110 + J 0.0427 Ohms/1000 ft	5.49 + J 1.11 PU						
	Z0 Impedance: 0.6650 + J 0.1052 Ohms/1000 ft	17.32 + J 2.74 PU						
CBL-0029		303 E1B1	304 E1L1	1	480	100.0 FEET	8	Copper
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:					
	+/- Impedance: 0.6404 + J 0.0475 Ohms/1000 ft	27.80 + J 2.06 PU						
	Z0 Impedance: 2.02 + J 0.1170 Ohms/1000 ft	87.60 + J 5.08 PU						
CBL-0030		303 E1B1	305 E1L2	1	480	340.0 FEET	3	Copper
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:					
	+/- Impedance: 0.2050 + J 0.0430 Ohms/1000 ft	30.25 + J 6.35 PU						
	Z0 Impedance: 0.6461 + J 0.1059 Ohms/1000 ft	95.34 + J 15.63 PU						
CBL-0031		200 UTC2_MDPH2	201 MDPH2	16	480	100.0 FEET	700	Aluminum
	Duct Material: Non-Magnetic	Insulation Type: XLPE	Insulation Class:		XHHW-2			
	+/- Impedance: 0.0340 + J 0.0380 Ohms/1000 ft	0.0922 + J 0.1031 PU						
	Z0 Impedance: 0.0540 + J 0.0967 Ohms/1000 ft	0.1465 + J 0.2623 PU						
CBL-0032		303 E1B1	BUS-0013	1	480	30.0 FEET	6	Copper
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:					
	+/- Impedance: 0.4100 + J 0.0437 Ohms/1000 ft	5.34 + J 0.5690 PU						
	Z0 Impedance: 1.29 + J 0.1076 Ohms/1000 ft	16.82 + J 1.40 PU						

FEEDER INPUT DATA

CABLE NAME	FEEDER FROM NAME	FEEDER TO NAME	QTY /PH	VOLTS L-L	LENGTH	FEEDER SIZE	FEEDER TYPE
CBL-0033	BUS-0037	108 SDPL1	6	208	40.0 FEET	600	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.0319 + J 0.0382 Ohms/1000 ft	0.4916 + J 0.5886 PU					
	Z0 Impedance: 0.1005 + J 0.0941 Ohms/1000 ft	1.55 + J 1.45 PU					
CBL-0034	BUS-0014	306 E1BL1	1	208	20.0 FEET	1	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.2110 + J 0.0427 Ohms/1000 ft	9.75 + J 1.97 PU					
	Z0 Impedance: 0.6650 + J 0.1052 Ohms/1000 ft	30.74 + J 4.86 PU					
CBL-0035	101 MDPH1	BUS-0039	1	480	80.0 FEET	1	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.2110 + J 0.0427 Ohms/1000 ft	7.33 + J 1.48 PU					
	Z0 Impedance: 0.6650 + J 0.1052 Ohms/1000 ft	23.09 + J 3.65 PU					
CBL-0036	300 GEN SEC	BUS-0040	1	480	150.0 FEET	1	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.2110 + J 0.0427 Ohms/1000 ft	13.74 + J 2.78 PU					
	Z0 Impedance: 0.6650 + J 0.1052 Ohms/1000 ft	43.29 + J 6.85 PU					
CBL-0037	301 ATS_E1B1	303 E1B1	1	480	20.0 FEET	1	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.2110 + J 0.0427 Ohms/1000 ft	1.83 + J 0.3707 PU					
	Z0 Impedance: 0.6650 + J 0.1052 Ohms/1000 ft	5.77 + J 0.9132 PU					
CBL-0038	306 E1BL1	307 E1BL2	1	208	30.0 FEET	4	Copper
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.2590 + J 0.0441 Ohms/1000 ft	17.96 + J 3.06 PU					
	Z0 Impedance: 0.8163 + J 0.1086 Ohms/1000 ft	56.60 + J 7.53 PU					
CBL-0039	BUS-0003	200 UTC2_MDPH2	9	480	100.0 FEET	600	Copper
	Duct Material: Magnetic	Insulation Type: THWN	Insulation Class:				
	+/- Impedance: 0.0209 + J 0.0382 Ohms/1000 ft	0.1008 + J 0.1842 PU					
	Z0 Impedance: 0.0659 + J 0.0941 Ohms/1000 ft	0.3178 + J 0.4538 PU					
CBL-0040	300 GEN SEC	BUS-0128	1	480	200.0 FEET	3/0	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.1060 + J 0.0400 Ohms/1000 ft	9.20 + J 3.47 PU					
	Z0 Impedance: 0.3341 + J 0.0985 Ohms/1000 ft	29.00 + J 8.55 PU					
CBL-0046	201 MDPH2	BUS-0055	2	480	30.0 FEET	500	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.0375 + J 0.0379 Ohms/1000 ft	0.2441 + J 0.2467 PU					
	Z0 Impedance: 0.1182 + J 0.0933 Ohms/1000 ft	0.7695 + J 0.6074 PU					

FEEDER INPUT DATA

CABLE NAME	FEEDER FROM NAME	FEEDER TO NAME	QTY /PH	VOLTS L-L	LENGTH	FEEDER SIZE	FEEDER TYPE
CBL-0047	BUS-0056	202 SDPL2	4	208	30.0 FEET	500	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.0375 + J 0.0379 Ohms/1000 ft	0.6501 + J 0.6570 PU					
	Z0 Impedance: 0.1182 + J 0.0933 Ohms/1000 ft	2.05 + J 1.62 PU					
CBL-0048	201 MDPH2	ACC-1	2	480	460.0 FEET	300	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.0602 + J 0.0393 Ohms/1000 ft	6.01 + J 3.92 PU					
	Z0 Impedance: 0.1897 + J 0.0968 Ohms/1000 ft	18.94 + J 9.66 PU					
CBL-0049	201 MDPH2	209 H2M1	1	480	100.0 FEET	300	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.0602 + J 0.0393 Ohms/1000 ft	2.61 + J 1.71 PU					
	Z0 Impedance: 0.1897 + J 0.0968 Ohms/1000 ft	8.23 + J 4.20 PU					
CBL-0050	201 MDPH2	210 H2M2	2	480	150.0 FEET	250	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.0722 + J 0.0399 Ohms/1000 ft	2.35 + J 1.30 PU					
	Z0 Impedance: 0.2275 + J 0.0983 Ohms/1000 ft	7.41 + J 3.20 PU					
CBL-0051	201 MDPH2	211 H2B2	2	480	30.0 FEET	250	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.0722 + J 0.0399 Ohms/1000 ft	0.4701 + J 0.2598 PU					
	Z0 Impedance: 0.2275 + J 0.0983 Ohms/1000 ft	1.48 + J 0.6400 PU					
CBL-0053	201 MDPH2	212 H2B1	1	480	40.0 FEET	6	Copper
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.4100 + J 0.0437 Ohms/1000 ft	7.12 + J 0.7587 PU					
	Z0 Impedance: 1.29 + J 0.1076 Ohms/1000 ft	22.43 + J 1.87 PU					
CBL-0054	201 MDPH2	213 SDPH21	4	480	500.0 FEET	350	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.0520 + J 0.0388 Ohms/1000 ft	2.82 + J 2.11 PU					
	Z0 Impedance: 0.1639 + J 0.0956 Ohms/1000 ft	8.89 + J 5.19 PU					
CBL-0055	201 MDPH2	229 SDPH22	4	480	750.0 FEET	600	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.0319 + J 0.0382 Ohms/1000 ft	2.60 + J 3.11 PU					
	Z0 Impedance: 0.1005 + J 0.0941 Ohms/1000 ft	8.18 + J 7.66 PU					
CBL-0056	201 MDPH2	BUS-0129	1	480	50.0 FEET	3/0	Aluminum
	Duct Material: Magnetic	Insulation Type: THWN	Insulation Class:				
	+/- Impedance: 0.1060 + J 0.0400 Ohms/1000 ft	2.30 + J 0.8681 PU					
	Z0 Impedance: 0.3341 + J 0.0985 Ohms/1000 ft	7.25 + J 2.14 PU					

FEEDER INPUT DATA

```
=====================================================================================================================================
CABLE                 FEEDER FROM                   FEEDER TO                    QTY  VOLTS   LENGTH          FEEDER
NAME                  NAME                          NAME                         /PH  L-L                  SIZE        TYPE
=====================================================================================================================================
CBL-0057              302 ATS_E2B1                  308 E2B1                      1   480   20.0 FEET    3/0  Aluminum
          Duct Material:   Magnetic    Insulation Type:     THWN    Insulation Class:
          +/-  Impedance: 0.1060 + J  0.0400  Ohms/1000 ft     0.9201 + J  0.3472  PU
          Z0   Impedance: 0.3341 + J  0.0985  Ohms/1000 ft       2.90 + J  0.8550  PU

CBL-0058              308 E2B1                      312 E2M1                      1   480  100.0 FEET     8     Copper
          Duct Material:   Magnetic    Insulation Type:     THWN    Insulation Class:
          +/-  Impedance: 0.6404 + J  0.0475  Ohms/1000 ft      27.80 + J    2.06  PU
          Z0   Impedance:   2.02 + J  0.1170  Ohms/1000 ft      87.60 + J    5.08  PU

CBL-0059              308 E2B1                      BUS-0070                      1   480  100.0 FEET     1   Aluminum
          Duct Material:   Magnetic    Insulation Type:     THWN    Insulation Class:
          +/-  Impedance: 0.2110 + J  0.0427  Ohms/1000 ft       9.16 + J    1.85  PU
          Z0   Impedance: 0.6650 + J  0.1052  Ohms/1000 ft      28.86 + J    4.57  PU

CBL-0060              BUS-0072                      309 E2BL1                     1   208   20.0 FEET    250  Aluminum
          Duct Material:   Magnetic    Insulation Type:     THWN    Insulation Class:
          +/-  Impedance: 0.0722 + J  0.0399  Ohms/1000 ft       3.34 + J    1.84  PU
          Z0   Impedance: 0.2275 + J  0.0983  Ohms/1000 ft      10.52 + J    4.54  PU

CBL-0061              309 E2BL1                     310 E2BL2                     1   208  450.0 FEET    4/0  Aluminum
          Duct Material:   Magnetic    Insulation Type:     THWN    Insulation Class:
          +/-  Impedance: 0.0844 + J  0.0393  Ohms/1000 ft      87.79 + J   40.88  PU
          Z0   Impedance: 0.2660 + J  0.0968  Ohms/1000 ft     276.67 + J  100.68  PU

CBL-0062              310 E2BL2                     311 E2BL3                     1   208  290.0 FEET    2/0  Aluminum
          Duct Material:   Magnetic    Insulation Type:     THWN    Insulation Class:
          +/-  Impedance: 0.1330 + J  0.0409  Ohms/1000 ft      89.15 + J   27.42  PU
          Z0   Impedance: 0.4192 + J  0.1007  Ohms/1000 ft     280.99 + J   67.50  PU

CBL-0063              308 E2B1                      313 E2B2                      1   480  480.0 FEET    1/0  Aluminum
          Duct Material:   Magnetic    Insulation Type:     THWN    Insulation Class:
          +/-  Impedance: 0.1680 + J  0.0417  Ohms/1000 ft      35.00 + J    8.69  PU
          Z0   Impedance: 0.5295 + J  0.1027  Ohms/1000 ft     110.31 + J   21.40  PU

CBL-0064              313 E2B2                      314 E2M3                      1   480   80.0 FEET     8     Copper
          Duct Material:   Magnetic    Insulation Type:     THWN    Insulation Class:
          +/-  Impedance: 0.6404 + J  0.0475  Ohms/1000 ft      22.24 + J    1.65  PU
          Z0   Impedance:   2.02 + J  0.1170  Ohms/1000 ft      70.08 + J    4.06  PU

CBL-0065              313 E2B2                      315 E2U1                      1   480  100.0 FEET     8     Copper
          Duct Material:   Magnetic    Insulation Type:     THWN    Insulation Class:
          +/-  Impedance: 0.6404 + J  0.0475  Ohms/1000 ft      27.80 + J    2.06  PU
          Z0   Impedance:   2.02 + J  0.1170  Ohms/1000 ft      87.60 + J    5.08  PU
```

FEEDER INPUT DATA

CABLE NAME	FEEDER FROM NAME	FEEDER TO NAME	QTY /PH	VOLTS L-L	LENGTH	FEEDER SIZE	FEEDER TYPE
CBL-0066	313 E2B2	316 E2B3	1	480	290.0 FEET	3	Copper
	Duct Material: Magnetic	Insulation Type: THWN	Insulation Class:				
	+/- Impedance: 0.2050 + J 0.0430 Ohms/1000 ft	25.80 + J 5.41 PU					
	Z0 Impedance: 0.6461 + J 0.1059 Ohms/1000 ft	81.32 + J 13.33 PU					
CBL-0067	316 E2B3	317 E2M2	1	480	140.0 FEET	8	Copper
	Duct Material: Magnetic	Insulation Type: THWN	Insulation Class:				
	+/- Impedance: 0.6404 + J 0.0475 Ohms/1000 ft	38.91 + J 2.89 PU					
	Z0 Impedance: 2.02 + J 0.1170 Ohms/1000 ft	122.63 + J 7.11 PU					
CBL-0068	316 E2B3	318 E2U2	1	480	160.0 FEET	8	Copper
	Duct Material: Magnetic	Insulation Type: THWN	Insulation Class:				
	+/- Impedance: 0.6404 + J 0.0475 Ohms/1000 ft	44.47 + J 3.30 PU					
	Z0 Impedance: 2.02 + J 0.1170 Ohms/1000 ft	140.15 + J 8.13 PU					
CBL-0069	202 SDPL2	203 L2M1	4	208	200.0 FEET	500	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.0375 + J 0.0379 Ohms/1000 ft	4.33 + J 4.38 PU					
	Z0 Impedance: 0.1182 + J 0.0933 Ohms/1000 ft	13.66 + J 10.78 PU					
CBL-0070	203 L2M1	204 L2M11	1	208	40.0 FEET	500	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.0375 + J 0.0379 Ohms/1000 ft	3.47 + J 3.50 PU					
	Z0 Impedance: 0.1182 + J 0.0933 Ohms/1000 ft	10.93 + J 8.63 PU					
CBL-0071	202 SDPL2	205 L2M2	2	208	120.0 FEET	250	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.0722 + J 0.0399 Ohms/1000 ft	10.01 + J 5.53 PU					
	Z0 Impedance: 0.2275 + J 0.0983 Ohms/1000 ft	31.55 + J 13.63 PU					
CBL-0072	205 L2M2	206 L2M21	1	208	20.0 FEET	6	Copper
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.4100 + J 0.0437 Ohms/1000 ft	18.95 + J 2.02 PU					
	Z0 Impedance: 1.29 + J 0.1076 Ohms/1000 ft	59.73 + J 4.97 PU					
CBL-0073	202 SDPL2	208 L2B1	1	208	30.0 FEET	1	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.2110 + J 0.0427 Ohms/1000 ft	14.63 + J 2.96 PU					
	Z0 Impedance: 0.6650 + J 0.1052 Ohms/1000 ft	46.11 + J 7.29 PU					
CBL-0074	202 SDPL2	207 L2B2	1	208	100.0 FEET	300	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.0602 + J 0.0393 Ohms/1000 ft	13.91 + J 9.08 PU					
	Z0 Impedance: 0.1897 + J 0.0968 Ohms/1000 ft	43.85 + J 22.37 PU					

FEEDER INPUT DATA

CABLE NAME	FEEDER FROM NAME	FEEDER TO NAME	QTY /PH	VOLTS L-L	LENGTH	FEEDER SIZE	FEEDER TYPE
CBL-0075	213 SDPH21	BUS-0057	2	480	30.0 FEET	500	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.0375 + J 0.0379 Ohms/1000 ft	0.2441 + J 0.2467 PU					
	Z0 Impedance: 0.1182 + J 0.0933 Ohms/1000 ft	0.7695 + J 0.6074 PU					
CBL-0076	BUS-0058	217 SDPL21	4	208	30.0 FEET	500	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.0375 + J 0.0379 Ohms/1000 ft	0.6501 + J 0.6570 PU					
	Z0 Impedance: 0.1182 + J 0.0933 Ohms/1000 ft	2.05 + J 1.62 PU					
CBL-0077	217 SDPL21	218 L21U1	1	208	100.0 FEET	3/0	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.1060 + J 0.0400 Ohms/1000 ft	24.50 + J 9.25 PU					
	Z0 Impedance: 0.3341 + J 0.0985 Ohms/1000 ft	77.22 + J 22.77 PU					
CBL-0078	217 SDPL21	219 L21U2	1	208	250.0 FEET	3/0	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.1060 + J 0.0400 Ohms/1000 ft	61.25 + J 23.11 PU					
	Z0 Impedance: 0.3341 + J 0.0985 Ohms/1000 ft	193.06 + J 56.92 PU					
CBL-0079	217 SDPL21	220 L21U3	1	208	130.0 FEET	3/0	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.1060 + J 0.0400 Ohms/1000 ft	31.85 + J 12.02 PU					
	Z0 Impedance: 0.3341 + J 0.0985 Ohms/1000 ft	100.39 + J 29.60 PU					
CBL-0080	217 SDPL21	221 L21U4	1	208	220.0 FEET	3/0	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.1060 + J 0.0400 Ohms/1000 ft	53.90 + J 20.34 PU					
	Z0 Impedance: 0.3341 + J 0.0985 Ohms/1000 ft	169.89 + J 50.09 PU					
CBL-0081	217 SDPL21	222 L21U5	1	208	90.0 FEET	3/0	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.1060 + J 0.0400 Ohms/1000 ft	22.05 + J 8.32 PU					
	Z0 Impedance: 0.3341 + J 0.0985 Ohms/1000 ft	69.50 + J 20.49 PU					
CBL-0082	217 SDPL21	223 L21M1	1	208	270.0 FEET	300	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.0602 + J 0.0393 Ohms/1000 ft	37.57 + J 24.53 PU					
	Z0 Impedance: 0.1897 + J 0.0968 Ohms/1000 ft	118.39 + J 60.41 PU					
CBL-0083	223 L21M1	224 L21M11	1	208	20.0 FEET	1	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.2110 + J 0.0427 Ohms/1000 ft	9.75 + J 1.97 PU					
	Z0 Impedance: 0.6650 + J 0.1052 Ohms/1000 ft	30.74 + J 4.86 PU					

FEEDER INPUT DATA

```
==========================================================================================================================
CABLE                   FEEDER FROM                    FEEDER TO                     QTY  VOLTS    LENGTH          FEEDER
NAME                    NAME                           NAME                          /PH  L-L                   SIZE      TYPE
==========================================================================================================================
CBL-0084                217 SDPL21                     225 L21M2                      1    208  100.0  FEET     3/0   Aluminum
             Duct Material:    Magnetic    Insulation Type:      THHN    Insulation Class:
             +/-  Impedance: 0.1060 + J  0.0400  Ohms/1000 ft      24.50 + J    9.25  PU
             Z0   Impedance: 0.3341 + J  0.0985  Ohms/1000 ft      77.22 + J   22.77  PU

CBL-0085                217 SDPL21                     226 L21M3                      1    208  220.0  FEET     300   Aluminum
             Duct Material:    Magnetic    Insulation Type:      THHN    Insulation Class:
             +/-  Impedance: 0.0602 + J  0.0393  Ohms/1000 ft      30.61 + J   19.98  PU
             Z0   Impedance: 0.1897 + J  0.0968  Ohms/1000 ft      96.46 + J   49.22  PU

CBL-0086                217 SDPL21                     227 L21M4                      1    208   60.0  FEET     3/0   Aluminum
             Duct Material:    Magnetic    Insulation Type:      THHN    Insulation Class:
             +/-  Impedance: 0.1060 + J  0.0400  Ohms/1000 ft      14.70 + J    5.55  PU
             Z0   Impedance: 0.3341 + J  0.0985  Ohms/1000 ft      46.33 + J   13.66  PU

CBL-0087                217 SDPL21                     228 L21B1                      1    208   10.0  FEET       6     Copper
             Duct Material:    Magnetic    Insulation Type:      THHN    Insulation Class:
             +/-  Impedance: 0.4100 + J  0.0437  Ohms/1000 ft       9.48 + J    1.01  PU
             Z0   Impedance:   1.29 + J  0.1076  Ohms/1000 ft      29.87 + J    2.49  PU

CBL-0088                213 SDPH21                     216 H21U1                      1    480  120.0  FEET       1   Aluminum
             Duct Material:    Magnetic    Insulation Type:      THHN    Insulation Class:
             +/-  Impedance: 0.2110 + J  0.0427  Ohms/1000 ft      10.99 + J    2.22  PU
             Z0   Impedance: 0.6650 + J  0.1052  Ohms/1000 ft      34.64 + J    5.48  PU

CBL-0089                213 SDPH21                     215 H21M1                      1    480   80.0  FEET       1   Aluminum
             Duct Material:    Magnetic    Insulation Type:      THHN    Insulation Class:
             +/-  Impedance: 0.2110 + J  0.0427  Ohms/1000 ft       7.33 + J    1.48  PU
             Z0   Impedance: 0.6650 + J  0.1052  Ohms/1000 ft      23.09 + J    3.65  PU

CBL-0090                213 SDPH21                     214 H21B1                      1    480   30.0  FEET       6     Copper
             Duct Material:    Magnetic    Insulation Type:      THHN    Insulation Class:
             +/-  Impedance: 0.4100 + J  0.0437  Ohms/1000 ft       5.34 + J  0.5690  PU
             Z0   Impedance:   1.29 + J  0.1076  Ohms/1000 ft      16.82 + J    1.40  PU

CBL-0091                229 SDPH22                     BUS-0059                       2    480   20.0  FEET     500   Aluminum
             Duct Material:    Magnetic    Insulation Type:      THHN    Insulation Class:
             +/-  Impedance: 0.0375 + J  0.0379  Ohms/1000 ft     0.1628 + J  0.1645  PU
             Z0   Impedance: 0.1182 + J  0.0933  Ohms/1000 ft     0.5130 + J  0.4049  PU

CBL-0092                BUS-0060                       233 SDPL22                     4    208   20.0  FEET     500   Aluminum
             Duct Material:    Magnetic    Insulation Type:      THHN    Insulation Class:
             +/-  Impedance: 0.0375 + J  0.0379  Ohms/1000 ft     0.4334 + J  0.4380  PU
             Z0   Impedance: 0.1182 + J  0.0933  Ohms/1000 ft       1.37 + J    1.08  PU
```

```
                                        FEEDER  INPUT  DATA
===========================================================================================================================
CABLE                      FEEDER FROM                     FEEDER TO                          QTY  VOLTS    LENGTH          FEEDER
NAME                       NAME                            NAME                               /PH  L-L                   SIZE       TYPE
===========================================================================================================================
CBL-0093                   233 SDPL22                      234 L22U1                          1    208  110.0  FEET     3/0   Aluminum
             Duct Material:    Magnetic     Insulation Type:       THHN     Insulation Class:
             +/-  Impedance: 0.1060 + J  0.0400  Ohms/1000 ft       26.95 + J   10.17  PU
             Z0   Impedance: 0.3341 + J  0.0985  Ohms/1000 ft       84.95 + J   25.04  PU

CBL-0094                   233 SDPL22                      235 L22U2                          1    208  130.0  FEET     3/0   Aluminum
             Duct Material:    Magnetic     Insulation Type:       THHN     Insulation Class:
             +/-  Impedance: 0.1060 + J  0.0400  Ohms/1000 ft       31.85 + J   12.02  PU
             Z0   Impedance: 0.3341 + J  0.0985  Ohms/1000 ft      100.39 + J   29.60  PU

CBL-0095                   233 SDPL22                      236 L22U3                          1    208  180.0  FEET     3/0   Aluminum
             Duct Material:    Magnetic     Insulation Type:       THHN     Insulation Class:
             +/-  Impedance: 0.1060 + J  0.0400  Ohms/1000 ft       44.10 + J   16.64  PU
             Z0   Impedance: 0.3341 + J  0.0985  Ohms/1000 ft      139.00 + J   40.98  PU

CBL-0096                   233 SDPL22                      237 L22U4                          1    208  120.0  FEET     3/0   Aluminum
             Duct Material:    Magnetic     Insulation Type:       THHN     Insulation Class:
             +/-  Impedance: 0.1060 + J  0.0400  Ohms/1000 ft       29.40 + J   11.09  PU
             Z0   Impedance: 0.3341 + J  0.0985  Ohms/1000 ft       92.67 + J   27.32  PU

CBL-0097                   233 SDPL22                      238 L22U5                          1    208  140.0  FEET     3/0   Aluminum
             Duct Material:    Magnetic     Insulation Type:       THHN     Insulation Class:
             +/-  Impedance: 0.1060 + J  0.0400  Ohms/1000 ft       34.30 + J   12.94  PU
             Z0   Impedance: 0.3341 + J  0.0985  Ohms/1000 ft      108.11 + J   31.87  PU

CBL-0098                   233 SDPL22                      239 L22M1                          1    208  110.0  FEET     3/0   Aluminum
             Duct Material:    Magnetic     Insulation Type:       THHN     Insulation Class:
             +/-  Impedance: 0.1060 + J  0.0400  Ohms/1000 ft       26.95 + J   10.17  PU
             Z0   Impedance: 0.3341 + J  0.0985  Ohms/1000 ft       84.95 + J   25.04  PU

CBL-0099                   233 SDPL22                      240 L22M2                          1    208  140.0  FEET     3/0   Aluminum
             Duct Material:    Magnetic     Insulation Type:       THHN     Insulation Class:
             +/-  Impedance: 0.1060 + J  0.0400  Ohms/1000 ft       34.30 + J   12.94  PU
             Z0   Impedance: 0.3341 + J  0.0985  Ohms/1000 ft      108.11 + J   31.87  PU

CBL-0100                   233 SDPL22                      241 L22M3                          1    208  140.0  FEET     3/0   Aluminum
             Duct Material:    Magnetic     Insulation Type:       THHN     Insulation Class:
             +/-  Impedance: 0.1060 + J  0.0400  Ohms/1000 ft       34.30 + J   12.94  PU
             Z0   Impedance: 0.3341 + J  0.0985  Ohms/1000 ft      108.11 + J   31.87  PU

CBL-0101                   233 SDPL22                      242 L22M4                          1    208  150.0  FEET     3/0   Aluminum
             Duct Material:    Magnetic     Insulation Type:       THHN     Insulation Class:
             +/-  Impedance: 0.1060 + J  0.0400  Ohms/1000 ft       36.75 + J   13.87  PU
             Z0   Impedance: 0.3341 + J  0.0985  Ohms/1000 ft      115.84 + J   34.15  PU
```

FEEDER INPUT DATA

CABLE NAME	FEEDER FROM NAME	FEEDER TO NAME	QTY /PH	VOLTS L-L	LENGTH	FEEDER SIZE	FEEDER TYPE
CBL-0102	233 SDPL22	243 L22M5	1	208	180.0 FEET	300	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.0602 + J 0.0393 Ohms/1000 ft	25.05 + J 16.35 PU					
	Z0 Impedance: 0.1897 + J 0.0968 Ohms/1000 ft	78.92 + J 40.27 PU					
CBL-0103	233 SDPL22	244 L22M6	1	208	170.0 FEET	3/0	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.1060 + J 0.0400 Ohms/1000 ft	41.65 + J 15.72 PU					
	Z0 Impedance: 0.3341 + J 0.0985 Ohms/1000 ft	131.28 + J 38.70 PU					
CBL-0104	233 SDPL22	245 L22B1	1	208	30.0 FEET	6	Copper
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.4100 + J 0.0437 Ohms/1000 ft	28.43 + J 3.03 PU					
	Z0 Impedance: 1.29 + J 0.1076 Ohms/1000 ft	89.60 + J 7.46 PU					
CBL-0105	229 SDPH22	231 H22M1	1	480	120.0 FEET	6	Copper
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.4100 + J 0.0437 Ohms/1000 ft	21.35 + J 2.28 PU					
	Z0 Impedance: 1.29 + J 0.1076 Ohms/1000 ft	67.30 + J 5.60 PU					
CBL-0106	229 SDPH22	232 H22U1	1	480	120.0 FEET	2/0	Aluminum
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.1330 + J 0.0409 Ohms/1000 ft	6.93 + J 2.13 PU					
	Z0 Impedance: 0.4192 + J 0.1007 Ohms/1000 ft	21.83 + J 5.24 PU					
CBL-0107	229 SDPH22	230 H22B1	1	480	20.0 FEET	6	Copper
	Duct Material: Magnetic	Insulation Type: THHN	Insulation Class:				
	+/- Impedance: 0.4100 + J 0.0437 Ohms/1000 ft	3.56 + J 0.3793 PU					
	Z0 Impedance: 1.29 + J 0.1076 Ohms/1000 ft	11.22 + J 0.9340 PU					

TRANSFORMER INPUT DATA

```
===================================================================================================================================
TRANSFORMER              PRIMARY RECORD                 VOLTS   * SECONDARY RECORD                VOLTS   FULL-LOAD   NOMINAL
NAME                     NO NAME                        L-L       NO NAME                         L-L     KVA         KVA
===================================================================================================================================
TE1                      BUS-0013                    D  480.00  BUS-0014                      YG  208.00  45.00         45.00
            Pos. Seq. Z%:    4.39 + J  3.95   (Zpu  97.45 + j  87.71 )   Shell Type
            Zero Seq. Z%:    4.39 + J  3.95   (Sec  97.45 + j  87.71 Pri  Open)
            Taps  Pri. 0.000 %  Sec. 0.000 %  Phase Shift (Pri. Leading Sec.):  30.00 Deg.

TE2                      BUS-0070                    D  480.00  BUS-0072                      YG  208.00  75.00         75.00
            Pos. Seq. Z%:    3.48 + J  4.52   (Zpu  46.34 + j  60.24 )   Shell Type
            Zero Seq. Z%:    3.48 + J  4.52   (Sec  46.34 + j  60.24 Pri  Open)
            Taps  Pri. 0.000 %  Sec. 0.000 %  Phase Shift (Pri. Leading Sec.):  30.00 Deg.

XF2-0001                 UTILITY PRI                 D 13200.0  BUS-0002                      YG  480.00 1500.00      1500.00
            Pos. Seq. Z%:   0.699 + J  5.74   (Zpu  0.466 + j   3.83 )   Shell Type
            Zero Seq. Z%:   0.699 + J  5.74   (Sec  0.466 + j   3.83 Pri  Open)
            Taps  Pri. 0.000 %  Sec. 0.000 %  Phase Shift (Pri. Leading Sec.):  30.00 Deg.

XF2-0004                 UTILITY PRI 2               D 13200.0  BUS-0003                      YG  480.00 1500.00      1500.00
            Pos. Seq. Z%:   0.699 + J  5.74   (Zpu  0.466 + j   3.83 )   Shell Type
            Zero Seq. Z%:   0.699 + J  5.74   (Sec  0.466 + j   3.83 Pri  Open)
            Taps  Pri. 0.000 %  Sec. 0.000 %  Phase Shift (Pri. Leading Sec.):  30.00 Deg.

XFMR_MD/G                BUS-0011                    D  480.00  BUS-0012                      YG  208.00  150.00       150.00
            Pos. Seq. Z%:    1.93 + J  5.18   (Zpu  12.85 + j  34.56 )   Shell Type
            Zero Seq. Z%:    1.93 + J  5.18   (Sec  12.85 + j  34.56 Pri  Open)
            Taps  Pri. 0.000 %  Sec. 0.000 %  Phase Shift (Pri. Leading Sec.):  30.00 Deg.

XFMR_SDPL1               BUS-0036                    D  480.00  BUS-0037                      YG  208.00  750.00       750.00
            Pos. Seq. Z%:   0.782 + J  5.24   (Zpu   1.04 + j   6.99 )   Shell Type
            Zero Seq. Z%:   0.782 + J  5.24   (Sec   1.04 + j   6.99 Pri  Open)
            Taps  Pri. 0.000 %  Sec. 0.000 %  Phase Shift (Pri. Leading Sec.):  30.00 Deg.
```

TRANSFORMER INPUT DATA

```
==================================================================================================================================
TRANSFORMER                    PRIMARY RECORD                     VOLTS    * SECONDARY RECORD                   VOLTS   FULL-LOAD    NOMINAL
NAME                           NO NAME                            L-L        NO NAME                            L-L     KVA          KVA
==================================================================================================================================
XFMR_SDPL2                     BUS-0055                       D   480.00   BUS-0056                        YG   208.00  500.00       500.00
               Pos. Seq. Z%:     1.72 + J   5.85   (Zpu   3.43 + j  11.71 )    Shell Type
               Zero Seq. Z%:     1.72 + J   5.85   (Sec   3.43 + j  11.71 Pri  Open)
               Taps  Pri. 0.000 %  Sec. 0.000 %  Phase Shift (Pri. Leading Sec.):  30.00 Deg.

XFMR_SDPL21                    BUS-0057                       D   480.00   BUS-0058                        YG   208.00  500.00       500.00
               Pos. Seq. Z%:     1.72 + J   5.85   (Zpu   3.43 + j  11.71 )    Shell Type
               Zero Seq. Z%:     1.72 + J   5.85   (Sec   3.43 + j  11.71 Pri  Open)
               Taps  Pri. 0.000 %  Sec. 0.000 %  Phase Shift (Pri. Leading Sec.):  30.00 Deg.

XFMR_SDPL22                    BUS-0059                       D   480.00   BUS-0060                        YG   208.00  500.00       500.00
               Pos. Seq. Z%:     1.72 + J   5.85   (Zpu   3.43 + j  11.71 )    Shell Type
               Zero Seq. Z%:     1.72 + J   5.85   (Sec   3.43 + j  11.71 Pri  Open)
               Taps  Pri. 0.000 %  Sec. 0.000 %  Phase Shift (Pri. Leading Sec.):  30.00 Deg.
```

```
                    GENERATION  CONTRIBUTION  DATA
=================================================================================
BUS                          CONTRIBUTION                VOLTAGE
NAME                         NAME                            L-L     MVA      X"d    X/R
=================================================================================
300 GEN SEC                  GEN-1                        480.00  0.250   0.1500    12.40
                 KG:  0.9174  xdsat:    2.05  Excitation Limit:     1.30  Ik -   ON
                 Pos  Sequence Impedance (100 MVA Base)   4.84 + J   60.00 PU
UTILITY PRI                  UTIL-0001                   13200.0 1829.05
                 Three Phase           Contribution:    80000.0 AMPS        8.00
                 Single Line to Ground Contribution:    80000.0 AMPS        8.00
                 Pos  Sequence Impedance (100 MVA Base)  0.0068 + J   0.0543 PU
                 Zero Sequence Impedance (100 MVA Base)  0.0068 + J   0.0543 PU

UTILITY PRI 2                UTIL-0003                   13200.0 1829.05
                 Three Phase           Contribution:    80000.0 AMPS        8.00
                 Single Line to Ground Contribution:    80000.0 AMPS        8.00
                 Pos  Sequence Impedance (100 MVA Base)  0.0068 + J   0.0543 PU
                 Zero Sequence Impedance (100 MVA Base)  0.0068 + J   0.0543 PU
```

MOTOR CONTRIBUTION DATA

BUS NAME	CONTRIBUTION NAME	VOLTAGE L-L	BASE kVA	X"d	X/R	Motor Number
101 MDPH1	MDPH1 MOTOR LOAD	480	375.00	0.2500	10.0	1.00
	Pos Sequence Impedance (100 MVA Base)	6.67 + j 66.67 PU				
201 MDPH2	MDPH2 MOTOR LOAD	480	375.00	0.2500	10.0	1.00
	Pos Sequence Impedance (100 MVA Base)	6.67 + j 66.67 PU				
ACC-1	MTRI-0005	480	275.74	0.2000	10.0	1.00
	Pos Sequence Impedance (100 MVA Base)	7.25 + j 72.53 PU				
ACC-2	MTRI-0003	480	275.74	0.2000	10.0	1.00
	Pos Sequence Impedance (100 MVA Base)	7.25 + j 72.53 PU				
ACC-3	MTRI-0004	480	75.20	0.2000	10.0	1.00
	Pos Sequence Impedance (100 MVA Base)	26.59 + j 265.95 PU				

APPENDIX C: SHORT CIRCUIT OUTPUT TABULATIONS

```
                    T H R E E   P H A S E   F A U L T   R E P O R T
                      (FOR APPLICATION OF LOW VOLTAGE BREAKERS)
                          PRE FAULT VOLTAGE: 1.0000
                          MODEL TRANSFORMER TAPS: NO
=========================================================================================================

 100 UTC_MDPH1              3P Duty: 34.442 KA AT  -82.96 DEG (  28.63 MVA)  X/R:     8.11
                VOLTAGE:    480.   EQUIV. IMPEDANCE=  0.0010 + J  0.0080  OHMS
                LOW VOLTAGE POWER CIRCUIT BREAKER   35.672 KA
                MOLDED CASE CIRCUIT BREAKER > 20KA  37.875 KA
                CBL-0001                     BUS-0002                       30.623 KA      ANG:   -82.93
                CBL-0002                     101 MDPH1                       3.818 KA      ANG:    96.83

 101 MDPH1                  3P Duty: 32.770 KA AT  -81.07 DEG (  27.24 MVA)  X/R:     6.46
                VOLTAGE:    480.   EQUIV. IMPEDANCE=  0.0013 + J  0.0084  OHMS
                LOW VOLTAGE POWER CIRCUIT BREAKER   32.770 KA
                MOLDED CASE CIRCUIT BREAKER > 20KA  34.666 KA
                CONTRIBUTIONS:  MDPH1 MOTOR LOAD                             1.795 KA      ANG:   -84.29
                CBL-0003                     ACC-2                           1.606 KA      ANG:    97.47
                CBL-0004                     ACC-3                           0.445 KA      ANG:    96.54
                CBL-0002                     100 UTC_MDPH1                  28.927 KA      ANG:   -80.76

 102 H1L1                   3P Duty: 27.263 KA AT  -69.99 DEG (  22.67 MVA)  X/R:     2.76
                VOLTAGE:    480.   EQUIV. IMPEDANCE=  0.0035 + J  0.0096  OHMS
                LOW VOLTAGE POWER CIRCUIT BREAKER   27.263 KA
                MOLDED CASE CIRCUIT BREAKER > 20KA  27.263 KA
                CBL-0005                     101 MDPH1                      27.263 KA      ANG:   -69.99

 103 H1L2                   3P Duty: 16.148 KA AT  -46.04 DEG (  13.43 MVA)  X/R:     1.04
                VOLTAGE:    480.   EQUIV. IMPEDANCE=  0.0119 + J  0.0124  OHMS
                LOW VOLTAGE POWER CIRCUIT BREAKER   16.148 KA
                MOLDED CASE CIRCUIT BREAKER < 20KA  16.148 KA
                MOLDED CASE CIRCUIT BREAKER > 20KA  16.148 KA
                CBL-0006                     101 MDPH1                      16.148 KA      ANG:   -46.04

 104 H1L3                   3P Duty: 15.160 KA AT  -53.22 DEG (  12.60 MVA)  X/R:     1.34
                VOLTAGE:    480.   EQUIV. IMPEDANCE=  0.0109 + J  0.0146  OHMS
                LOW VOLTAGE POWER CIRCUIT BREAKER   15.160 KA
                MOLDED CASE CIRCUIT BREAKER < 20KA  15.160 KA
                MOLDED CASE CIRCUIT BREAKER > 20KA  15.160 KA
                CBL-0007                     101 MDPH1                      15.160 KA      ANG:   -53.22

 105 H1L4                   3P Duty: 16.748 KA AT  -57.66 DEG (  13.92 MVA)  X/R:     1.58
                VOLTAGE:    480.   EQUIV. IMPEDANCE=  0.0089 + J  0.0140  OHMS
                LOW VOLTAGE POWER CIRCUIT BREAKER   16.748 KA
                MOLDED CASE CIRCUIT BREAKER < 20KA  16.748 KA
                MOLDED CASE CIRCUIT BREAKER > 20KA  16.748 KA
                CBL-0008                     101 MDPH1                      16.748 KA      ANG:   -57.66
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            T H R E E   P H A S E   F A U L T   R E P O R T
              (FOR APPLICATION OF LOW VOLTAGE BREAKERS)
                  PRE FAULT VOLTAGE: 1.0000
                  MODEL TRANSFORMER TAPS: NO
==================================================================================================================

 106 MD/G                 3P Duty:  6.096 KA AT  -66.82 DEG (   2.20 MVA)  X/R:     2.34
            VOLTAGE:   208.   EQUIV. IMPEDANCE=  0.0078 + J  0.0181  OHMS
            LOW VOLTAGE POWER CIRCUIT BREAKER    6.096 KA
            MOLDED CASE CIRCUIT BREAKER < 10KA   6.608 KA
            MOLDED CASE CIRCUIT BREAKER < 20KA   6.096 KA
            MOLDED CASE CIRCUIT BREAKER > 20KA   6.096 KA
            CBL-0010                     BUS-0012                         6.096 KA     ANG:   -66.82

 107 G/GA                 3P Duty:  5.742 KA AT  -64.64 DEG (   2.07 MVA)  X/R:     2.11
            VOLTAGE:   208.   EQUIV. IMPEDANCE=  0.0090 + J  0.0189  OHMS
            LOW VOLTAGE POWER CIRCUIT BREAKER    5.742 KA
            MOLDED CASE CIRCUIT BREAKER < 10KA   6.052 KA
            MOLDED CASE CIRCUIT BREAKER < 20KA   5.742 KA
            MOLDED CASE CIRCUIT BREAKER > 20KA   5.742 KA
            CBL-0011                     106 MD/G                         5.742 KA     ANG:   -64.64

 108 SDPL1                3P Duty: 23.911 KA AT  -78.42 DEG (   8.61 MVA)  X/R:     4.90
            VOLTAGE:   208.   EQUIV. IMPEDANCE=  0.0010 + J  0.0049  OHMS
            LOW VOLTAGE POWER CIRCUIT BREAKER   23.911 KA
            MOLDED CASE CIRCUIT BREAKER > 20KA  23.911 KA
            CBL-0033                     BUS-0037                        23.911 KA     ANG:  -258.42

 109 L1M1                 3P Duty:  2.688 KA AT  -33.83 DEG (   0.97 MVA)  X/R:     0.67
            VOLTAGE:   208.   EQUIV. IMPEDANCE=  0.0371 + J  0.0249  OHMS
            LOW VOLTAGE POWER CIRCUIT BREAKER    2.688 KA
            MOLDED CASE CIRCUIT BREAKER < 10KA   2.688 KA
            MOLDED CASE CIRCUIT BREAKER < 20KA   2.688 KA
            MOLDED CASE CIRCUIT BREAKER > 20KA   2.688 KA
            CBL-0018                     108 SDPL1                        2.688 KA     ANG:   -33.83

 110 L1L1                 3P Duty: 17.385 KA AT  -68.71 DEG (   6.26 MVA)  X/R:     2.57
            VOLTAGE:   208.   EQUIV. IMPEDANCE=  0.0025 + J  0.0064  OHMS
            LOW VOLTAGE POWER CIRCUIT BREAKER   17.385 KA
            MOLDED CASE CIRCUIT BREAKER < 20KA  17.385 KA
            MOLDED CASE CIRCUIT BREAKER > 20KA  17.385 KA
            CBL-0019                     108 SDPL1                       17.385 KA     ANG:   -68.71

 111 L1L2                 3P Duty: 14.738 KA AT  -64.98 DEG (   5.31 MVA)  X/R:     2.15
            VOLTAGE:   208.   EQUIV. IMPEDANCE=  0.0034 + J  0.0074  OHMS
            LOW VOLTAGE POWER CIRCUIT BREAKER   14.738 KA
            MOLDED CASE CIRCUIT BREAKER < 20KA  14.738 KA
            MOLDED CASE CIRCUIT BREAKER > 20KA  14.738 KA
            CBL-0020                     108 SDPL1                       14.738 KA     ANG:   -64.98
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              T H R E E   P H A S E   F A U L T   R E P O R T
                 (FOR APPLICATION OF LOW VOLTAGE BREAKERS)
                       PRE FAULT VOLTAGE: 1.0000
                       MODEL TRANSFORMER TAPS: NO
==============================================================================================================

 112 L1L3                3P Duty: 10.956 KA AT  -49.32 DEG (   3.95 MVA)  X/R:     1.16
              VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0071 + J  0.0083  OHMS
              LOW VOLTAGE POWER CIRCUIT BREAKER   10.956 KA
              MOLDED CASE CIRCUIT BREAKER < 20KA  10.956 KA
              MOLDED CASE CIRCUIT BREAKER > 20KA  10.956 KA
              CBL-0021                      108 SDPL1                         10.956 KA     ANG:  -49.32

 113 L1L31               3P Duty:  9.241 KA AT  -44.52 DEG (   3.33 MVA)  X/R:     0.98
              VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0093 + J  0.0091  OHMS
              LOW VOLTAGE POWER CIRCUIT BREAKER    9.241 KA
              MOLDED CASE CIRCUIT BREAKER < 10KA   9.241 KA
              MOLDED CASE CIRCUIT BREAKER < 20KA   9.241 KA
              MOLDED CASE CIRCUIT BREAKER > 20KA   9.241 KA
              CBL-0027                      112 L1L3                           9.241 KA     ANG:  -44.52

 114 L1L4                3P Duty:  5.335 KA AT  -42.26 DEG (   1.92 MVA)  X/R:     0.91
              VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0167 + J  0.0151  OHMS
              LOW VOLTAGE POWER CIRCUIT BREAKER    5.335 KA
              MOLDED CASE CIRCUIT BREAKER < 10KA   5.335 KA
              MOLDED CASE CIRCUIT BREAKER < 20KA   5.335 KA
              MOLDED CASE CIRCUIT BREAKER > 20KA   5.335 KA
              CBL-0022                      108 SDPL1                          5.335 KA     ANG:  -42.26

 115 L1L5                3P Duty:  5.422 KA AT  -48.04 DEG (   1.95 MVA)  X/R:     1.11
              VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0148 + J  0.0165  OHMS
              LOW VOLTAGE POWER CIRCUIT BREAKER    5.422 KA
              MOLDED CASE CIRCUIT BREAKER < 10KA   5.422 KA
              MOLDED CASE CIRCUIT BREAKER < 20KA   5.422 KA
              MOLDED CASE CIRCUIT BREAKER > 20KA   5.422 KA
              CBL-0023                      108 SDPL1                          5.422 KA     ANG:  -48.04

 116 L1L6                3P Duty:  7.102 KA AT  -32.20 DEG (   2.56 MVA)  X/R:     0.63
              VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0143 + J  0.0090  OHMS
              LOW VOLTAGE POWER CIRCUIT BREAKER    7.102 KA
              MOLDED CASE CIRCUIT BREAKER < 10KA   7.102 KA
              MOLDED CASE CIRCUIT BREAKER < 20KA   7.102 KA
              MOLDED CASE CIRCUIT BREAKER > 20KA   7.102 KA
              CBL-0024                      108 SDPL1                          7.102 KA     ANG:  -32.20

 117 L1B1                3P Duty: 13.179 KA AT  -46.01 DEG (   4.75 MVA)  X/R:     1.04
              VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0063 + J  0.0066  OHMS
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             T H R E E   P H A S E   F A U L T   R E P O R T
               (FOR APPLICATION OF LOW VOLTAGE BREAKERS)
                    PRE FAULT VOLTAGE: 1.0000
                    MODEL TRANSFORMER TAPS: NO
================================================================================================================
             LOW VOLTAGE POWER CIRCUIT BREAKER   13.179 KA
             MOLDED CASE CIRCUIT BREAKER < 20KA  13.179 KA
             MOLDED CASE CIRCUIT BREAKER > 20KA  13.179 KA
             CBL-0025                      108 SDPL1                          13.179 KA      ANG:  -46.01

 118 L1B2                  3P Duty:  2.534 KA AT  -19.43 DEG (   0.91 MVA)  X/R:     0.35
             VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0447 + J  0.0158  OHMS
             LOW VOLTAGE POWER CIRCUIT BREAKER    2.534 KA
             MOLDED CASE CIRCUIT BREAKER < 10KA   2.534 KA
             MOLDED CASE CIRCUIT BREAKER < 20KA   2.534 KA
             MOLDED CASE CIRCUIT BREAKER > 20KA   2.534 KA
             CBL-0026                      108 SDPL1                           2.534 KA      ANG:  -19.43

 119 H1B1                  3P Duty: 15.630 KA AT  -38.00 DEG (  12.99 MVA)  X/R:     0.78
             VOLTAGE:    480.   EQUIV. IMPEDANCE=  0.0140 + J  0.0109  OHMS
             LOW VOLTAGE POWER CIRCUIT BREAKER   15.630 KA
             MOLDED CASE CIRCUIT BREAKER < 20KA  15.630 KA
             MOLDED CASE CIRCUIT BREAKER > 20KA  15.630 KA
             CBL-0028                      101 MDPH1                          15.630 KA      ANG:  -38.00

 200 UTC2_MDPH2            3P Duty: 32.642 KA AT  -81.99 DEG (  27.14 MVA)  X/R:     7.16
             VOLTAGE:    480.   EQUIV. IMPEDANCE=  0.0012 + J  0.0084  OHMS
             LOW VOLTAGE POWER CIRCUIT BREAKER   33.126 KA
             MOLDED CASE CIRCUIT BREAKER > 20KA  35.171 KA
             CBL-0039                      BUS-0003                           29.310 KA      ANG: -261.96
             CBL-0031                      201 MDPH2                           3.333 KA      ANG:  -82.25

 201 MDPH2                 3P Duty: 31.848 KA AT  -81.07 DEG (  26.48 MVA)  X/R:     6.44
             VOLTAGE:    480.   EQUIV. IMPEDANCE=  0.0014 + J  0.0086  OHMS
             LOW VOLTAGE POWER CIRCUIT BREAKER   31.848 KA
             MOLDED CASE CIRCUIT BREAKER > 20KA  33.670 KA
             CONTRIBUTIONS:  MDPH2 MOTOR LOAD                                  1.795 KA      ANG:  -84.29
             CBL-0048                      ACC-1                               1.550 KA      ANG: -260.16
             CBL-0031                      200 UTC2_MDPH2                     28.506 KA      ANG: -260.91

 202 SDPL2                 3P Duty: 16.266 KA AT  -73.26 DEG (   5.86 MVA)  X/R:     3.33
             VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0021 + J  0.0071  OHMS
             LOW VOLTAGE POWER CIRCUIT BREAKER   16.266 KA
             MOLDED CASE CIRCUIT BREAKER < 20KA  16.468 KA
             MOLDED CASE CIRCUIT BREAKER > 20KA  16.266 KA
             CBL-0047                      BUS-0056                           16.266 KA      ANG:  -73.26

 203 L2M1                  3P Duty: 12.232 KA AT  -65.95 DEG (   4.41 MVA)  X/R:     2.24
             VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0040 + J  0.0090  OHMS
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            T H R E E   P H A S E   F A U L T   R E P O R T
               (FOR APPLICATION OF LOW VOLTAGE BREAKERS)
                     PRE FAULT VOLTAGE: 1.0000
                     MODEL TRANSFORMER TAPS: NO
==============================================================================================================
               LOW VOLTAGE POWER CIRCUIT BREAKER   12.232 KA
               MOLDED CASE CIRCUIT BREAKER < 20KA  12.232 KA
               MOLDED CASE CIRCUIT BREAKER > 20KA  12.232 KA
               CBL-0069                       202 SDPL2                          12.232 KA     ANG:  -65.95

 204 L2M11                     3P Duty: 10.145 KA AT  -62.31 DEG (   3.66 MVA)  X/R:     1.91
               VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0055 + J  0.0105  OHMS
               LOW VOLTAGE POWER CIRCUIT BREAKER   10.145 KA
               MOLDED CASE CIRCUIT BREAKER < 20KA  10.145 KA
               MOLDED CASE CIRCUIT BREAKER > 20KA  10.145 KA
               CBL-0070                       203 L2M1                           10.145 KA     ANG:  -62.31

 205 L2M2                      3P Duty: 10.481 KA AT  -55.69 DEG (   3.78 MVA)  X/R:     1.47
               VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0065 + J  0.0095  OHMS
               LOW VOLTAGE POWER CIRCUIT BREAKER   10.481 KA
               MOLDED CASE CIRCUIT BREAKER < 20KA  10.481 KA
               MOLDED CASE CIRCUIT BREAKER > 20KA  10.481 KA
               CBL-0071                       202 SDPL2                          10.481 KA     ANG:  -55.69

 206 L2M21                     3P Duty:  6.695 KA AT  -35.19 DEG (   2.41 MVA)  X/R:     0.71
               VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0147 + J  0.0103  OHMS
               LOW VOLTAGE POWER CIRCUIT BREAKER    6.695 KA
               MOLDED CASE CIRCUIT BREAKER < 10KA   6.695 KA
               MOLDED CASE CIRCUIT BREAKER < 20KA   6.695 KA
               MOLDED CASE CIRCUIT BREAKER > 20KA   6.695 KA
               CBL-0072                       205 L2M2                            6.695 KA     ANG:  -35.19

 207 L2B2                      3P Duty:  8.773 KA AT  -53.48 DEG (   3.16 MVA)  X/R:     1.35
               VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0081 + J  0.0110  OHMS
               LOW VOLTAGE POWER CIRCUIT BREAKER    8.773 KA
               MOLDED CASE CIRCUIT BREAKER < 10KA   8.773 KA
               MOLDED CASE CIRCUIT BREAKER < 20KA   8.773 KA
               MOLDED CASE CIRCUIT BREAKER > 20KA   8.773 KA
               CBL-0074                       202 SDPL2                           8.773 KA     ANG:  -53.48

 208 L2B1                      3P Duty: 10.105 KA AT  -44.64 DEG (   3.64 MVA)  X/R:     0.99
               VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0085 + J  0.0084  OHMS
               LOW VOLTAGE POWER CIRCUIT BREAKER   10.105 KA
               MOLDED CASE CIRCUIT BREAKER < 20KA  10.105 KA
               MOLDED CASE CIRCUIT BREAKER > 20KA  10.105 KA
               CBL-0073                       202 SDPL2                          10.105 KA     ANG:  -44.64

 209 H2M1                      3P Duty: 19.068 KA AT  -59.53 DEG (  15.85 MVA)  X/R:     1.70
               VOLTAGE:    480.   EQUIV. IMPEDANCE=  0.0074 + J  0.0125  OHMS
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               T H R E E   P H A S E   F A U L T   R E P O R T
                  (FOR APPLICATION OF LOW VOLTAGE BREAKERS)
                        PRE FAULT VOLTAGE: 1.0000
                        MODEL TRANSFORMER TAPS: NO
=========================================================================================================
               LOW VOLTAGE POWER CIRCUIT BREAKER   19.068 KA
               MOLDED CASE CIRCUIT BREAKER < 20KA  19.068 KA
               MOLDED CASE CIRCUIT BREAKER > 20KA  19.068 KA
               CBL-0049                       201 MDPH2                          19.068 KA     ANG:  -59.53

210 H2M2                      3P Duty: 20.652 KA AT  -59.72 DEG (  17.17 MVA)  X/R:     1.72
               VOLTAGE:   480.   EQUIV. IMPEDANCE=  0.0068 + J  0.0116  OHMS
               LOW VOLTAGE POWER CIRCUIT BREAKER   20.652 KA
               MOLDED CASE CIRCUIT BREAKER > 20KA  20.652 KA
               CBL-0050                       201 MDPH2                          20.652 KA     ANG:  -59.72

211 H2B2                      3P Duty: 29.137 KA AT  -75.17 DEG (  24.22 MVA)  X/R:     3.80
               VOLTAGE:   480.   EQUIV. IMPEDANCE=  0.0024 + J  0.0092  OHMS
               LOW VOLTAGE POWER CIRCUIT BREAKER   29.137 KA
               MOLDED CASE CIRCUIT BREAKER > 20KA  29.137 KA
               CBL-0051                       201 MDPH2                          29.137 KA     ANG:  -75.17

212 H2B1                      3P Duty: 13.489 KA AT  -30.23 DEG (  11.21 MVA)  X/R:     0.58
               VOLTAGE:   480.   EQUIV. IMPEDANCE=  0.0178 + J  0.0103  OHMS
               LOW VOLTAGE POWER CIRCUIT BREAKER   13.489 KA
               MOLDED CASE CIRCUIT BREAKER < 20KA  13.489 KA
               MOLDED CASE CIRCUIT BREAKER > 20KA  13.489 KA
               CBL-0053                       201 MDPH2                          13.489 KA     ANG:  -30.23

213 SDPH21                    3P Duty: 17.799 KA AT  -59.72 DEG (  14.80 MVA)  X/R:     1.72
               VOLTAGE:   480.   EQUIV. IMPEDANCE=  0.0079 + J  0.0134  OHMS
               LOW VOLTAGE POWER CIRCUIT BREAKER   17.799 KA
               MOLDED CASE CIRCUIT BREAKER < 20KA  17.799 KA
               MOLDED CASE CIRCUIT BREAKER > 20KA  17.799 KA
               CBL-0054                       201 MDPH2                          17.799 KA     ANG:  -59.72

214 H21B1                     3P Duty: 11.096 KA AT  -36.22 DEG (   9.22 MVA)  X/R:     0.73
               VOLTAGE:   480.   EQUIV. IMPEDANCE=  0.0202 + J  0.0148  OHMS
               LOW VOLTAGE POWER CIRCUIT BREAKER   11.096 KA
               MOLDED CASE CIRCUIT BREAKER < 20KA  11.096 KA
               MOLDED CASE CIRCUIT BREAKER > 20KA  11.096 KA
               CBL-0090                       213 SDPH21                         11.096 KA     ANG:  -36.22

215 H21M1                     3P Duty:  9.258 KA AT  -34.29 DEG (   7.70 MVA)  X/R:     0.68
               VOLTAGE:   480.   EQUIV. IMPEDANCE=  0.0247 + J  0.0169  OHMS
               LOW VOLTAGE POWER CIRCUIT BREAKER    9.258 KA
               MOLDED CASE CIRCUIT BREAKER < 10KA   9.258 KA
               MOLDED CASE CIRCUIT BREAKER < 20KA   9.258 KA
               MOLDED CASE CIRCUIT BREAKER > 20KA   9.258 KA
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             T H R E E   P H A S E   F A U L T   R E P O R T
               (FOR APPLICATION OF LOW VOLTAGE BREAKERS)
                    PRE FAULT VOLTAGE: 1.0000
                    MODEL TRANSFORMER TAPS: NO
============================================================================================================

             CONTRIBUTIONS TO  215 H21M1                        (CONTINUED)
             CBL-0089                     213 SDPH21                              9.258 KA     ANG:  -34.29

 216 H21U1                   3P Duty:  7.290 KA AT  -29.24 DEG (   6.06 MVA)  X/R:     0.56
             VOLTAGE:    480.   EQUIV. IMPEDANCE=  0.0332 + J  0.0186  OHMS
             LOW VOLTAGE POWER CIRCUIT BREAKER    7.290 KA
             MOLDED CASE CIRCUIT BREAKER < 10KA   7.290 KA
             MOLDED CASE CIRCUIT BREAKER < 20KA   7.290 KA
             MOLDED CASE CIRCUIT BREAKER > 20KA   7.290 KA
             CBL-0088                     213 SDPH21                              7.290 KA     ANG:  -29.24

 217 SDPL21                  3P Duty: 13.877 KA AT  -67.25 DEG (   5.00 MVA)  X/R:     2.39
             VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0033 + J  0.0080  OHMS
             LOW VOLTAGE POWER CIRCUIT BREAKER   13.877 KA
             MOLDED CASE CIRCUIT BREAKER < 20KA  13.877 KA
             MOLDED CASE CIRCUIT BREAKER > 20KA  13.877 KA
             CBL-0076                     BUS-0058                               13.877 KA     ANG:  -67.25

 218 L21U1                   3P Duty:  6.532 KA AT  -40.66 DEG (   2.35 MVA)  X/R:     0.86
             VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0139 + J  0.0120  OHMS
             LOW VOLTAGE POWER CIRCUIT BREAKER    6.532 KA
             MOLDED CASE CIRCUIT BREAKER < 10KA   6.532 KA
             MOLDED CASE CIRCUIT BREAKER < 20KA   6.532 KA
             MOLDED CASE CIRCUIT BREAKER > 20KA   6.532 KA
             CBL-0077                     217 SDPL21                              6.532 KA     ANG:  -40.66

 219 L21U2                   3P Duty:  3.446 KA AT  -31.07 DEG (   1.24 MVA)  X/R:     0.60
             VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0298 + J  0.0180  OHMS
             LOW VOLTAGE POWER CIRCUIT BREAKER    3.446 KA
             MOLDED CASE CIRCUIT BREAKER < 10KA   3.446 KA
             MOLDED CASE CIRCUIT BREAKER < 20KA   3.446 KA
             MOLDED CASE CIRCUIT BREAKER > 20KA   3.446 KA
             CBL-0078                     217 SDPL21                              3.446 KA     ANG:  -31.07

 220 L21U3                   3P Duty:  5.557 KA AT  -37.58 DEG (   2.00 MVA)  X/R:     0.77
             VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0171 + J  0.0132  OHMS
             LOW VOLTAGE POWER CIRCUIT BREAKER    5.557 KA
             MOLDED CASE CIRCUIT BREAKER < 10KA   5.557 KA
             MOLDED CASE CIRCUIT BREAKER < 20KA   5.557 KA
             MOLDED CASE CIRCUIT BREAKER > 20KA   5.557 KA
             CBL-0079                     217 SDPL21                              5.557 KA     ANG:  -37.58

 221 L21U4                   3P Duty:  3.811 KA AT  -32.18 DEG (   1.37 MVA)  X/R:     0.63
             VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0267 + J  0.0168  OHMS
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            T H R E E   P H A S E   F A U L T   R E P O R T
               (FOR APPLICATION OF LOW VOLTAGE BREAKERS)
                     PRE FAULT VOLTAGE: 1.0000
                     MODEL TRANSFORMER TAPS: NO
==========================================================================================================
            LOW VOLTAGE POWER CIRCUIT BREAKER    3.811 KA
            MOLDED CASE CIRCUIT BREAKER < 10KA   3.811 KA
            MOLDED CASE CIRCUIT BREAKER < 20KA   3.811 KA
            MOLDED CASE CIRCUIT BREAKER > 20KA   3.811 KA
            CBL-0080                        217 SDPL21                          3.811 KA      ANG:  -32.18

 222 L21U5                3P Duty:  6.931 KA AT  -41.95 DEG (   2.50 MVA)  X/R:     0.90
            VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0129 + J  0.0116  OHMS
            LOW VOLTAGE POWER CIRCUIT BREAKER    6.931 KA
            MOLDED CASE CIRCUIT BREAKER < 10KA   6.931 KA
            MOLDED CASE CIRCUIT BREAKER < 20KA   6.931 KA
            MOLDED CASE CIRCUIT BREAKER > 20KA   6.931 KA
            CBL-0081                        217 SDPL21                          6.931 KA      ANG:  -41.95

 223 L21M1                3P Duty:  4.445 KA AT  -43.49 DEG (   1.60 MVA)  X/R:     0.95
            VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0196 + J  0.0186  OHMS
            LOW VOLTAGE POWER CIRCUIT BREAKER    4.445 KA
            MOLDED CASE CIRCUIT BREAKER < 10KA   4.445 KA
            MOLDED CASE CIRCUIT BREAKER < 20KA   4.445 KA
            MOLDED CASE CIRCUIT BREAKER > 20KA   4.445 KA
            CBL-0082                        217 SDPL21                          4.445 KA      ANG:  -43.49

 224 L21M11               3P Duty:  3.905 KA AT  -39.23 DEG (   1.41 MVA)  X/R:     0.82
            VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0238 + J  0.0194  OHMS
            LOW VOLTAGE POWER CIRCUIT BREAKER    3.905 KA
            MOLDED CASE CIRCUIT BREAKER < 10KA   3.905 KA
            MOLDED CASE CIRCUIT BREAKER < 20KA   3.905 KA
            MOLDED CASE CIRCUIT BREAKER > 20KA   3.905 KA
            CBL-0083                        223 L21M1                           3.905 KA      ANG:  -39.23

 225 L21M2                3P Duty:  6.532 KA AT  -40.66 DEG (   2.35 MVA)  X/R:     0.86
            VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0139 + J  0.0120  OHMS
            LOW VOLTAGE POWER CIRCUIT BREAKER    6.532 KA
            MOLDED CASE CIRCUIT BREAKER < 10KA   6.532 KA
            MOLDED CASE CIRCUIT BREAKER < 20KA   6.532 KA
            MOLDED CASE CIRCUIT BREAKER > 20KA   6.532 KA
            CBL-0084                        217 SDPL21                          6.532 KA      ANG:  -40.66

 226 L21M3                3P Duty:  5.113 KA AT  -45.06 DEG (   1.84 MVA)  X/R:     1.00
            VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0166 + J  0.0166  OHMS
            LOW VOLTAGE POWER CIRCUIT BREAKER    5.113 KA
            MOLDED CASE CIRCUIT BREAKER < 10KA   5.113 KA
            MOLDED CASE CIRCUIT BREAKER < 20KA   5.113 KA
            MOLDED CASE CIRCUIT BREAKER > 20KA   5.113 KA
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            T H R E E   P H A S E   F A U L T   R E P O R T
              (FOR APPLICATION OF LOW VOLTAGE BREAKERS)
                   PRE FAULT VOLTAGE: 1.0000
                   MODEL TRANSFORMER TAPS: NO
=================================================================================================================

            CONTRIBUTIONS TO  226 L21M3                      (CONTINUED)
            CBL-0085                     217 SDPL21                        5.113 KA     ANG:  -45.06

 227 L21M4                3P Duty:  8.450 KA AT  -46.92 DEG (    3.04 MVA)  X/R:     1.07
            VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0097 + J  0.0104  OHMS
            LOW VOLTAGE POWER CIRCUIT BREAKER     8.450 KA
            MOLDED CASE CIRCUIT BREAKER < 10KA    8.450 KA
            MOLDED CASE CIRCUIT BREAKER < 20KA    8.450 KA
            MOLDED CASE CIRCUIT BREAKER > 20KA    8.450 KA
            CBL-0086                     217 SDPL21                        8.450 KA     ANG:  -46.92

 228 L21B1                3P Duty: 10.685 KA AT  -48.50 DEG (    3.85 MVA)  X/R:     1.13
            VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0074 + J  0.0084  OHMS
            LOW VOLTAGE POWER CIRCUIT BREAKER    10.685 KA
            MOLDED CASE CIRCUIT BREAKER < 20KA   10.685 KA
            MOLDED CASE CIRCUIT BREAKER > 20KA   10.685 KA
            CBL-0087                     217 SDPL21                       10.685 KA     ANG:  -48.50

 229 SDPH22               3P Duty: 15.945 KA AT  -65.05 DEG (   13.26 MVA)  X/R:     2.15
            VOLTAGE:    480.   EQUIV. IMPEDANCE=  0.0073 + J  0.0158  OHMS
            LOW VOLTAGE POWER CIRCUIT BREAKER    15.945 KA
            MOLDED CASE CIRCUIT BREAKER < 20KA   15.945 KA
            MOLDED CASE CIRCUIT BREAKER > 20KA   15.945 KA
            CBL-0055                     201 MDPH2                        15.945 KA     ANG:  -65.05

 230 H22B1                3P Duty: 12.178 KA AT  -46.96 DEG (   10.12 MVA)  X/R:     1.07
            VOLTAGE:    480.   EQUIV. IMPEDANCE=  0.0155 + J  0.0166  OHMS
            LOW VOLTAGE POWER CIRCUIT BREAKER    12.178 KA
            MOLDED CASE CIRCUIT BREAKER < 20KA   12.178 KA
            MOLDED CASE CIRCUIT BREAKER > 20KA   12.178 KA
            CBL-0107                     229 SDPH22                       12.178 KA     ANG:  -46.96

 231 H22M1                3P Duty:  4.595 KA AT  -20.38 DEG (    3.82 MVA)  X/R:     0.37
            VOLTAGE:    480.   EQUIV. IMPEDANCE=  0.0565 + J  0.0210  OHMS
            LOW VOLTAGE POWER CIRCUIT BREAKER     4.595 KA
            MOLDED CASE CIRCUIT BREAKER < 10KA    4.595 KA
            MOLDED CASE CIRCUIT BREAKER < 20KA    4.595 KA
            MOLDED CASE CIRCUIT BREAKER > 20KA    4.595 KA
            CBL-0105                     229 SDPH22                        4.595 KA     ANG:  -20.38

 232 H22U1                3P Duty:  8.900 KA AT  -41.58 DEG (    7.40 MVA)  X/R:     0.89
            VOLTAGE:    480.   EQUIV. IMPEDANCE=  0.0233 + J  0.0207  OHMS
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              T H R E E   P H A S E   F A U L T   R E P O R T
                (FOR APPLICATION OF LOW VOLTAGE BREAKERS)
                     PRE FAULT VOLTAGE: 1.0000
                     MODEL TRANSFORMER TAPS: NO
==========================================================================================================
              LOW VOLTAGE POWER CIRCUIT BREAKER    8.900 KA
              MOLDED CASE CIRCUIT BREAKER < 10KA   8.900 KA
              MOLDED CASE CIRCUIT BREAKER < 20KA   8.900 KA
              MOLDED CASE CIRCUIT BREAKER > 20KA   8.900 KA
              CBL-0106                        229 SDPH22                        8.900 KA     ANG:  -41.58

 233 SDPL22                  3P Duty: 13.565 KA AT  -69.36 DEG (   4.89 MVA)  X/R:     2.66
              VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0031 + J  0.0083  OHMS
              LOW VOLTAGE POWER CIRCUIT BREAKER   13.565 KA
              MOLDED CASE CIRCUIT BREAKER < 20KA  13.565 KA
              MOLDED CASE CIRCUIT BREAKER > 20KA  13.565 KA
              CBL-0092                        BUS-0060                         13.565 KA     ANG:  -69.36

 234 L22U1                   3P Duty:  6.166 KA AT  -40.64 DEG (   2.22 MVA)  X/R:     0.86
              VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0148 + J  0.0127  OHMS
              LOW VOLTAGE POWER CIRCUIT BREAKER    6.166 KA
              MOLDED CASE CIRCUIT BREAKER < 10KA   6.166 KA
              MOLDED CASE CIRCUIT BREAKER < 20KA   6.166 KA
              MOLDED CASE CIRCUIT BREAKER > 20KA   6.166 KA
              CBL-0093                        233 SDPL22                        6.166 KA     ANG:  139.36

 235 L22U2                   3P Duty:  5.554 KA AT  -38.59 DEG (   2.00 MVA)  X/R:     0.80
              VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0169 + J  0.0135  OHMS
              LOW VOLTAGE POWER CIRCUIT BREAKER    5.554 KA
              MOLDED CASE CIRCUIT BREAKER < 10KA   5.554 KA
              MOLDED CASE CIRCUIT BREAKER < 20KA   5.554 KA
              MOLDED CASE CIRCUIT BREAKER > 20KA   5.554 KA
              CBL-0094                        233 SDPL22                        5.554 KA     ANG:  -38.59

 236 L22U3                   3P Duty:  4.437 KA AT  -34.90 DEG (   1.60 MVA)  X/R:     0.70
              VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0222 + J  0.0155  OHMS
              LOW VOLTAGE POWER CIRCUIT BREAKER    4.437 KA
              MOLDED CASE CIRCUIT BREAKER < 10KA   4.437 KA
              MOLDED CASE CIRCUIT BREAKER < 20KA   4.437 KA
              MOLDED CASE CIRCUIT BREAKER > 20KA   4.437 KA
              CBL-0095                        233 SDPL22                        4.437 KA     ANG:  -34.90

 237 L22U4                   3P Duty:  5.845 KA AT  -39.56 DEG (   2.11 MVA)  X/R:     0.83
              VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0158 + J  0.0131  OHMS
              LOW VOLTAGE POWER CIRCUIT BREAKER    5.845 KA
              MOLDED CASE CIRCUIT BREAKER < 10KA   5.845 KA
              MOLDED CASE CIRCUIT BREAKER < 20KA   5.845 KA
              MOLDED CASE CIRCUIT BREAKER > 20KA   5.845 KA
              CBL-0096                        233 SDPL22                        5.845 KA     ANG:  -39.56
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            T H R E E   P H A S E   F A U L T   R E P O R T
              (FOR APPLICATION OF LOW VOLTAGE BREAKERS)
                   PRE FAULT VOLTAGE: 1.0000
                   MODEL TRANSFORMER TAPS: NO
===============================================================================================================

 238 L22U5              3P Duty:  5.290 KA AT  -37.71 DEG (   1.91 MVA)  X/R:    0.77
            VOLTAGE:   208.   EQUIV. IMPEDANCE=  0.0180 + J  0.0139  OHMS
            LOW VOLTAGE POWER CIRCUIT BREAKER    5.290 KA
            MOLDED CASE CIRCUIT BREAKER < 10KA   5.290 KA
            MOLDED CASE CIRCUIT BREAKER < 20KA   5.290 KA
            MOLDED CASE CIRCUIT BREAKER > 20KA   5.290 KA
            CBL-0097                    233 SDPL22                          5.290 KA      ANG:   -37.71

 239 L22M1              3P Duty:  6.166 KA AT  -40.64 DEG (   2.22 MVA)  X/R:    0.86
            VOLTAGE:   208.   EQUIV. IMPEDANCE=  0.0148 + J  0.0127  OHMS
            LOW VOLTAGE POWER CIRCUIT BREAKER    6.166 KA
            MOLDED CASE CIRCUIT BREAKER < 10KA   6.166 KA
            MOLDED CASE CIRCUIT BREAKER < 20KA   6.166 KA
            MOLDED CASE CIRCUIT BREAKER > 20KA   6.166 KA
            CBL-0098                    233 SDPL22                          6.166 KA      ANG:   -40.64

 240 L22M2              3P Duty:  5.290 KA AT  -37.71 DEG (   1.91 MVA)  X/R:    0.77
            VOLTAGE:   208.   EQUIV. IMPEDANCE=  0.0180 + J  0.0139  OHMS
            LOW VOLTAGE POWER CIRCUIT BREAKER    5.290 KA
            MOLDED CASE CIRCUIT BREAKER < 10KA   5.290 KA
            MOLDED CASE CIRCUIT BREAKER < 20KA   5.290 KA
            MOLDED CASE CIRCUIT BREAKER > 20KA   5.290 KA
            CBL-0099                    233 SDPL22                          5.290 KA      ANG:   -37.71

 241 L22M3              3P Duty:  5.290 KA AT  -37.71 DEG (   1.91 MVA)  X/R:    0.77
            VOLTAGE:   208.   EQUIV. IMPEDANCE=  0.0180 + J  0.0139  OHMS
            LOW VOLTAGE POWER CIRCUIT BREAKER    5.290 KA
            MOLDED CASE CIRCUIT BREAKER < 10KA   5.290 KA
            MOLDED CASE CIRCUIT BREAKER < 20KA   5.290 KA
            MOLDED CASE CIRCUIT BREAKER > 20KA   5.290 KA
            CBL-0100                    233 SDPL22                          5.290 KA      ANG:   -37.71

 242 L22M4              3P Duty:  5.049 KA AT  -36.91 DEG (   1.82 MVA)  X/R:    0.75
            VOLTAGE:   208.   EQUIV. IMPEDANCE=  0.0190 + J  0.0143  OHMS
            LOW VOLTAGE POWER CIRCUIT BREAKER    5.049 KA
            MOLDED CASE CIRCUIT BREAKER < 10KA   5.049 KA
            MOLDED CASE CIRCUIT BREAKER < 20KA   5.049 KA
            MOLDED CASE CIRCUIT BREAKER > 20KA   5.049 KA
            CBL-0101                    233 SDPL22                          5.049 KA      ANG:   -36.91

 243 L22M5              3P Duty:  5.787 KA AT  -47.74 DEG (   2.08 MVA)  X/R:    1.10
            VOLTAGE:   208.   EQUIV. IMPEDANCE=  0.0140 + J  0.0154  OHMS
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              T H R E E   P H A S E   F A U L T   R E P O R T
                (FOR APPLICATION OF LOW VOLTAGE BREAKERS)
                     PRE FAULT VOLTAGE: 1.0000
                     MODEL TRANSFORMER TAPS: NO
==========================================================================================================
              LOW VOLTAGE POWER CIRCUIT BREAKER    5.787 KA
              MOLDED CASE CIRCUIT BREAKER < 10KA   5.787 KA
              MOLDED CASE CIRCUIT BREAKER < 20KA   5.787 KA
              MOLDED CASE CIRCUIT BREAKER > 20KA   5.787 KA
              CBL-0102                     233 SDPL22                         5.787 KA    ANG:  -47.74

 244 L22M6                  3P Duty:  4.624 KA AT  -35.51 DEG (   1.67 MVA)  X/R:    0.71
              VOLTAGE:   208.  EQUIV. IMPEDANCE=  0.0211 + J  0.0151  OHMS
              LOW VOLTAGE POWER CIRCUIT BREAKER    4.624 KA
              MOLDED CASE CIRCUIT BREAKER < 10KA   4.624 KA
              MOLDED CASE CIRCUIT BREAKER < 20KA   4.624 KA
              MOLDED CASE CIRCUIT BREAKER > 20KA   4.624 KA
              CBL-0103                     233 SDPL22                         4.624 KA    ANG:  -35.51

 245 L22B1                  3P Duty:  6.612 KA AT  -31.89 DEG (   2.38 MVA)  X/R:    0.62
              VOLTAGE:   208.  EQUIV. IMPEDANCE=  0.0154 + J  0.0096  OHMS
              LOW VOLTAGE POWER CIRCUIT BREAKER    6.612 KA
              MOLDED CASE CIRCUIT BREAKER < 10KA   6.612 KA
              MOLDED CASE CIRCUIT BREAKER < 20KA   6.612 KA
              MOLDED CASE CIRCUIT BREAKER > 20KA   6.612 KA
              CBL-0104                     233 SDPL22                         6.612 KA    ANG:  -31.89

 300 GEN SEC                3P Duty:  1.998 KA AT  -85.39 DEG (   1.66 MVA)  X/R:   12.40
              VOLTAGE:   480.  EQUIV. IMPEDANCE=  0.0111 + J  0.1382  OHMS
              LOW VOLTAGE POWER CIRCUIT BREAKER    2.190 KA
              MOLDED CASE CIRCUIT BREAKER < 10KA   3.052 KA
              MOLDED CASE CIRCUIT BREAKER < 20KA   2.586 KA
              MOLDED CASE CIRCUIT BREAKER > 20KA   2.325 KA
              CONTRIBUTIONS:  GEN-1                                           1.998 KA    ANG:  -85.39

 301 ATS_E1B1               3P Duty: 12.790 KA AT  -32.90 DEG (  10.63 MVA)  X/R:    0.65
              VOLTAGE:   480.  EQUIV. IMPEDANCE=  0.0182 + J  0.0118  OHMS
              LOW VOLTAGE POWER CIRCUIT BREAKER   12.790 KA
              MOLDED CASE CIRCUIT BREAKER < 20KA  12.790 KA
              MOLDED CASE CIRCUIT BREAKER > 20KA  12.790 KA
              ATS                          BUS-0039                          12.790 KA    ANG:  -32.90

 302 ATS_E2B1               3P Duty: 22.152 KA AT  -57.88 DEG (  18.42 MVA)  X/R:    1.60
              VOLTAGE:   480.  EQUIV. IMPEDANCE=  0.0067 + J  0.0106  OHMS
              LOW VOLTAGE POWER CIRCUIT BREAKER   22.152 KA
              MOLDED CASE CIRCUIT BREAKER > 20KA  22.152 KA
              ATS 200A                     BUS-0129                          22.152 KA    ANG:  122.12

 303 E1B1                   3P Duty: 10.773 KA AT  -29.39 DEG (   8.96 MVA)  X/R:    0.56
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                T H R E E   P H A S E   F A U L T   R E P O R T
                   (FOR APPLICATION OF LOW VOLTAGE BREAKERS)
                         PRE FAULT VOLTAGE: 1.0000
                         MODEL TRANSFORMER TAPS: NO
==========================================================================================================
                VOLTAGE:   480.   EQUIV. IMPEDANCE=  0.0224 + J  0.0126  OHMS
                LOW VOLTAGE POWER CIRCUIT BREAKER   10.773 KA
                MOLDED CASE CIRCUIT BREAKER < 20KA  10.773 KA
                MOLDED CASE CIRCUIT BREAKER > 20KA  10.773 KA
                CBL-0037                      301 ATS_E1B1                       10.773 KA     ANG:  -29.39

 304 E1L1                     3P Duty:  3.143 KA AT  -11.36 DEG (   2.61 MVA)  X/R:     0.20
                VOLTAGE:   480.   EQUIV. IMPEDANCE=  0.0865 + J  0.0174  OHMS
                LOW VOLTAGE POWER CIRCUIT BREAKER    3.143 KA
                MOLDED CASE CIRCUIT BREAKER < 10KA   3.143 KA
                MOLDED CASE CIRCUIT BREAKER < 20KA   3.143 KA
                MOLDED CASE CIRCUIT BREAKER > 20KA   3.143 KA
                CBL-0029                      303 E1B1                            3.143 KA     ANG:  -11.36

 305 E1L2                     3P Duty:  2.885 KA AT  -16.48 DEG (   2.40 MVA)  X/R:     0.30
                VOLTAGE:   480.   EQUIV. IMPEDANCE=  0.0921 + J  0.0272  OHMS
                LOW VOLTAGE POWER CIRCUIT BREAKER    2.885 KA
                MOLDED CASE CIRCUIT BREAKER < 10KA   2.885 KA
                MOLDED CASE CIRCUIT BREAKER < 20KA   2.885 KA
                MOLDED CASE CIRCUIT BREAKER > 20KA   2.885 KA
                CBL-0030                      303 E1B1                            2.885 KA     ANG:  -16.48

 306 E1BL1                    3P Duty:  1.787 KA AT  -38.06 DEG (   0.64 MVA)  X/R:     0.78
                VOLTAGE:   208.   EQUIV. IMPEDANCE=  0.0529 + J  0.0414  OHMS
                LOW VOLTAGE POWER CIRCUIT BREAKER    1.787 KA
                MOLDED CASE CIRCUIT BREAKER < 10KA   1.787 KA
                MOLDED CASE CIRCUIT BREAKER < 20KA   1.787 KA
                MOLDED CASE CIRCUIT BREAKER > 20KA   1.787 KA
                CBL-0034                      BUS-0014                            1.787 KA     ANG:  -38.06

 307 E1BL2                    3P Duty:  1.618 KA AT  -35.16 DEG (   0.58 MVA)  X/R:     0.70
                VOLTAGE:   208.   EQUIV. IMPEDANCE=  0.0607 + J  0.0427  OHMS
                LOW VOLTAGE POWER CIRCUIT BREAKER    1.618 KA
                MOLDED CASE CIRCUIT BREAKER < 10KA   1.618 KA
                MOLDED CASE CIRCUIT BREAKER < 20KA   1.618 KA
                MOLDED CASE CIRCUIT BREAKER > 20KA   1.618 KA
                CBL-0038                      306 E1BL1                           1.618 KA     ANG:  -35.16

 308 E2B1                     3P Duty: 19.271 KA AT  -52.42 DEG (  16.02 MVA)  X/R:     1.30
                VOLTAGE:   480.   EQUIV. IMPEDANCE=  0.0088 + J  0.0114  OHMS
                LOW VOLTAGE POWER CIRCUIT BREAKER   19.271 KA
                MOLDED CASE CIRCUIT BREAKER < 20KA  19.271 KA
                MOLDED CASE CIRCUIT BREAKER > 20KA  19.271 KA
                CBL-0057                      302 ATS_E2B1                       19.271 KA     ANG:  -52.42
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             T H R E E   P H A S E   F A U L T   R E P O R T
                (FOR APPLICATION OF LOW VOLTAGE BREAKERS)
                     PRE FAULT VOLTAGE: 1.0000
                     MODEL TRANSFORMER TAPS: NO
============================================================================================================

             CONTRIBUTIONS TO  308 E2B1                    (CONTINUED)

 309 E2BL1                3P Duty:  2.981 KA AT  -47.72 DEG (   1.07 MVA)  X/R:     1.10
             VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0271 + J  0.0298  OHMS
             LOW VOLTAGE POWER CIRCUIT BREAKER    2.981 KA
             MOLDED CASE CIRCUIT BREAKER < 10KA   2.981 KA
             MOLDED CASE CIRCUIT BREAKER < 20KA   2.981 KA
             MOLDED CASE CIRCUIT BREAKER > 20KA   2.981 KA
             CBL-0060                    BUS-0072                            2.981 KA     ANG:  132.28

 310 E2BL2                3P Duty:  1.491 KA AT  -36.12 DEG (   0.54 MVA)  X/R:     0.73
             VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.0651 + J  0.0475  OHMS
             LOW VOLTAGE POWER CIRCUIT BREAKER    1.491 KA
             MOLDED CASE CIRCUIT BREAKER < 10KA   1.491 KA
             MOLDED CASE CIRCUIT BREAKER < 20KA   1.491 KA
             MOLDED CASE CIRCUIT BREAKER > 20KA   1.491 KA
             CBL-0061                    309 E2BL1                           1.491 KA     ANG:  -36.12

 311 E2BL3                3P Duty:  1.005 KA AT  -29.79 DEG (   0.36 MVA)  X/R:     0.57
             VOLTAGE:    208.   EQUIV. IMPEDANCE=  0.1037 + J  0.0593  OHMS
             LOW VOLTAGE POWER CIRCUIT BREAKER    1.005 KA
             MOLDED CASE CIRCUIT BREAKER < 10KA   1.005 KA
             MOLDED CASE CIRCUIT BREAKER < 20KA   1.005 KA
             MOLDED CASE CIRCUIT BREAKER > 20KA   1.005 KA
             CBL-0062                    310 E2BL2                           1.005 KA     ANG:  -29.79

 312 E2M1                 3P Duty:  3.716 KA AT  -12.50 DEG (   3.09 MVA)  X/R:     0.22
             VOLTAGE:    480.   EQUIV. IMPEDANCE=  0.0728 + J  0.0161  OHMS
             LOW VOLTAGE POWER CIRCUIT BREAKER    3.716 KA
             MOLDED CASE CIRCUIT BREAKER < 10KA   3.716 KA
             MOLDED CASE CIRCUIT BREAKER < 20KA   3.716 KA
             MOLDED CASE CIRCUIT BREAKER > 20KA   3.716 KA
             CBL-0058                    308 E2B1                            3.716 KA     ANG:  -12.50

 313 E2B2                 3P Duty:  2.924 KA AT  -19.36 DEG (   2.43 MVA)  X/R:     0.35
             VOLTAGE:    480.   EQUIV. IMPEDANCE=  0.0894 + J  0.0314  OHMS
             LOW VOLTAGE POWER CIRCUIT BREAKER    2.924 KA
             MOLDED CASE CIRCUIT BREAKER < 10KA   2.924 KA
             MOLDED CASE CIRCUIT BREAKER < 20KA   2.924 KA
             MOLDED CASE CIRCUIT BREAKER > 20KA   2.924 KA
             CBL-0063                    308 E2B1                            2.924 KA     ANG:  -19.36

 314 E2M3                 3P Duty:  1.911 KA AT  -14.06 DEG (   1.59 MVA)  X/R:     0.25
             VOLTAGE:    480.   EQUIV. IMPEDANCE=  0.1406 + J  0.0352  OHMS
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              T H R E E   P H A S E   F A U L T   R E P O R T
                 (FOR APPLICATION OF LOW VOLTAGE BREAKERS)
                      PRE FAULT VOLTAGE: 1.0000
                      MODEL TRANSFORMER TAPS: NO
==========================================================================================================
              LOW VOLTAGE POWER CIRCUIT BREAKER    1.911 KA
              MOLDED CASE CIRCUIT BREAKER < 10KA   1.911 KA
              MOLDED CASE CIRCUIT BREAKER < 20KA   1.911 KA
              MOLDED CASE CIRCUIT BREAKER > 20KA   1.911 KA
              CBL-0064                       313 E2B2                              1.911 KA      ANG:  -14.06

 315 E2U1                  3P Duty:  1.758 KA AT  -13.26 DEG (   1.46 MVA)  X/R:      0.24
              VOLTAGE:    480.   EQUIV. IMPEDANCE=  0.1535 + J  0.0362  OHMS
              LOW VOLTAGE POWER CIRCUIT BREAKER    1.758 KA
              MOLDED CASE CIRCUIT BREAKER < 10KA   1.758 KA
              MOLDED CASE CIRCUIT BREAKER < 20KA   1.758 KA
              MOLDED CASE CIRCUIT BREAKER > 20KA   1.758 KA
              CBL-0065                       313 E2B2                              1.758 KA      ANG:  -13.26

 316 E2B3                  3P Duty:  1.786 KA AT  -16.42 DEG (   1.48 MVA)  X/R:      0.29
              VOLTAGE:    480.   EQUIV. IMPEDANCE=  0.1489 + J  0.0439  OHMS
              LOW VOLTAGE POWER CIRCUIT BREAKER    1.786 KA
              MOLDED CASE CIRCUIT BREAKER < 10KA   1.786 KA
              MOLDED CASE CIRCUIT BREAKER < 20KA   1.786 KA
              MOLDED CASE CIRCUIT BREAKER > 20KA   1.786 KA
              CBL-0066                       313 E2B2                              1.786 KA      ANG:  -16.42

 317 E2M2                  3P Duty:  1.137 KA AT  -11.96 DEG (   0.94 MVA)  X/R:      0.21
              VOLTAGE:    480.   EQUIV. IMPEDANCE=  0.2385 + J  0.0505  OHMS
              LOW VOLTAGE POWER CIRCUIT BREAKER    1.137 KA
              MOLDED CASE CIRCUIT BREAKER < 10KA   1.137 KA
              MOLDED CASE CIRCUIT BREAKER < 20KA   1.137 KA
              MOLDED CASE CIRCUIT BREAKER > 20KA   1.137 KA
              CBL-0067                       316 E2B3                              1.137 KA      ANG:  -11.96

 318 E2U2                  3P Duty:  1.080 KA AT  -11.58 DEG (   0.90 MVA)  X/R:      0.20
              VOLTAGE:    480.   EQUIV. IMPEDANCE=  0.2513 + J  0.0515  OHMS
              LOW VOLTAGE POWER CIRCUIT BREAKER    1.080 KA
              MOLDED CASE CIRCUIT BREAKER < 10KA   1.080 KA
              MOLDED CASE CIRCUIT BREAKER < 20KA   1.080 KA
              MOLDED CASE CIRCUIT BREAKER > 20KA   1.080 KA
              CBL-0068                       316 E2B3                              1.080 KA      ANG:  -11.58

 ACC-1                     3P Duty: 13.109 KA AT  -53.91 DEG (  10.90 MVA)  X/R:      2.05
              VOLTAGE:    480.   EQUIV. IMPEDANCE=  0.0125 + J  0.0171  OHMS
              LOW VOLTAGE POWER CIRCUIT BREAKER   13.109 KA
              MOLDED CASE CIRCUIT BREAKER < 20KA  13.109 KA
              MOLDED CASE CIRCUIT BREAKER > 20KA  13.109 KA
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               T H R E E   P H A S E   F A U L T   R E P O R T
                  (FOR APPLICATION OF LOW VOLTAGE BREAKERS)
                       PRE FAULT VOLTAGE: 1.0000
                       MODEL TRANSFORMER TAPS: NO
================================================================================================================

               CONTRIBUTIONS TO  ACC-1                           (CONTINUED)
               CONTRIBUTIONS:  MTRI-0005                                             1.650 KA      ANG:  -84.29
               CBL-0048                    201 MDPH2                                11.715 KA      ANG:  -49.83

ACC-2                         3P Duty: 20.489 KA AT  -62.75 DEG (  17.03 MVA)  X/R:     2.38
               VOLTAGE:    480.   EQUIV. IMPEDANCE=  0.0062 + J  0.0120  OHMS
               LOW VOLTAGE POWER CIRCUIT BREAKER   20.489 KA
               MOLDED CASE CIRCUIT BREAKER > 20KA  20.489 KA
               CONTRIBUTIONS:  MTRI-0003                                             1.650 KA      ANG:  -84.29
               CBL-0003                    101 MDPH1                                18.964 KA      ANG:  -60.91

ACC-3                         3P Duty: 15.894 KA AT  -53.08 DEG (  13.21 MVA)  X/R:     1.49
               VOLTAGE:    480.   EQUIV. IMPEDANCE=  0.0105 + J  0.0139  OHMS
               LOW VOLTAGE POWER CIRCUIT BREAKER   15.894 KA
               MOLDED CASE CIRCUIT BREAKER < 20KA  15.894 KA
               MOLDED CASE CIRCUIT BREAKER > 20KA  15.894 KA
               CONTRIBUTIONS:  MTRI-0004                                             0.450 KA      ANG:  -84.29
               CBL-0004                    101 MDPH1                                15.511 KA      ANG:  -52.22

BUS-0002                      3P Duty: 34.594 KA AT  -83.06 DEG (  28.76 MVA)  X/R:     8.23
               VOLTAGE:    480.   EQUIV. IMPEDANCE=  0.0010 + J  0.0080  OHMS
               LOW VOLTAGE POWER CIRCUIT BREAKER   35.910 KA
               MOLDED CASE CIRCUIT BREAKER > 20KA  38.127 KA
               XF2-0001                    UTILITY PRI                              30.778 KA      ANG: -263.04
               CBL-0001                    100 UTC_MDPH1                             3.816 KA      ANG:   96.84

UTILITY PRI                   3P Duty: 80.124 KA AT  -82.88 DEG (1831.87 MVA)  X/R:     8.00
               VOLTAGE:  13200.   EQUIV. IMPEDANCE=  0.0118 + J  0.0944  OHMS
               CONTRIBUTIONS:  UTIL-0001                                            80.000 KA      ANG:  -82.87
               XF2-0001                    BUS-0002                                  0.124 KA      ANG:   96.86

UTILITY PRI 2                 3P Duty: 80.109 KA AT  -82.87 DEG (1831.54 MVA)  X/R:     8.00
               VOLTAGE:  13200.   EQUIV. IMPEDANCE=  0.0118 + J  0.0944  OHMS
               CONTRIBUTIONS:  UTIL-0003                                            80.000 KA      ANG:  -82.87
               XF2-0004                    BUS-0003                                  0.109 KA      ANG:  -82.22
```

FAULT STUDY SUMMARY
(FOR APPLICATION OF LOW VOLTAGE BREAKERS)
PRE FAULT VOLTAGE: 1.0000
MODEL TRANSFORMER TAPS: NO

BUS RECORD NO NAME	VOLTAGE L-L	AVAILABLE FAULT DUTIES (KA) 3 PHASE	X/R	LINE/GRND	X/R
100 UTC_MDPH1	480.	34.442	8.11		
101 MDPH1	480.	32.770	6.46		
102 H1L1	480.	27.263	2.76		
103 H1L2	480.	16.148	1.04		
104 H1L3	480.	15.160	1.34		
105 H1L4	480.	16.748	1.58		
106 MD/G	208.	6.096	2.34		
107 G/GA	208.	5.742	2.11		
108 SDPL1	208.	23.911	4.90		
109 L1M1	208.	2.688	0.67		
110 L1L1	208.	17.385	2.57		
111 L1L2	208.	14.738	2.15		
112 L1L3	208.	10.956	1.16		
113 L1L31	208.	9.241	0.98		
114 L1L4	208.	5.335	0.91		
115 L1L5	208.	5.422	1.11		
116 L1L6	208.	7.102	0.63		
117 L1B1	208.	13.179	1.04		
118 L1B2	208.	2.534	0.35		
119 H1B1	480.	15.630	0.78		
200 UTC2_MDPH2	480.	32.642	7.16		
201 MDPH2	480.	31.848	6.44		
202 SDPL2	208.	16.266	3.33		
203 L2M1	208.	12.232	2.24		
204 L2M11	208.	10.145	1.91		
205 L2M2	208.	10.481	1.47		
206 L2M21	208.	6.695	0.71		
207 L2B2	208.	8.773	1.35		
208 L2B1	208.	10.105	0.99		
209 H2M1	480.	19.068	1.70		
210 H2M2	480.	20.652	1.72		
211 H2B2	480.	29.137	3.80		
212 H2B1	480.	13.489	0.58		
213 SDPH21	480.	17.799	1.72		
214 H21B1	480.	11.096	0.73		
215 H21M1	480.	9.258	0.68		
216 H21U1	480.	7.290	0.56		
217 SDPL21	208.	13.877	2.39		
218 L21U1	208.	6.532	0.86		
219 L21U2	208.	3.446	0.60		
220 L21U3	208.	5.557	0.77		
221 L21U4	208.	3.811	0.63		
222 L21U5	208.	6.931	0.90		
223 L21M1	208.	4.445	0.95		

F A U L T S T U D Y S U M M A R Y
(FOR APPLICATION OF LOW VOLTAGE BREAKERS)
PRE FAULT VOLTAGE: 1.0000
MODEL TRANSFORMER TAPS: NO

BUS RECORD NO	NAME	VOLTAGE L-L	AVAILABLE FAULT DUTIES (KA) 3 PHASE	X/R	LINE/GRND	X/R
224	L21M11	208.	3.905	0.82		
225	L21M2	208.	6.532	0.86		
226	L21M3	208.	5.113	1.00		
227	L21M4	208.	8.450	1.07		
228	L21B1	208.	10.685	1.13		
229	SDPH22	480.	15.945	2.15		
230	H22B1	480.	12.178	1.07		
231	H22M1	480.	4.595	0.37		
232	H22U1	480.	8.900	0.89		
233	SDPL22	208.	13.565	2.66		
234	L22U1	208.	6.166	0.86		
235	L22U2	208.	5.554	0.80		
236	L22U3	208.	4.437	0.70		
237	L22U4	208.	5.845	0.83		
238	L22U5	208.	5.290	0.77		
239	L22M1	208.	6.166	0.86		
240	L22M2	208.	5.290	0.77		
241	L22M3	208.	5.290	0.77		
242	L22M4	208.	5.049	0.75		
243	L22M5	208.	5.787	1.10		
244	L22M6	208.	4.624	0.71		
245	L22B1	208.	6.612	0.62		
300	GEN SEC	480.	1.998	12.40		
301	ATS_E1B1	480.	12.790	0.65		
302	ATS_E2B1	480.	22.152	1.60		
303	E1B1	480.	10.773	0.56		
304	E1L1	480.	3.143	0.20		
305	E1L2	480.	2.885	0.30		
306	E1BL1	208.	1.787	0.78		
307	E1BL2	208.	1.618	0.70		
308	E2B1	480.	19.271	1.30		
309	E2BL1	208.	2.981	1.10		
310	E2BL2	208.	1.491	0.73		
311	E2BL3	208.	1.005	0.57		
312	E2M1	480.	3.716	0.22		
313	E2B2	480.	2.924	0.35		
314	E2M3	480.	1.911	0.25		
315	E2U1	480.	1.758	0.24		
316	E2B3	480.	1.786	0.29		
317	E2M2	480.	1.137	0.21		
318	E2U2	480.	1.080	0.20		

F A U L T   S T U D Y   S U M M A R Y
(FOR APPLICATION OF LOW VOLTAGE BREAKERS)
PRE FAULT VOLTAGE: 1.0000
MODEL TRANSFORMER TAPS: NO

BUS RECORD NO NAME	VOLTAGE L-L	A V A I L A B L E F A U L T D U T I E S (KA) 3 PHASE	X/R	LINE/GRND	X/R
ACC-1	480.	13.109	2.05		
ACC-2	480.	20.489	2.38		
ACC-3	480.	15.894	1.49		
BUS-0002	480.	34.594	8.23		
UTILITY PRI	13200.	80.124	8.00		
UTILITY PRI 2	13200.	80.109	8.00		

110 FAULTED BUSES, 115 BRANCHES,   8 CONTRIBUTIONS

*** SHORT CIRCUIT STUDY COMPLETE ***

APPENDIX D: REFERENCES

I. SUPPLIED DATA

1 System Drawings

II. ELECTRICAL CONTRACTOR INFORMATION

1 Conductor Run Data

2 Other Electrical System Data

III. POWER SYSTEM ENGINEERING

1 Trip Dials for Micrologic 6.0, 6.0A, 6.0P, 6.0H

2 Trip Dials for H-, J-Frame Micrologic 3.2 & 3.2S

3 Trip Dials for L-Frame Micrologic 3.3 & 3.3S

4 Trip Dials for Electronic Trip ET1.0 & ET1.0I

5 Trip Dials for Molded Case Breakers

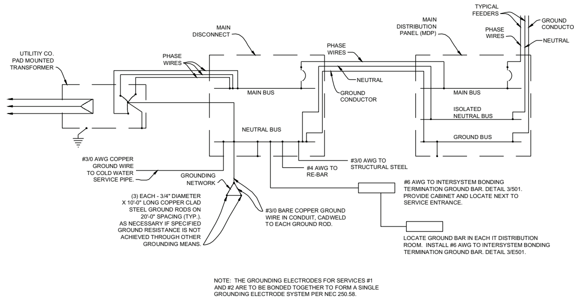
6 Trip Dials for Ground Fault Relays

7 Std AF Study Options - SKM

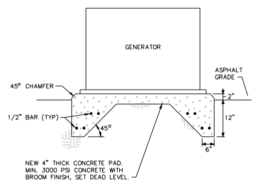
8 Approach Boundaries Table - 70E

9 PPE Table - 70E

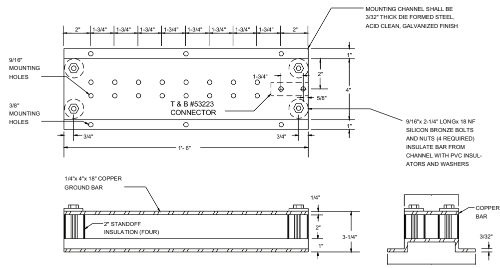
10 Project Recommendation & Action Table



4 E501 SECONDARY DISTRIBUTION GROUNDING SYSEM
NOT TO SCALE



2 E501 GENERATOR PAD DETAIL
NOT TO SCALE



3 E501 GROUND BAR DETAIL
E600 NOT TO SCALE

FAULT CURRENT CALCULATION SCHEDULE							
LOCATION	SHORT CIRCUIT I(SC)	CONSTANT "C"	VOLTAGE	AVAILABLE I(SC)	FEEDER LENGTH	FACTOR "F"	MULTIPLIER "M"
UTILITY TRANS.	31,200	-	480	31,200		-	-
MAIN DISCONNECT	30,117	187,608	480	31,200	60	0.036	0.965
MDPH1	29,155	187,608	480	30,117	57	0.033	0.968
-PANEL 'H1B1'	19,759	7,292	480	29,155	33	0.476	0.678
-PANEL 'E1B1'	13,124	4,645	480	29,155	54	1.222	0.450
--TRANSFORMER 'TE1'	4,451			13,124			
---PANEL 'E1BL1'	4,122	4,645	208	4,451	10	0.080	0.926
----PANEL 'E1BL2'	1,589	3,806	208	4,122	177	1.595	0.385
--PANEL 'E1L1'	4,504	1,557	480	13,124	63	1.914	0.343
--PANEL 'E1L2'	3,118	4,760	480	13,124	323	3.210	0.238
-PANEL 'H1L1'	24,492	24,244	480	29,155	38	0.190	0.840
-PANEL 'H1L2	13,609	8,826	480	29,155	83	1.142	0.467
-PANEL 'H1L3	14,115	13,909	480	29,155	122	1.066	0.484
-PANEL 'H1L4'	14,327	30,968	480	29,155	305	1.035	0.491
--TRANSFORMER 'TMD/G"	16,931			14,327			
---(E) PANEL 'MD/G'	16,347	39,406	208	16,931	10	0.036	0.965
----PANEL 'G/GA'	15,441	13,909	208	16,347	6	0.059	0.945
-TRANSFORMER 'T1'	31,571			29,155			
--SDPL1	30,993	140,706	208	31,571	10	0.019	0.982
---PANEL 'L1B1'	16,036	7,186	208	30,993	26	0.933	0.517
---PANEL 'L1B2'	3,123	5,777	208	30,993	200	8.924	0.101
---PANEL 'L1L1'	22,833	37,510	208	30,993	52	0.357	0.737
---PANEL 'L1L2'	20,452	37,510	208	30,993	75	0.515	0.660
---PANEL 'L1L3'	14,010	24,244	208	30,993	114	1.212	0.452
----PANEL 'L1L31'	12,376	8,826	208	14,010	10	0.132	0.883
---PANEL 'L1L4'	7,087	13,909	208	30,993	182	3.373	0.229
---PANEL 'L1L5	6,557	16,670	208	30,993	241	3.727	0.212
---PANEL 'L1L6'	9,832	7,186	208	30,993	60	2.152	0.317
---PANEL 'L1M1'	3,918	12,122	208	30,993	325	6.911	0.126

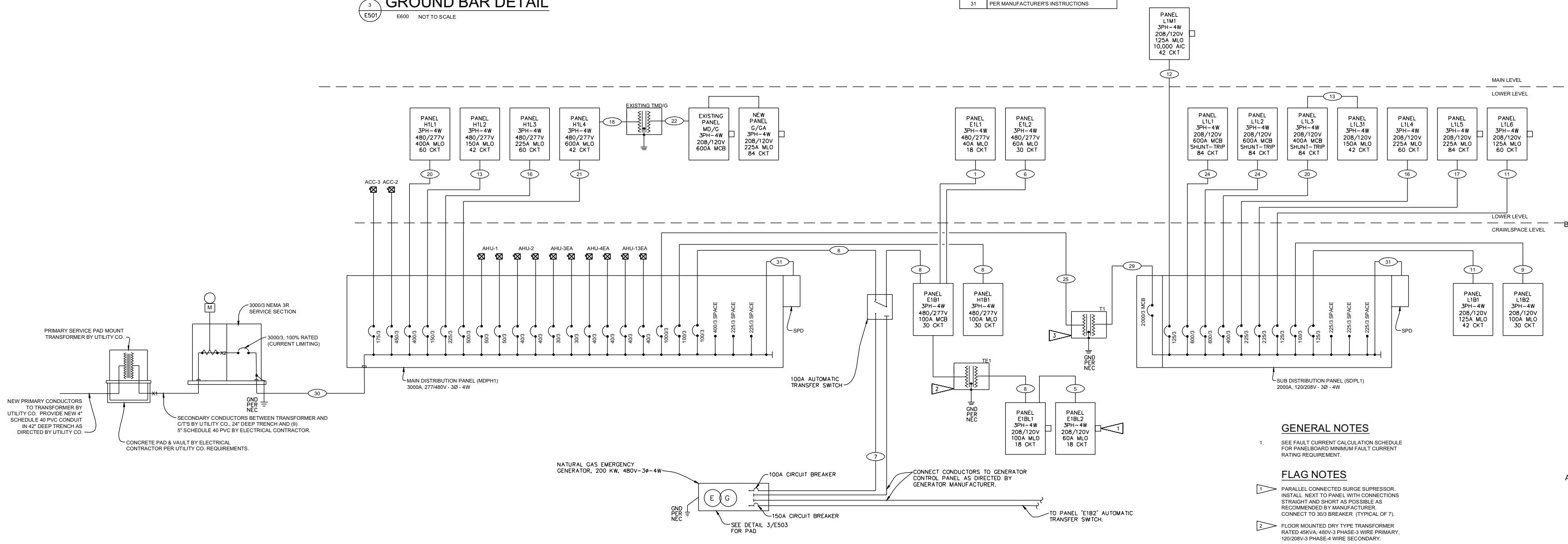
NOTES:
1. VOLTAGE (V) = LINE TO LINE
2. FEEDER LENGTH IN FEET (L).
3. (C) = FEEDER CONSTANT
4. (F) = (1.73 X L X AVAILABLE I(SC))/(C X V) (3 PHASE); (F) = (2 X L X AVAILABLE I(SC))/(C X V) (1 PHASE)
5. (M) = 1/(1+F)
6. SHORT CIRCUIT I(SC) = CALCULATED FAULT CURRENT AVAILABLE AT THE POINT ON ELECTRICAL ONE LINE.
7. AVAILABLE I(SC) =FAULT CURRENT AT FEEDER STARTING POINT OF FEEDER.

ELECTRICAL LOAD SUMMARY (SERVICE 1)			
(CALCULATIONS PER NEC 2011 EDITION)			
DESCRIPTION	CONNECTED LOAD (KVA)	DEMAND PER NEC	KVA
EXISTING LOAD	0.00	125%	0.00
LIGHTING	100.54	125%	125.68
RECEPTACLES 10 KVA OR LESS	10.00	100%	10.00
RECEPTACLES OVER 10 KVA	214.08	50%	107.04
MECHANICAL	1544.29	100%	1544.29
LARGEST MOTOR	47.53	25%	11.88
KITCHEN LOADS	0.00	65%	0.00
TOTAL 3 PHASE LOAD IN KVA			1798.89
SERVICE VOLTAGE=		480	
MINIMUM SERVICE AMPACITY=			2164

NO.	FEEDER SCHEDULE RACEWAY AND CONDUCTORS (AWG OR KCMIL)
1	3/4"C - #8 CU + #10 GND
2	3/4"C - #6 CU
3	1"C - #6 CU + #8 GND
4	1"C - #6 CU + #10 GND
5	1-1/4"C - #4 CU + #8 GND
6	1-1/4"C - #3 CU + #6 GND
7	1-1/4"C - #1 AL
8	1-1/2"C - #1 AL + #6 GND
9	2"C - #1/0 AL + #4 GND
10	2"C - #2/0 AL + #3 GND
11	2"C - #2/0 AL + #4 GND
12	2-1/2"C - #250 AL + #1 GND
13	2"C - #3/0 AL + #4 GND
14	2-1/2"C - #4/0 AL + #2 GND
15	2-1/2"C - #250 AL + #2 GND
16	2-1/2"C - #300 AL + #2 GND
17	3"C - #400 AL + #1/0 GND
18	3"C - #500 AL
19	3"C - #500 AL + #2 GND
20	(2) 2-1/2"C - #250 AL + #1 GND
21	(2) 3"C - #350 AL + #1/0 GND
22	(2) 3"C - #350 CU + #3 GND
23	(2) 3-1/2"PVC - #500 AL
24	(2) 3"C - #500 AL + #2/0 GND
25	(4) 3"PVC - #350 AL
26	(4) 3" PVC - #350 AL + #4/0 GND
27	(4) 4" PVC - #600 AL + #400 GND
28	(4) 3-1/2" PVC - #500 AL + #250 GND
29	(6) 4" PVC - #600 AL + #400 GND
30	(8) 4" PVC - #700 AL + #600 GND
31	PER MANUFACTURER'S INSTRUCTIONS

FAULT CURRENT CALCULATION SCHEDULE							
LOCATION	SHORT CIRCUIT I(SC)	CONSTANT "C"	VOLTAGE	AVAILABLE I(SC)	FEEDER LENGTH	FACTOR "F"	MULTIPLIER "M"
UTILITY TRANS.	31,200	-	480	31,200		-	-
MAIN DISCONNECT	30,117	187,608	480	31,200	60	0.036	0.965
MDPH2	28,945	187,608	480	30,117	70	0.041	0.961
-PANEL 'H2B1'	20,238	2,425	480	28,945	10	0.430	0.699
-PANEL 'H2B2'	22,098	24,244	480	28,945	72	0.310	0.763
-PANEL 'E2B1'	18,031	8,826	480	22,098	25	0.226	0.816
--PANEL 'E2M1'	7,087	1,557	480	18,031	37	1.544	0.393
--PANEL 'E2B2'	3,347	5,777	480	18,031	390	4.387	0.186
---PANEL 'E2M3'	2,601	1,557	480	3,347	37	0.287	0.777
---PANEL 'E2U1'	2,879	1,557	480	3,347	21	0.163	0.860
--PANEL 'E2B3'	1,784	4,760	480	18,031	577	9.107	0.099
---PANEL 'E2M2'	1,402	1,557	480	1,784	57	0.272	0.786
---PANEL 'E2U2'	1,366	1,557	480	1,784	64	0.306	0.766
--TRANSFORMER 'TE2'	9,913			18,031	67		
---PANEL 'E2BL1'	9,282	12,122	208	9,913	10	0.068	0.936
----PANEL 'E2BL2'	2,667	10,740	208	9,282	345	2.480	0.287
-----PANEL 'E2BL3'	1,583	7,186	208	2,667	222	0.685	0.593
-PANEL 'H2M1'	20,712	13,909	480	28,945	53	0.398	0.716
-PANEL 'H2M2'	20,421	24,244	480	28,945	97	0.417	0.706
-TRANSFORMER 'T2'	41,089			28,945	10		
--SDPL2	39,511	85,560	208	41,089	10	0.040	0.962
---PANEL 'L2B1'	23,140	4,645	208	39,511	10	0.707	0.586
---PANEL 'L2B2'	13,671	13,909	208	39,511	80	1.890	0.346
---PANEL 'L2M1'	27,987	37,510	208	39,511	47	0.412	0.708
----PANEL 'L2M11'	21,359	18,755	208	27,987	25	0.310	0.763
---PANEL 'L2M2'	18,956	24,244	208	39,511	80	1.084	0.480
----PANEL 'L2M21'	11,487	2,425	208	18,956	10	0.650	0.606
-SDPH21	18,157	67,248	480	28,945	383	0.594	0.627
--PANEL 'H21B1'	12,925	2,425	480	18,157	15	0.405	0.712
--PANEL 'H21M1'	4,996	4,645	480	18,157	187	2.635	0.275
--PANEL 'H21U1'	9,840	4,645	480	18,157	60	0.845	0.542
--TRANSFORMER 'T21'	30,450			18,157	10		
---SDPL21	29,575	85,560	208	30,450	10	0.030	0.971
----PANEL 'L21B1'	11,729	2,425	208	29,575	15	1.522	0.397
----PANEL 'L21M1'	6,519	13,909	208	29,575	200	3.537	0.220
----PANEL 'L21M2'	11,425	8,826	208	29,575	57	1.589	0.386
----PANEL 'L21M3'	8,136	13,909	208	29,575	149	2.635	0.275
----PANEL 'L21M4'	17,148	8,826	208	29,575	26	0.725	0.580
----PANEL 'L21U1'	10,022	8,826	208	29,575	70	1.951	0.339
----PANEL 'L21U2'	4,657	8,826	208	29,575	192	5.351	0.157
----PANEL 'L21U3'	8,779	8,826	208	29,575	85	2.369	0.297
----PANEL 'L21U4'	5,105	8,826	208	29,575	172	4.794	0.173
----PANEL 'L21U5'	13,625	8,826	208	29,575	42	1.171	0.461
-SDPH22	17,619	93,804	480	28,945	578	0.643	0.609
--PANEL 'H22B1'	11,563	2,425	480	17,619	20	0.524	0.656
--PANEL 'H22M1'	6,716	2,425	480	17,619	62	1.624	0.381
--PANEL 'H22U1'	11,191	7,186	480	17,619	65	0.574	0.635
--TRANSFORMER 'T22'	26,904			17,619	10		
---SDPL22	26,218	85,560	208	26,904	10	0.026	0.975
----PANEL 'L22B1'	9,369	2,425	208	26,218	20	1.798	0.357
----PANEL 'L22M1'	12,131	8,826	208	26,218	47	1.161	0.463
----PANEL 'L22M2'	7,891	8,826	208	26,218	94	2.322	0.301
----PANEL 'L22M3'	8,071	8,826	208	26,218	91	2.248	0.308
----PANEL 'L22M4'	7,663	8,826	208	26,218	98	2.421	0.292
----PANEL 'L22M5'	9,099	13,909	208	26,218	120	1.881	0.347
----PANEL 'L22M6'	6,452	8,826	208	26,218	124	3.064	0.246
----PANEL 'L22U1'	9,966	8,826	208	26,218	66	1.631	0.380
----PANEL 'L22U2'	7,006	8,826	208	26,218	111	2.742	0.267
----PANEL 'L22U3'	5,513	8,826	208	26,218	152	3.755	0.210
----PANEL 'L22U4'	7,245	8,826	208	26,218	106	2.619	0.276
----PANEL 'L22U5'	7,099	8,826	208	26,218	109	2.693	0.271

NOTES:
1. VOLTAGE (V) = LINE TO LINE
2. FEEDER LENGTH IN FEET (L).
3. (C) = FEEDER CONSTANT
4. (F) = (1.73 X L X AVAILABLE I(SC))/(C X V) (3 PHASE); (F) = (2 X L X AVAILABLE I(SC))/(C X V) (1 PHASE)
5. (M) = 1/(1+F)
6. SHORT CIRCUIT I(SC) = CALCULATED FAULT CURRENT AVAILABLE AT THE POINT ON ELECTRICAL ONE LINE.
7. AVAILABLE I(SC) =FAULT CURRENT AT FEEDER STARTING POINT OF FEEDER.



1 E501 ELECTRICAL ONE-LINE DIAGRAM (SERVICE 1)
NOT TO SCALE

GENERAL NOTES

1. SEE FAULT CURRENT CALCULATION SCHEDULE FOR PANELBOARD MINIMUM FAULT CURRENT RATING REQUIREMENT.

FLAG NOTES

1. PARALLEL CONNECTED SURGE SUPRESSOR. INSTALL NEXT TO PANEL WITH CONNECTIONS STRAIGHT AND SHORT AS POSSIBLE AS RECOMMENDED BY MANUFACTURER. CONNECT TO 30/3 BREAKER (TYPICAL OF 7).
2. FLOOR MOUNTED DRY TYPE TRANSFORMER RATED 45KVA, 480V-3 PHASE-3 WIRE PRIMARY, 120/208V-3 PHASE-4 WIRE SECONDARY.
3. FLOOR MOUNTED DRY TYPE TRANSFORMER RATED 750KVA, 480V-3 PHASE-3 WIRE PRIMARY, 120/208V-3 PHASE-4 WIRE SECONDARY.

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SEAL

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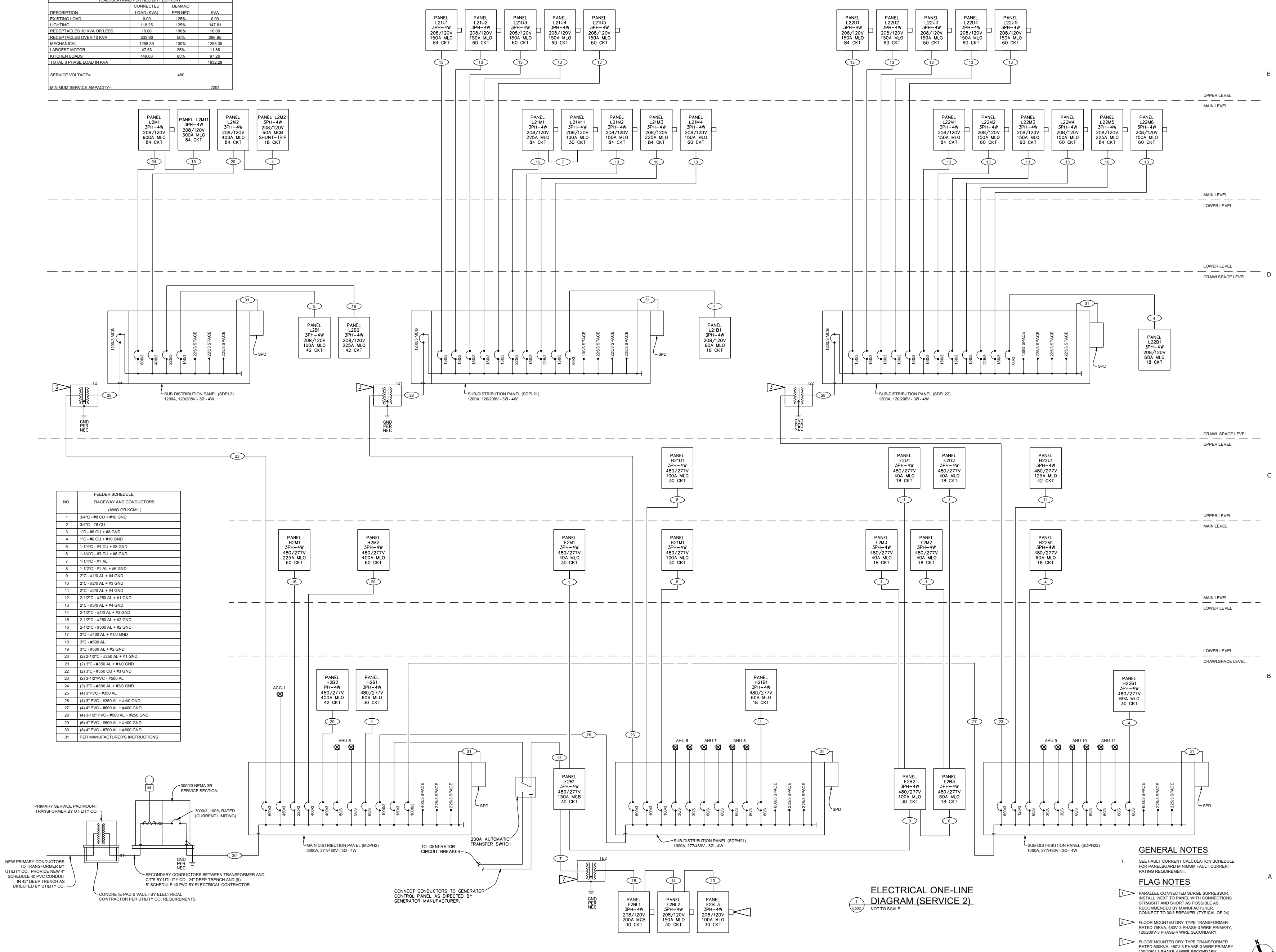
PROJECT PHASE
95% (GMP) SUBMITTAL
NOT FOR CONSTRUCTION

PROJECT INFORMATION
KELLY WALSH HIGH SCHOOL
NATRONA COUNTY SCHOOL DISTRICT No. 1
3500 EAST 12TH STREET
CASPER, WY 82609

PROJECT #: 11-02/12110
ISSUE DATE: MAR 17, 2014
REVISIONS
NO DESCRIPTION DATE

SHEET INFORMATION
ELECTRICAL DETAILS, ONE-LINES & DIAGRAMS
6.E501

ELECTRICAL LOAD SUMMARY (SERVICE 2)			
(CALCULATIONS PER NEC 2011 EDITION)			
DESCRIPTION	CONNECTED LOAD (KVA)	DEMAND PER NEC	KVA
EXISTING LOAD	0.00	125%	0.00
LIGHTING	118.25	125%	147.81
RECEPTACLES 10 KVA OR LESS	10.00	100%	10.00
RECEPTACLES OVER 10 KVA	533.90	50%	266.95
MECHANICAL	1298.39	100%	1298.39
LARGEST MOTOR	47.53	25%	11.88
KITCHEN LOADS	149.63	65%	97.26
TOTAL 3 PHASE LOAD IN KVA			1832.29
SERVICE VOLTAGE=		480	
MINIMUM SERVICE AMPACITY=			2204



NO.	FEEDER SCHEDULE RACEWAY AND CONDUCTORS (AWG OR KCMIL)
1	3/4"C - #8 CU + #10 GND
2	3/4"C - #6 CU
3	1"C - #6 CU + #8 GND
4	1"C - #6 CU + #10 GND
5	1-1/4"C - #4 CU + #8 GND
6	1-1/4"C - #3 CU + #6 GND
7	1-1/4"C - #1 AL
8	1-1/2"C - #1 AL + #6 GND
9	2"C - #1/0 AL + #4 GND
10	2"C - #2/0 AL + #3 GND
11	2"C - #2/0 AL + #4 GND
12	2-1/2"C - #250 AL + #1 GND
13	2"C - #3/0 AL + #4 GND
14	2-1/2"C - #4/0 AL + #2 GND
15	2-1/2"C - #250 AL + #2 GND
16	2-1/2"C - #300 AL + #2 GND
17	3"C - #400 AL + #1/0 GND
18	3"C - #500 AL
19	3"C - #500 AL + #2 GND
20	(2) 2-1/2"C - #250 AL + #1 GND
21	(2) 3"C - #350 AL + #1/0 GND
22	(2) 3"C - #350 CU + #3 GND
23	(2) 3-1/2"PVC - #500 AL
24	(2) 3"C - #500 AL + #2/0 GND
25	(4) 3"PVC - #350 AL
26	(4) 3" PVC - #350 AL + #4/0 GND
27	(4) 4" PVC - #600 AL + #400 GND
28	(4) 3-1/2" PVC - #500 AL + #250 GND
29	(6) 4" PVC - #600 AL + #400 GND
30	(8) 4" PVC - #700 AL + #600 GND
31	PER MANUFACTURER'S INSTRUCTIONS

ELECTRICAL ONE-LINE DIAGRAM (SERVICE 2)

1 E502 NOT TO SCALE

GENERAL NOTES

1. SEE FAULT CURRENT CALCULATION SCHEDULE FOR PANELBOARD MINIMUM FAULT CURRENT RATING REQUIREMENT.

FLAG NOTES

1. PARALLEL CONNECTED SURGE SUPRESSOR. INSTALL NEXT TO PANEL WITH CONNECTIONS STRAIGHT AND SHORT AS POSSIBLE AS RECOMMENDED BY MANUFACTURER. CONNECT TO 30/3 BREAKER (TYPICAL OF 24).
2. FLOOR MOUNTED DRY TYPE TRANSFORMER RATED 75KVA, 480V-3 PHASE-3 WIRE PRIMARY, 120/208V-3 PHASE-4 WIRE SECONDARY.
3. FLOOR MOUNTED DRY TYPE TRANSFORMER RATED 500KVA, 480V-3 PHASE-3 WIRE PRIMARY, 120/208V-3 PHASE-4 WIRE SECONDARY.

ARCHITECT

RB+B Architects, Inc.
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F - 970.484.0264

www.rbbarchitects.com

SEAL

CONSULTANT

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1607 CY Ave., Suite #303
Casper, Wyoming 82604
Ph: (307) 266-5033

PROJECT PHASE

95% (GMP) SUBMITTAL

NOT FOR CONSTRUCTION

PROJECT INFORMATION

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6.E502

LV ELECTRONIC DEVICES (use with SWGR, SWBDs, MCCs, Panels, Bus Plugs)

NAME (Building or Equip) MD/G	VOLTAGE 208		REV.#
LOCATION (Building or Equip)	SWGR CONT CURRENT RATING:		PG. __ OF __
FED FROM H1L4	SWGR BUS BRACING:		
DRAWING REF	Section #		
COLLECTED BY	DATE COMPLETED		

BKR I.D. PHOTO #	CIRCUIT BREAKER INFO. MFG. BREAKER TRIP UNIT	FRAME (AF) SENSOR (AS) (In) PLUG (AP)	INTR. RATING RMS SYM	RANGE / SETTING LTPU (Ir) RANGE SETTING	LTD (tr) RANGE SETTING	STPU (Isd) RANGE SETTING	STD (tsd) RANGE SETTING	INST. (It) RANGE SETTING	GFPU (Ig) RANGE SETTING	GFD (tg) RANGE SETTING
CELL 2	WEST	800		.5 - 1.0	2 - 24	2 - S2	.1 - .5	2 - M2	A - K	.1 - 5
FEEDS PNL. A	DSII-308	800	30 kA	1	20	6	0.2	M2	B	0.2
	DIGITRIP	800 or ARP#					OUT*			OUT*
MAIN	MLO									
	(2) 500KCMIL									
G/GA	200A	TFJ236200								
FEEDER	350 KCMIL									
	GGA									
LARGEST	400A	TJK436F000								
FEEDER	750KCMIL									
DIMMER SYSTEM										
FEEDER	100A	TED134100								
TO 1/GB	#1 AWG									

Area in gray is an example. * I2T - ON OR OFF, IN OR OUT

NOTES: PHOTO#

1. If the breaker uses current-limiting fuse, record fuse data.

2. If the breaker uses separate ground fault module, record GFP data.

USE 'A' for Not Applicable; USE 'B' for Not Accessible

For location use building, floor, room ex. Bldg 1, 2nd Floor, RM 208B.
For equipment located outside use compass heading and nearest building, grounds Ex. Eastside of Bldg #1 , grounds

PANELBOARD/SWITCHBOARD with T-M BKRS

NAME (Equip)	VOLTAGE	**REV.#**
LOCATION (Building or Equip)	PANEL/SWBD CONT CURRENT:	**PG. __ OF __**
	SWBD (ONLY) BUS BRACING:	
DRAWING REF	Section #	
COLLECTED BY	DATE COMPLETED	
FED FROM		

MAIN BREAKER DATA						**FEEDER BREAKER DATA (Note 4)**							**CABLE (LOAD SIDE)**		
MFG. TYPE	CAT# (see Notes)	CONT. CURRENT	INTR (SYM)	RANGE INST.	SETTINGS INST.	I.D.	MFG. TYPE	CAT# (see Notes)	CONT. CURRENT	INTR (SYM)	RANGE INST.	SETTINGS INST.	SIZE	# / PH	LENGTH (FT)
SQD OR MLO	MA	800	30KA	L0, 2 ,3, 4, HI	H1	CKT 1	SQD	MA	800	30KA	LO, 2 ,3, 4, HI	H1	3/0	1	150

Area in gray is an example.

1. If the breaker uses a separate ground fault module, record GFP data.
2. If the breaker uses current-limiting fuse, record the fuse cat. # and amp. rating.
3. If breakers use electronic trip devices, record data on LVCB-E trip sheet
4. Record data for largest and smallest (lowest SC rating) bkr; and bkr feeding subpanels

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NOTES:

PHOTO #

CABLE

NAME (Building or Equip)	DRAWING REF	PG. ___ OF ___
LOCATION (See note below)	COLLECTED BY	REV # ______
	DATE COMPLETED	

FROM EQUIP.*	TO EQUIP.*	CONDUCTOR LENGTH IN FEET	NUMBER OF CABLES PER PHASE	CABLE SIZE / PHASE AND NEUTRAL (e.g. AWG, KCMIL)	CONDUCTOR MATERIAL** (if other than CU)	INSULATION TYPE** (if other than THHN)	CONDUIT TYPE** (if other than STEEL)
PANEL H5A	PANEL H5B	125	2	500MCM / PH & Neutral	AL	THW	PVC
MDPH2	ATS_E2B1	50	1	3/0AWG / PH & Neutral	AL	THHN	EMT
ATS_E2B1	E2B1	20	1	3/0AWG / PH & Neutral	AL	THHN	EMT
E2B1	TE2	100	1	1AWG / PH & Neutral	AL	THHN	EMT
TE2	E2BL1	20	1	250MCM / PH & Neutral	AL	THHN	EMT
E2BL1	E2BL2	450	1	4/0AWG / PH & Neutral	AL	THHN	EMT
E2BL2	E2BL3	290	1	2/0AWG / PH & Neutral	AL	THHN	EMT
E2B1	E2M1	100	1	8AWG / PH & Neutral	Cu	THHN	EMT
E2B1	E2B2	480	1	1/0AWG / PH & Neutral	AL	THHN	EMT
E2B2	314 E2M3	80	1	8AWG / PH & Neutral	Cu	THHN	EMT
E2B2	E2U1	100	1	8AWG / PH & Neutral	Cu	THHN	EMT
E2B2	E2B3	290	1	3AWG / PH & Neutral	Cu	THHN	EMT
E2B3	E2M2	140	1	8AWG / PH & Neutral	Cu	THHN	EMT
E2B3	E2U2	160	1	8AWG / PH & Neutral	Cu	THHN	EMT

Area in gray is an example.

*** Panelboard, switchboard, and transformer designations, etc..**

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Notes

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CABLE

NAME (Building or Equip)	DRAWING REF	PG. ___ OF ___
LOCATION (See note below)	COLLECTED BY	REV # ______
	DATE COMPLETED	

FROM EQUIP.*	TO EQUIP.*	CONDUCTOR LENGTH IN FEET	NUMBER OF CABLES PER PHASE	CABLE SIZE / PHASE AND NEUTRAL (e.g. AWG, KCMIL)	CONDUCTOR MATERIAL** (if other than CU)	INSULATION TYPE** (if other than THHN)	CONDUIT TYPE** (if other than STEEL)
PANEL H5A	PANEL H5B	125	2	500MCM / PH & Neutral	AL	THW	PVC
XFMR_SDPL22	SDPL22	20	4	500MCM / PH & Neutral	AL	THHN	EMT
SDPL22	L22U1	110	1	3/0AWG / PH & Neutral	AL	THHN	EMT
SDPL22	L22U2	130	1	3/0AWG / PH & Neutral	AL	THHN	EMT
SDPL22	L22U3	180	1	3/0AWG / PH & Neutral	AL	THHN	EMT
SDPL22	L22U4	120	1	3/0AWG / PH & Neutral	AL	THHN	EMT
SDPL22	L22U5	140	1	3/0AWG / PH & Neutral	AL	THHN	EMT
SDPL22	L22M1	110	1	3/0AWG / PH & Neutral	AL	THHN	EMT
SDPL22	L22M2	140	1	3/0AWG / PH & Neutral	AL	THHN	EMT
SDPL22	L22M3	140	1	3/0AWG / PH & Neutral	AL	THHN	EMT
SDPL22	L22M4	150	1	3/0AWG / PH & Neutral	AL	THHN	EMT
SDPL22	L22M5	180	1	300MCM / PH & Neutral	AL	THHN	EMT
SDPL22	L22M6	170		3/0AWG / PH & Neutral	AL	THHN	EMT
SDPL22	L22B1	30	1	6AWG / PH & Neutral	Cu	THHN	EMT

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NAME (Building or Equip)	DRAWING REF	PG. ___ OF ___
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PANEL H5A	PANEL H5B	125	2	500MCM / PH & Neutral	AL	THW	PVC
SDPL21	L21U3	130	1	3/0AWG / PH & Neutral	AL	THHN	EMT
SDPL21	L21U4	220	1	3/0AWG / PH & Neutral	AL	THHN	EMT
SDPL21	L21U5	90	1	3/0AWG / PH & Neutral	AL	THHN	EMT
SDPL21	L21M1	270	1	300MCM / PH & Neutral	AL	THHN	EMT
L21M1	L21M11	20	1	1AWG / PH & Neutral	AL	THHN	EMT
SDPL21	L21M2	100	1	3/0AWG / PH & Neutral	AL	THHN	EMT
SDPL21	L21M3	220	1	300MCM / PH & Neutral	AL	THHN	EMT
SDPL21	L21M4	60	1	3/0AWG / PH & Neutral	AL	THHN	EMT
SDPL21	L21B1	10	1	6AWG / PH & Neutral	Cu	THHN	EMT
MDPH2	SDPH22	750	4	600MC / PH & Neutral	AL	THHN	EMT
SDPH22	H22B1	20	1	6AWG / PH & Neutral	Cu	THHN	EMT
SDPH22	H22M1	120	1	6AWG / PH & Neutral	Cu	THHN	EMT
SDPH22	H22U1	120	1	2/0AWG / PH & Neutral	AL	THHN	EMT
SDPH22	XFMR_SDPL22	20	2	500MCM / PH	AL	THHN	EMT

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FROM EQUIP.*	TO EQUIP.*	CONDUCTOR LENGTH IN FEET	NUMBER OF CABLES PER PHASE	CABLE SIZE / PHASE AND NEUTRAL (e.g. AWG, KCMIL)	CONDUCTOR MATERIAL** (if other than CU)	INSULATION TYPE** (if other than THHN)	CONDUIT TYPE** (if other than STEEL)
PANEL H5A	PANEL H5B	125	2	500MCM / PH & Neutral	AL	THW	PVC
SDPL2	L2B1	30	1	1 AWG / PH & Neutral	AL	THHN	EMT
MDPH2	ACC-1	460	2	300MCM / PH	AL	THHN	EMT
MDPH2	H2M1	100	1	300MCM / PH & Neutral	AL	THHN	EMT
MDPH2	H2M2	150	2	250MCM / PH & Neutral	AL	THHN	EMT
MDPH2	H2B2	30	2	250MCM / PH & Neutral	AL	THHN	EMT
MDPH2	H2B1	40	1	6AWG / PH & Neutral	Cu	THHN	EMT
MDPH2	SDPH21	500	4	350MCM / PH & Neutral	AL	THHN	EMT
SDPH21	H21B1	30	1	6AWG / PH & Neutral	Cu	THHN	EMT
SDPH21	H21M1	80	1	1AWG / PH & Neutral	AL	THHN	EMT
SDPH21	H21U1	120	1	1AWG / PH & Neutral	AL	THHN	EMT
SDPH21	XFMR_SDPL21	30	2	500MCM / PH	AL	THHN	EMT
XFMR_SDPL21	SDPL21	30	4	500MCM / PH & Neutral	AL	THHN	EMT
SDPL21	L21U1	100	1	3/0AWG / PH & Neutral	AL	THHN	EMT
30	L21U2	250	1	3/0AWG / PH & Neutral	AL	THHN	EMT

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Notes

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PANEL H5A	PANEL H5B	125	2	500MCM / PH & Neutral	AL	THW	PVC
E1B1	TE1	30	1	6AWG / PH	Cu	THHN	EMT
TE1	E1BL1	20	1	1AWG / PH & Neutral	AL	THHN	EMT
E1BL1	E1BL2	30	1	4AWG / PH & Neutral	Cu	THHN	EMT
GEN SEC	ATS_E1B1	150	1	1AWG / PH & Neutral	AL	THHN	EMT
GEN SEC	MDPH2	200	1	3/0AWG / PH & Neutral	AL	THHN	EMT
UTILITY SEC	UTC_MDPH2	100	9				
UTC_MDPH2	MDPH2	100	16	700MCM / PH & Neutral	AL	THHN	PVC
MDPH2	XFMR_SDPL2	30	2	500MCM / PH & Neutral	AL	THHN	EMT
XFMR_SDPL2	SDPL2	30	4	500MCM / PH & Neutral	AL	THHN	EMT
SDPL2	L2M1	200	4	500MCM / PH & Neutral	AL	THHN	EMT
L2M1	L2M11	40	1	500MCM / PH & Neutral	AL	THHN	EMT
SDPL2	L2M2	120	2	250MCM / PH & Neutral	AL	THHN	EMT
L2M2	L2M21	20	1	6AWG / PH & Neutral	Cu	THHN	EMT
SDPL2	L2B2	100	1	300MCM / PH & Neutral	AL	THHN	EMT

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PANEL H5A	PANEL H5B	125	2	500MCM / PH & Neutral	AL	THW	PVC
SDPL1	L1L1	80	2	500MCM / PH & Neutral	AL	THHN	EMT
SDPL1	L1L2	130	2	500MCM / PH & Neutral	AL	THHN	EMT
SDPL1	L1L3	170	2	250MCM / PH & Neutral	AL	THHN	EMT
L1L3	L1L31	20	1	3/0AWG / PH & Neutral	AL	THHN	EMT
SDPL1	L1L4	260	1	300MCM / PH & Neutral	AL	THHN	EMT
SDPL1	L1L5	300	1	400MCM/PH & Neutral	AL	THHN	EMT
SDPL1	L1L6	100	1	2/0AWG / PH & Neutral	AL	THHN	EMT
SDPL1	L1B1	40	1	2/0AWG / PH & Neutral	AL	THHN	EMT
SDPL1	L1B2	260	1	1/0AWG / PH & Neutral	AL	THHN	EMT
MDPH1	H1B1	60	1	1AWG / PH & Neutral	AL	THHN	EMT
MDPH1	ATS_E1B1	80	1	1AWG / PH & Neutral	AL	THHN	EMT
ATS_E1B1	E1B1	20	1	1AWG / PH & Neutral	AL	THHN	EMT
E1B1	E1L1	100	1	8AWG / PH & Neutral	Cu	THHN	EMT
E1B1	E1L2	340	1	3AWG / PH & Neutral	Cu	THHN	EMT

Area in gray is an example.

Notes

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FROM EQUIP.*	TO EQUIP.*	CONDUCTOR LENGTH IN FEET	NUMBER OF CABLES PER PHASE	CABLE SIZE / PHASE AND NEUTRAL (e.g. AWG, KCMIL)	CONDUCTOR MATERIAL** (if other than CU)	INSULATION TYPE** (if other than THHN)	CONDUIT TYPE** (if other than STEEL)
PANEL H5A	PANEL H5B	125	2	500MCM / PH & Neutral	AL	THW	PVC
UTILITY SEC	UTC	100	9				
UTC	MDPH1	100	16	700MCM / PH & Neutral	AL	THHN	PVC
MDPH1	ACC-3	180	1	4/0 AWG / PH	AL	THHN	PVC
MDPH1	ACC-2	250	2	300MCM / PH	AL	THHN	PVC
MDPH1	H1L1	60	2	250MCM / PH & Neutral	AL	THHN	EMT
MDPH1	H1L2	100	1	3/0AWG / PH & Neutral	AL	THHN	EMT
MDPH1	H1L3	160	1	300MCM/PH & Neutral	AL	THHN	EMT
MDPH1	H1L4	290	2	350MCM/PH & Neutral	AL	THHN	EMT
H1L4	XFMR_MD/G	20	1	4/0AWG / PH	Cu	THHN	EMT
XFMR_MD/G	MD/G	20	2	350MCM / PH & Neutral	Cu	THHN	EMT
MD/G	G/GA	20	1	300MCM / PH & Neutral	AL	THHN	EMT
MDPH1	XFMR_SDPL1	40	4	350MCM / PH	AL	THHN	EMT
XFMR_SDPL1	SDPL1	40	6	600MCM/PH & Neutral	AL	THHN	EMT
SDPL1	L1M1	500	1	250MCM/PH & Neutral	AL	THHN	EMT

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LIGHTING TRANSFORMERS – LOW-VOLTAGE DRY-TYPE

NAME (Building or Equip)	REV.#
DRAWING REF	PG. __ OF __
COLLECTED BY	DATE COMPLETED

I.D.	FROM EQUIP.	TO EQUIP.	LOCATION	MFG. TYPE	CATALOG # OR Series #	KVA	% Z / TAP (RANGE)	PRIMARY VOLTAGE & CONN	SECONDARY VOLTAGE & CONN
T-1A	PANEL HA	PANEL LA	Bldg 43 Rm 312	SQD DRY TYPE	EE112T3H	112.5	5.6	480 V DELTA	208Y/120 V WYE-GND
XFMR_MD/G	H1L4	MD/G	LOWER - E Rm E119			225		480 V DELTA	208Y/120 V WYE-GND
XFMR_TE1	PANEL E1B1	PANEL E1BL1	BASEMENT - D	SQD DRY TYPE	EE45T3H42DB	45	2 - 2.5%, 4 - 2.5%	480V DELTA	208Y/120 V WYE-GND
XFMR_T1	MDPH1	SDPL1	BASEMENT - D	SQD DRY TYPE	EE750T68H61DB	750	2 - 2.5%	480V DELTA	208Y/120 V WYE-GND
XFMR_TE2	PANEL E2B1	PANEL E2BL1	LOWER - F	SQD DRY TYPE	EE75T3H47DB	75	2 - 2.5%, 4 - 2.5%	480V DELTA	208Y/120 V WYE-GND
XFMR_T2	MDPH2	SDPL2	LOWER - F	SQD DRY TYPE	EE500T68H57DB	500	2 - 2.5%	480V DELTA	208Y/120 V WYE-GND
XFMR_T21	SDPH21	SDPL21	CRAWLSPACE - G	SQD DRY TYPE	EE500T68H57DB	500	2 - 2.5%	480V DELTA	208Y/120 V WYE-GND
XFMR_T22	SDPH22	SDPL22	CRAWLSPACE - H	SQD DRY TYPE	EE500T68H57DB	500	2 -2.5%	480V DELTA	208Y/120 V WYE-GND

USE 'A' for Not Applicable; USE 'B' for Not Accessible

NOTES:

PHOTO#

MOTOR

NAME (Building or Equip)									REV.#	
LOCATION (Building or Equip)									PG. __ OF __	
DRAWING REF										
COLLECTED BY				DATE COMPLETED						
I.D. & FED FROM	MFG. TYPE	# OF MOTORS: INDIVIDUAL / COMBINED	INDIVIDUAL HP or COMBINED HP (CHP) (see note)	FLA/S.F.	RPM / FREQ	LR CODE / S.F.	VOLTAGE	DRIVE FED? Y OR N	BYPASS? Y OR N	SOFT-START Y OR N
AHU-1	WESTINGHOUSE	1	75	90/1.0	1800	G	480			
MCC-1-1A	INDUCTION	4	100 CHP		60HZ	1.15	480			
ACC-3	MCQUAY						480			
MDPH1					60HZ					
ACC-2	MCQUAY						480			
MDPH1										
ACC-1	MCQUAY						480			
MDPH2										
AHU-1	MCQUAY	1	25		1750		480	Y		
MDPH1		INDIVIDUAL	INDIVIDUAL HP		60HZ					
AHU-1	MCQUAY	1	25		1750		480	Y		
MDPH1		INDIVIDUAL	INDIVIDUAL HP		60HZ					
AHU-2	MCQUAY	2	40		1750		480	Y		
MDPH1		COMBINED	COMBINED HP (CHP)		60HZ					
AHU-3EA	MCQUAY	2	30		1750		480	Y		
MDPH1		COMBINED	COMBINED HP (CHP)		60HZ					
AHU-4EA	MCQUAY	2	40		1750		480	Y		
MDPH1		COMBINED	COMBINED HP (CHP)		60HZ					
AHU-13EA	MCQUAY	2	40		1750		480	Y		
MDPH1		COMBINED	COMBINED HP (CHP)		60HZ					
AHU-6	MCQUAY	2	30		1750		480	Y		
MDPH2		COMBINED	COMBINED HP (CHP)		60HZ					
AHU-5	MCQUAY	2	30		1750		480	Y		
SDPH21		COMBINED	COMBINED HP (CHP)		60HZ					
AHU-7	MCQUAY	1	30		1750		480	Y		
SDPH21		INDIVIDUAL	INDIVIDUAL HP		60HZ					
AHU-7	MCQUAY	1	30		1750		480	Y		
SDPH21		INDIVIDUAL	INDIVIDUAL HP		60HZ					

MOTOR

NAME (Building or Equip)		REV.#	
LOCATION (Building or Equip)		PG. __ OF __	
DRAWING REF			
COLLECTED BY	DATE COMPLETED		

I.D. & FED FROM	MFG. TYPE	# OF MOTORS: INDIVIDUAL COMBINED	INDIVIDUAL HP or COMBINED HP (CHP) (see note)	FLA/S.F.	RPM FREQ	LR CODE S.F.	VOLTAGE	DRIVE FED? Y OR N	BYPASS? Y OR N	SOFT-START Y OR N
AHU-8 SDPH21	MCQUAY	1 INDIVIDUAL	30 INDIVIDUAL HP		1750 60HZ		480	Y		
AHU-8 SDPH21	MCQUAY	1 INDIVIDUAL	30 INDIVIDUAL HP		1750 60HZ		480	Y		
AHU-9 SDPH22	MCQUAY	2 COMBINED	30 COMBINED HP (CHP)		1750 60HZ		480	Y		
AHU-10 SDPH22	MCQUAY	1 INDIVIDUAL	30 INDIVIDUAL HP		1750 60HZ		480	Y		
AHU-10 SDPH22	MCQUAY	1 INDIVIDUAL	30 INDIVIDUAL HP		1750 60HZ		480	Y		
AHU-11 SDPH22	MCQUAY	1 INDIVIDUAL	30 INDIVIDUAL HP		1750 60HZ		480	Y		
AHU-11 SDPH22	MCQUAY	1 INDIVIDUAL	30 INDIVIDUAL HP		1750 60HZ		480	Y		
AHU-12 H1L4	MCQUAY	1 INDIVIDUAL	30 INDIVIDUAL HP		1750 60HZ		480	Y		
AHU-12 H1L4	MCQUAY	1 INDIVIDUAL	30 INDIVIDUAL HP		1750 60HZ		480	Y		
CWP-1 H2B2	ARMSTRONG	1 INDIVIDUAL	40 INDIVIDUAL HP		3600		480	Y		
DC-1 H1L2	TORIT UNIMASTER	1 INDIVIDUAL	30 INDIVIDUAL HP		60HZ		480			
HWP-1/2 H2B2	ARMSTRONG	1 INDIVIDUAL	50 INDIVIDUAL HP		1800		480	Y		
HWP-1/2 H2B2	ARMSTRONG	1 INDIVIDUAL	50 INDIVIDUAL HP		1800		480	Y		
WFC-1 H1L1	TORIT POWERCORE	1 INDIVIDUAL	30 INDIVIDUAL HP				480	Y		

MOTOR

NAME (Building or Equip)		**REV.#**	
LOCATION (Building or Equip)		**PG. __ OF __**	
DRAWING REF			
COLLECTED BY	DATE COMPLETED		

I.D. & FED FROM	MFG. TYPE	# OF MOTORS: INDIVIDUAL COMBINED	INDIVIDUAL HP or COMBINED HP (CHP) (see note)	FLA/S.F.	RPM FREQ	LR CODE S.F.	VOLTAGE	DRIVE FED? Y OR N	BYPASS? Y OR N	SOFT-START Y OR N
PAC-1 H2B2	GARDNER DENVER	1 INDIVIDUAL	27 INDIVIDUAL HP				480			

Area in gray is an example.

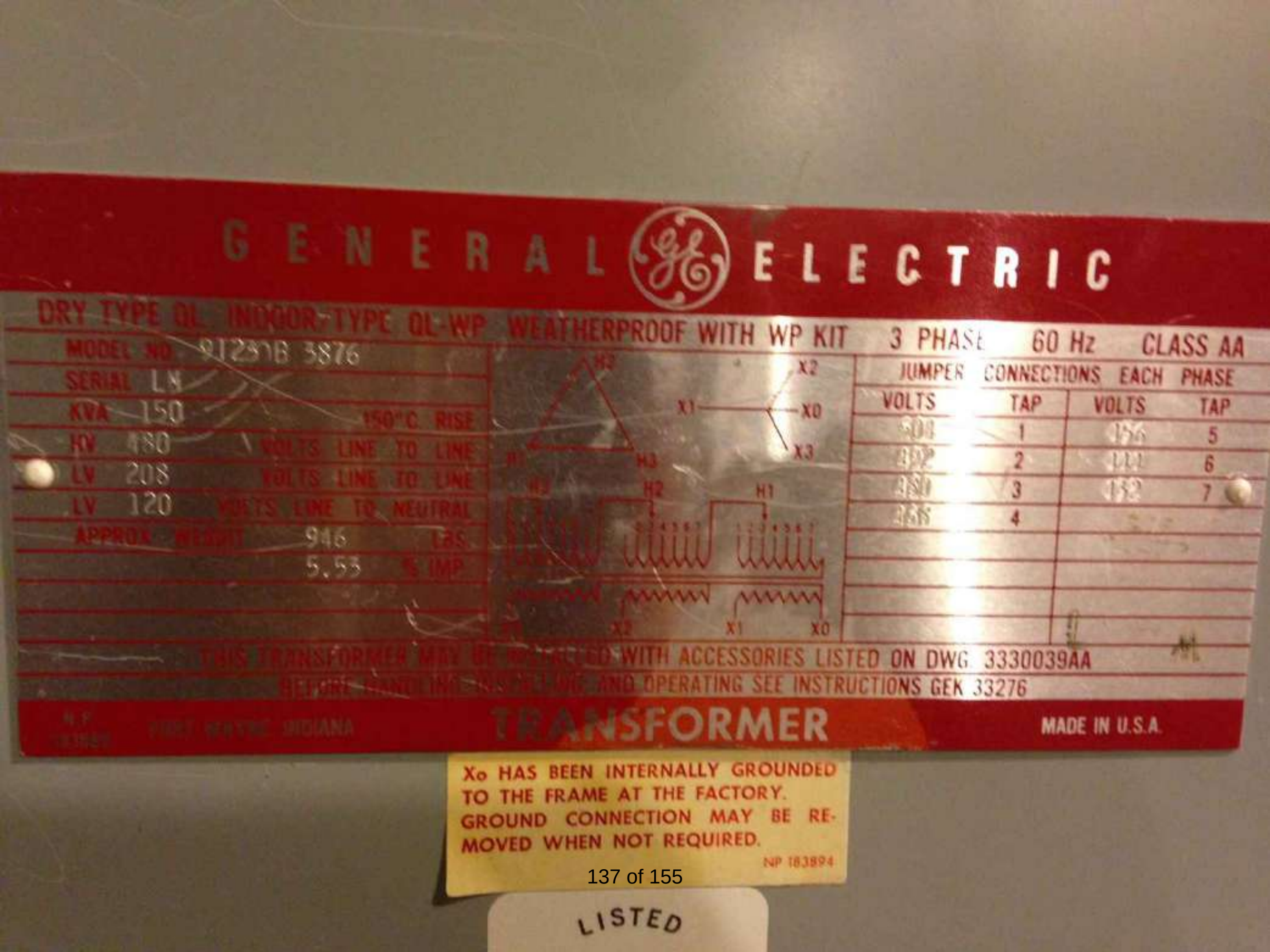
1. Individually list motors 25 HP and larger. For motors less than 25 HP, record location and combined HP.
2. On individually listed motors, include starter type if other than full voltage non-reversing.

USE 'A' for __Not Applicable__; USE 'B' for __Not Accessible__

For location use building, floor, room ex. Bldg 1, 2nd Floor, RM 208B.

For equipment located outside use compass heading and nearest building, grounds Ex. Eastside of Bldg #1 , grounds

NOTES:	PHOTO:


GENERAL ELECTRIC
DRY TYPE QL INDOOR-TYPE QL-WP WEATHERPROOF WITH WP KIT
3 PHASE 60 Hz CLASS AA
MODEL NO.
SERIAL
KVA 150
150°C RISE
HV 480 VOLTS LINE TO LINE
LV 208 VOLTS LINE TO LINE
LV 120 VOLTS LINE TO NEUTRAL
APPROX WEIGHT 946 LBS
5.53 % IMP
JUMPER CONNECTIONS EACH PHASE
VOLTS TAP VOLTS TAP
1 5
2 6
3 7
4
H1 H2 H3 X0 X1 X2 X3
THIS TRANSFORMER MAY BE EQUIPPED WITH ACCESSORIES LISTED ON DWG. 3330039AA
BEFORE HANDLING, INSTALLING AND OPERATING SEE INSTRUCTIONS GEK 33276
TRANSFORMER
MADE IN U.S.A.
Xo HAS BEEN INTERNALLY GROUNDED TO THE FRAME AT THE FACTORY. GROUND CONNECTION MAY BE RE-MOVED WHEN NOT REQUIRED.
NP 183894
LISTED

GENERAC® | INDUSTRIAL POWER

SUBMITTAL DATA

ALTERNATOR DATA

200kW ALTERNATOR
60 Hz

Alternator Ratings (Series Wye Testing)

kW	200	
kVA	250	
Type	Brushless/PMG	
Connections	12 Lead	
Efficiency @ 1.0 Power Factor	208/240	480/600
20% Load	88.45	89.8
40% Load	89.14	90.5
60% Load	89.54	90.9
80% Load	89.44	90.8
100% Load	89.24	90.6
100% @ 0.8 PF	88.75	90.1

Machine Parameters @ Max kW Ratings

Subtransient Reactance p.u.	0.15
Transient Reactance	0.23
Synchronous Reactance	2.05
Negative Sequence Reactance	0.26
Zero Sequence Reactance	0.07
Short Circuit Ratio	0.28
Excitation Voltage	190
Excitation Current @ Rated kW	5.0A
Lamination Type	520

Machine Parameters Continued

Waveform Distortion	<5%
Telephone Influence Factor	<50
Synchronous Speed	1800 rpm
Maximum Overspeed	3300 rpm
Number of Bearings	1 Sealed Ball
Insulation System	Class H
Excitation System	Class H

Temperature Rise vs Output (0.8 pf)

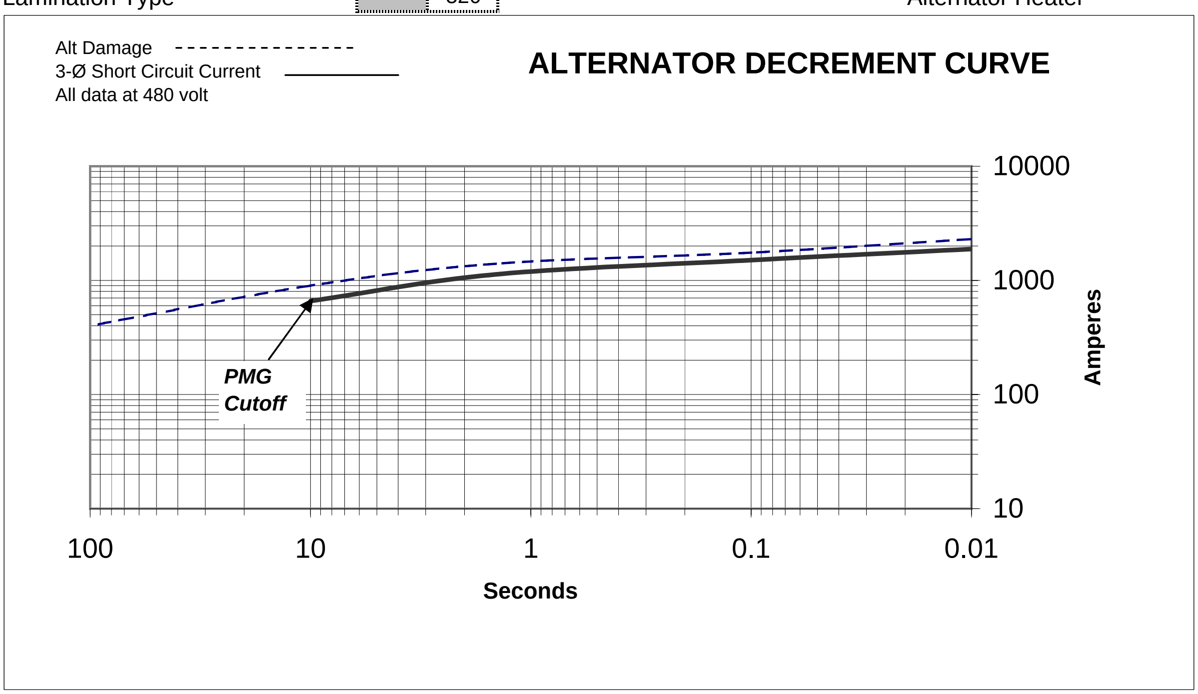
kW Rating	Temp Rise °C
153	80 °
183	105 °
200	120 °

Temperature Rise is based 40° C Ambient

Instantaneous Voltage Dip

Voltage	10%	15%	20%	25%	30%	35%
208, 240	140	210	280	350	420	490
480	187	280	373	467	560	653
600						

Options - - - - - - - - - - - - - Antifungal Coating
Alternator Heater



KELLY WALSH HIGH SCHOOL
200KW ~~150~~KW STANDBY NATURAL GAS GENERATOR SYSTEM SUBMITTALS

BILL OF MATERIALS

Quantity (1) Generac industrial gas engine driven generator, turbocharged, aftercooled, 6 cylinder 12.9L engine, consisting of the following features and accessories:

- **Fuel system - Natural gas**
- **SG0150KG20129N18HPSYE**
- **Stationary Emergency-Standby rated**
- 200KW **~~150~~ kW Rating, synchronous alternator, wired for 277/480 VAC 3 Phase, 60 HZ**
- **Permanent magnet excitation**
- **H-100 Control Panel**
  - **Meets NFPA 99 and 110 requirements**
  - **Temp Range -40 to 70 degrees C**
  - **Digital microprocessor:**
    - **Two 4 line x 20 displays, full system status**
    - **3 phase sensing, +/-0.25% digital voltage regulation**
    - **RS232, RS485 and Canbus remote ports**
    - **Waterproof connections**
    - **All engine sensors are 4-20 ma for minimal interference**
    - **Programmable I/O**
    - **Built-in PLC for special applications**
  - **Engine function monitoring and control:**
    - **Full range standby operation; Programmable auto crank, Emergency Stop, Auto-Off-Manual switch**
    - **Isochronous governor, +/-0.25% frequency regulation**
    - **Full system status on all AC output and engine function parameters**
    - **Service reminders, trending, fault history (alarm log)**
    - **I2T function for full generator protection**
    - **Selectable low-speed exercise**
  - **2-wire start controls for any 2-wire transfer switch**
- **Electronic governor Frequency regulation, isochronous Steady state regulation +/- 0.25%**
- 150A **~~100~~A UL CB, 100% Rated**
  - **Thermal/Mag w/ST & Contacts, LH**
- **100A UL CB, 100% Rated**
  - **Thermal/Mag w/ST & Contacts., RH**
- **Sound attenuated, Level 1 Acoustic enclosure**
  - **Industrial Grey enclosure, powder paint finish**
- **225AH, 1155 CCA, 8D battery**
  - **installed**
- **10AMP battery charger-installed**
- **Battery heating pad, installed**
- **Battery charging alternator**
- **Battery cables**
- **Battery tray**
- **Fuel shut-off solenoid valve**
- **Solenoid activated starter motor**

CIRCUIT BREAKER DATA

GENERAC | INDUSTRIAL POWER

SUBMITTAL DATA

EATON CIRCUIT BREAKERS
100% RATED THERMAL-MAGNETIC

2

AMPS	VOLTS	ACCESSORIES	EATON #	SERIES	FRAME	GENERAC #
70	600	No Accessories	JGE3070FAGC	G	JG-FRAME	0H9302TH00
		Shunt Trip & Aux. Contacts	JGE3070FAGCA2( )[2]			0H9302TH( )[3]
80	600	No Accessories	JGE3080FAGC	G	JG-FRAME	0J0841TH00
		Shunt Trip & Aux. Contacts	JGE3080FAGCA2( )[2]			0J0841TH( )[3]
90	600	No Accessories	JGE3090FAGC	G	JG-FRAME	0J0837TH00
		Shunt Trip & Aux. Contacts	JGE3090FAGCA2( )[2]			0J0837TH( )[3]
100	600	No Accessories	JGE3100FAGC	G	JG-FRAME	0H9314TH00
		Shunt Trip & Aux. Contacts	JGE3100FAGCA2( )[2]			0H9314TH( )[3]
125	600	No Accessories	JGE3125FAGC	G	JG-FRAME	0J0231TH00
		Shunt Trip & Aux. Contacts	JGE3125FAGCA2( )[2]			0J0231TH( )[3]
150	600	No Accessories	JGE3150FAGC	G	JG-FRAME	0H9315TH00
		Shunt Trip & Aux. Contacts	JGE3150FAGCA2( )[2]			0H9315TH( )[3]
175	600	No Accessories	JGE3175FAGC	G	JG-FRAME	0H9316TH00
		Shunt Trip & Aux. Contacts	JGE3175FAGCA2( )[2]			0H9316TH( )[3]
200	600	No Accessories	JGE3200FAGC	G	JG-FRAME	0J0232TH00
		Shunt Trip & Aux. Contacts	JGE3200FAGCA2( )[2]			0J0232TH( )[3]
225	600	No Accessories	JGE3225FAGC	G	JG-FRAME	0H9317TH00
		Shunt Trip & Aux. Contacts	JGE3225FAGCA2( )[2]			0H9317TH( )[3]
250	600	No Accessories	JGE3250FAGC	G	JG-FRAME	0H9318TH00
		Shunt Trip & Aux. Contacts	JGE3250FAGCA2( )[2]			0H9318TH( )[3]
300	600	No Accessories	LGE3300FAGC	G	LG-FRAME	0H9319TH00
		Shunt Trip & Aux. Contacts	LGE3300FAGCA2( )[2]			0H9319TH( )[3]
350	600	No Accessories	LGE3350FAGC	G	LG-FRAME	0H9320TH00
		Shunt Trip & Aux. Contacts	LGE3350FAGCA2( )[2]			0H9320TH( )[3]
400	600	No Accessories	LGE3400FAGC	G	LG-FRAME	0H9321TH00
		Shunt Trip & Aux. Contacts	LGE3400FAGCA2( )[2]			0H9321TH( )[3]
500	600	No Accessories	LGE3500FAGC	G	LG-FRAME	0H9323TH00
		Shunt Trip & Aux. Contacts	LGE3500FAGCA2( )[2]			0H9323TH( )[3]
600	600	No Accessories	LGE3600FAGC	G	LG-FRAME	0H9324TH00
		Shunt Trip & Aux. Contacts	LGE3600FAGCA2( )[2]			0H9324TH( )[3]
700[1]	600	No Accessories	CMDLB3800T33W	C	M-FRAME	0H9325TH00
		Shunt Trip & Aux. Contacts	CMDLB3800T33WA13S02			0H9325THB0
800[1]	600	No Accessories	CMDLB3800T33W	C	M-FRAME	0H9326TH00
		Shunt Trip & Aux. Contacts	CMDLB3800T33WA13S02			0H9326THB0
900[1]	600	No Accessories	CND312T33W	C	N-FRAME	0H9327TH00
		Shunt Trip & Aux. Contacts	CND312T33WA12S03			0H9327THB0
1000[1]	600	No Accessories	CND312T33W	C	N-FRAME	0H9328TH00
		Shunt Trip & Aux. Contacts	CND312T33WA12S03			0H9328THB0
1200[1]	600	No Accessories	CND312T33W	C	N-FRAME	0H9329TH00
		Shunt Trip & Aux. Contacts	CND312T33WA12S03			0H9329THB0
1400[1]	600	No Accessories	CRD316T33W	C	R-FRAME	0H9360TH00
		Shunt Trip & Aux. Contacts	CRD316T33WA12S21			0H9360THB0
1600[1]	600	No Accessories	CRD316T33W	C	R-FRAME	0H9361TH00
		Shunt Trip & Aux. Contacts	CRD316T33WA12S21			0H9361THB0
2000[1]	600	No Accessories	CRD320T33W	C	R-FRAME	0H9367TH00
		Shunt Trip & Aux. Contacts	CRD320T33WA12S21			0H9367THB0

[1] LS-type electronic trip breaker

[2] S4 = 12VDC
[2] S1 = 24VDC

[3] B0 = 12VDC
[3] C0 = 24VDC

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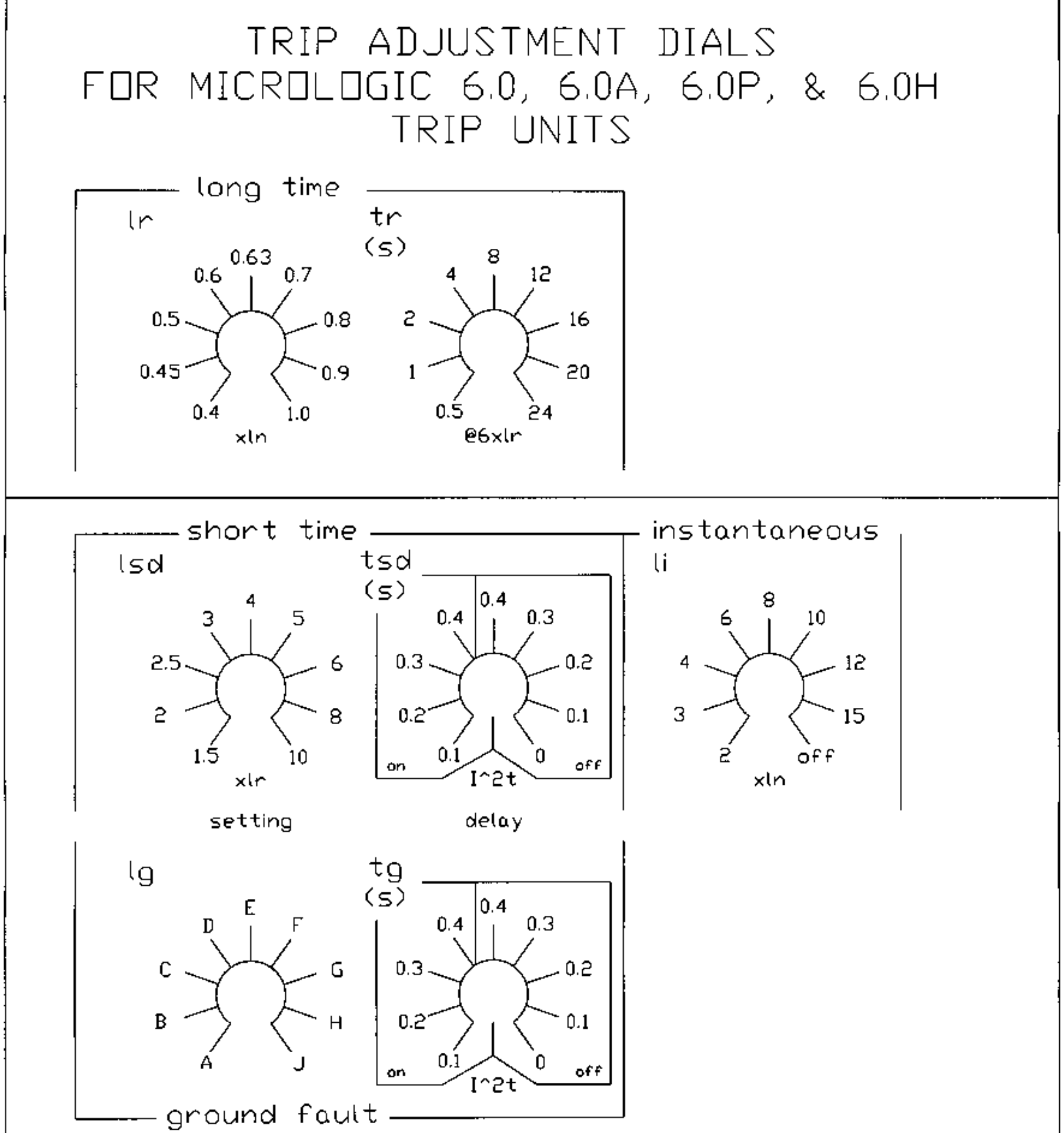


Notes

In = sensor
Ir = long time pickup setting
tr = long time delay setting
Isd = short time pickup setting
tsd = short time delay setting
Ii = instantaneous setting

Ig = ground fault pickup setting
tg = ground fault delay setting

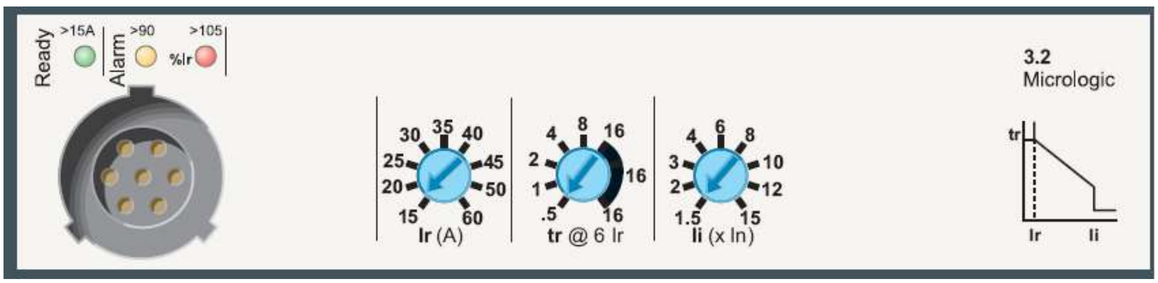
1) Eight interchangeable rating plugs are available to limit the long-time pickup setting range for greater versatility. (Type A is the standard plug and corresponds to settings shown above.)

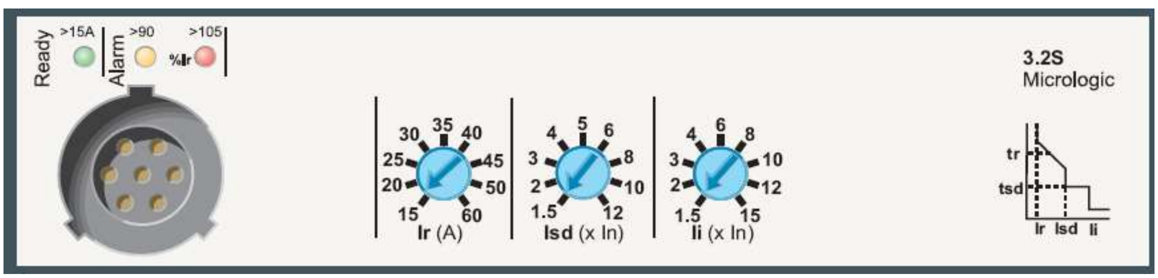
2) P and H trip units also have protective relay features and selectable long-time delay bands such as I^4 T. These settings are programmed in through a keypad or computer link.

Trip Dials for H-, J-Frame Micrologic 3.2 & 3.2S

The following dial descriptions may be applicable for Micrologic 3.2 & 3.2S trip units.

Sensor rating is **In**
Long-time pickup protection adjustment dial **Ir**
Long-time delay protection adjustment dial **tr**
Short-time pickup protection adjustment dial **Isd**
Instantaneous protection adjustment dial **Ii**



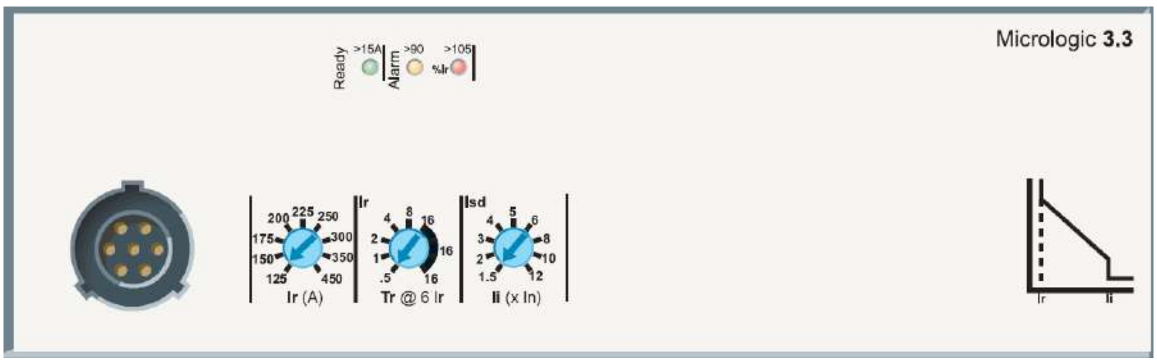


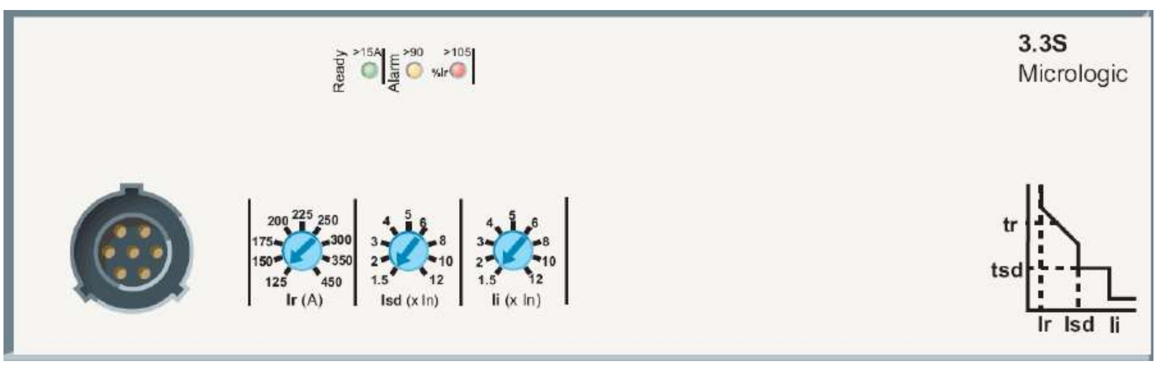
For more information on how to set these trip units, please refer to the User Guide 48940-313-01.

Trip Dials for L-Frame Micrologic 3.3 & 3.3S

The following dial descriptions may be applicable for Micrologic 3.3 & 3.3S trip units.

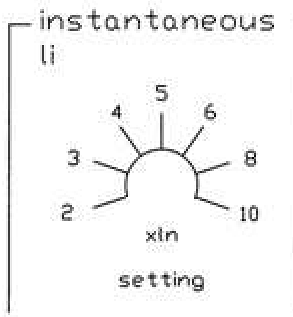
Sensor rating is **In**
Long-time pickup protection adjustment dial **Ir**
Long-time delay protection adjustment dial **tr**
Short-time pickup protection adjustment dial **Isd**
Instantaneous protection adjustment dial **Ii**



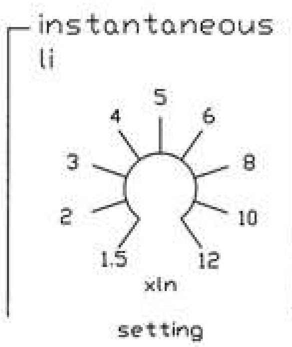


For more information on how to set these trip units, please refer to the User Guide 48940-313-01.

TRIP ADJUSTMENT DIAL
FOR M-FRAME, ET1.0

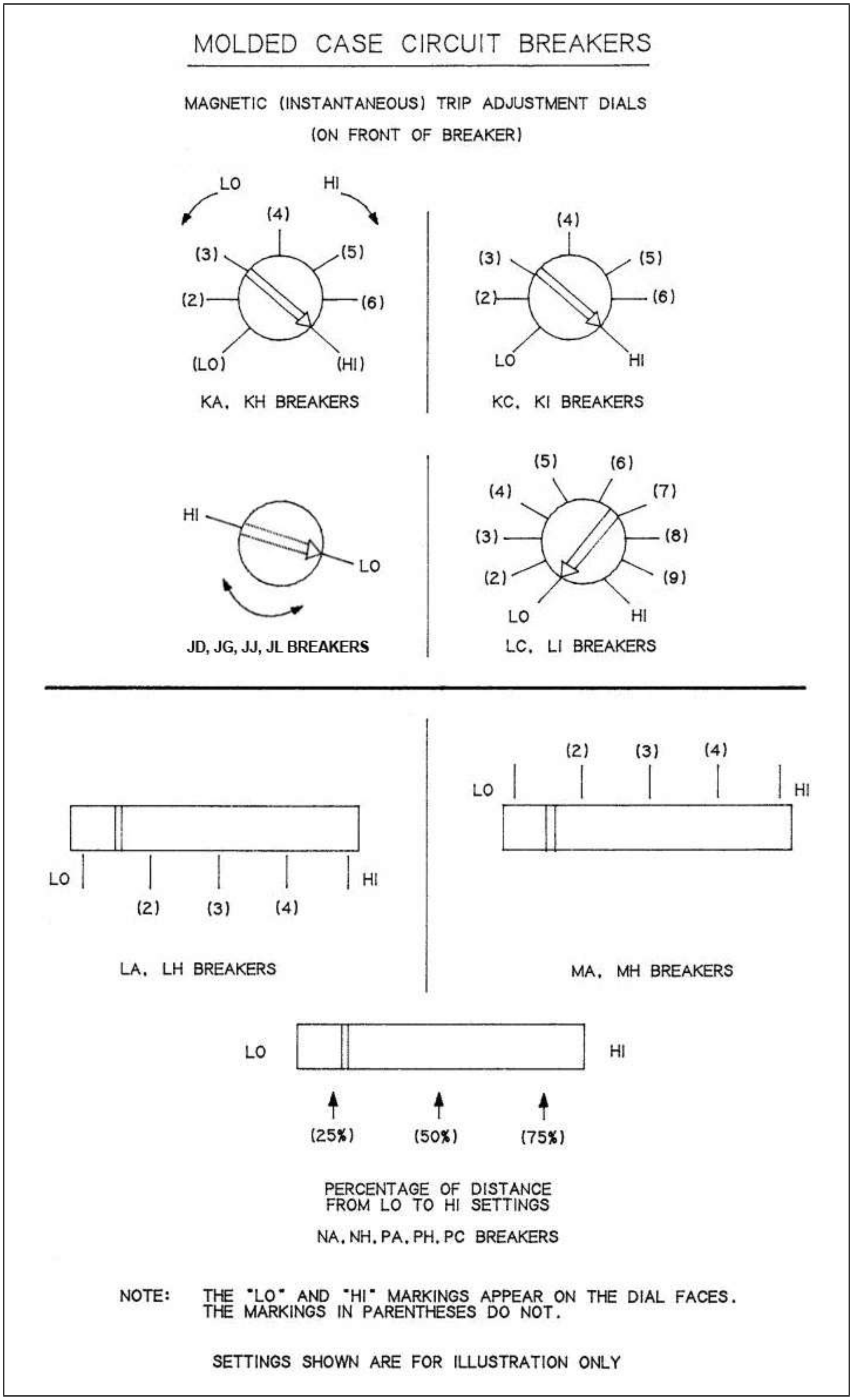


TRIP ADJUSTMENT DIAL
FOR P- AND R-FRAME, ET1.0I

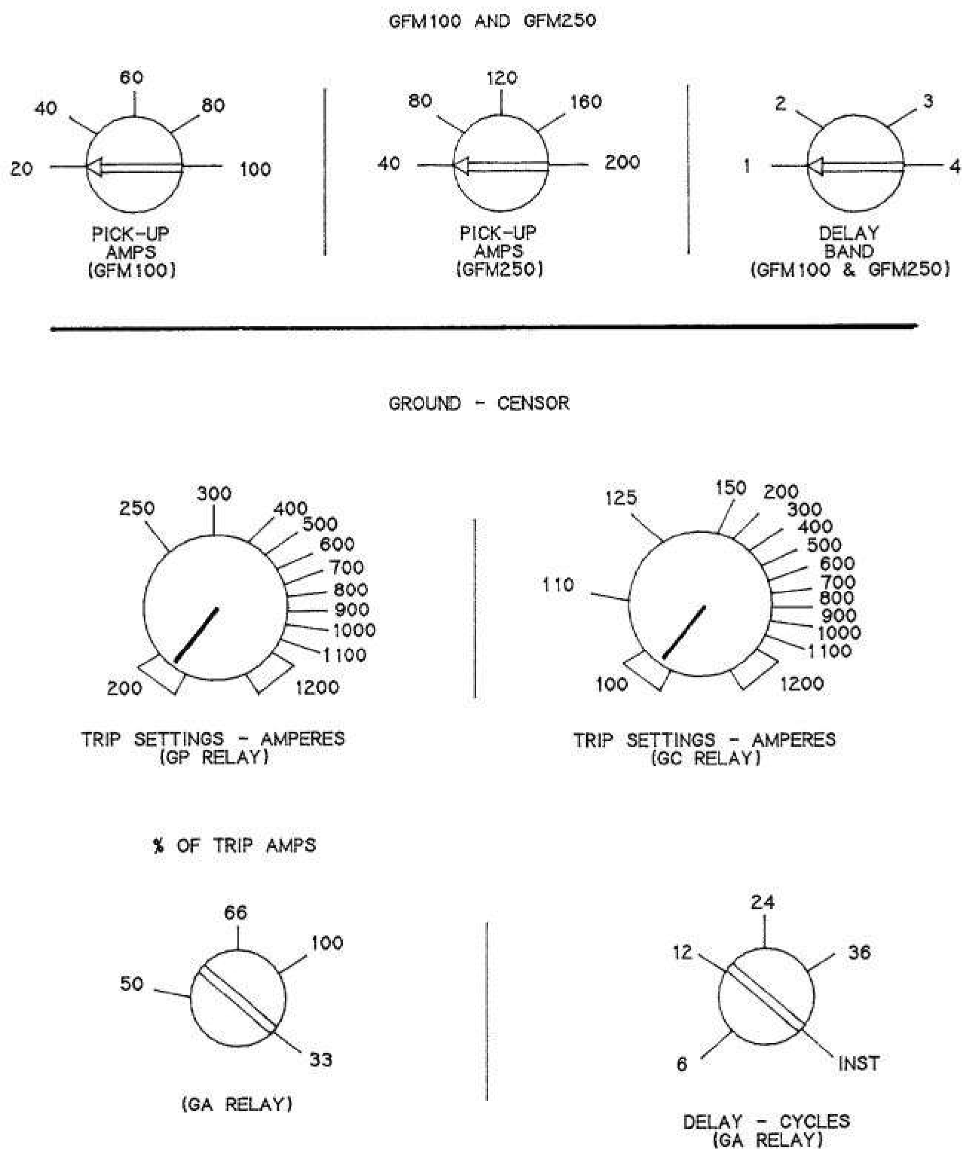


Notes

Ii = instantaneous setting


MOLDED CASE CIRCUIT BREAKERS
MAGNETIC (INSTANTANEOUS) TRIP ADJUSTMENT DIALS
(ON FRONT OF BREAKER)
LO
HI
(4)
(3)
(5)
(2)
(6)
(LO)
(HI)
KA, KH BREAKERS
(4)
(3)
(5)
(2)
(6)
LO
HI
KC, KI BREAKERS
HI
LO
JD, JG, JJ, JL BREAKERS
(5)
(6)
(4)
(7)
(3)
(8)
(2)
(9)
LO
HI
LC, LI BREAKERS
LO
HI
(2)
(3)
(4)
LA, LH BREAKERS
(2)
(3)
(4)
LO
HI
MA, MH BREAKERS
LO
HI
(25%)
(50%)
(75%)
PERCENTAGE OF DISTANCE
FROM LO TO HI SETTINGS
NA, NH, PA, PH, PC BREAKERS
NOTE: THE "LO" AND "HI" MARKINGS APPEAR ON THE DIAL FACES.
THE MARKINGS IN PARENTHESES DO NOT.
SETTINGS SHOWN ARE FOR ILLUSTRATION ONLY

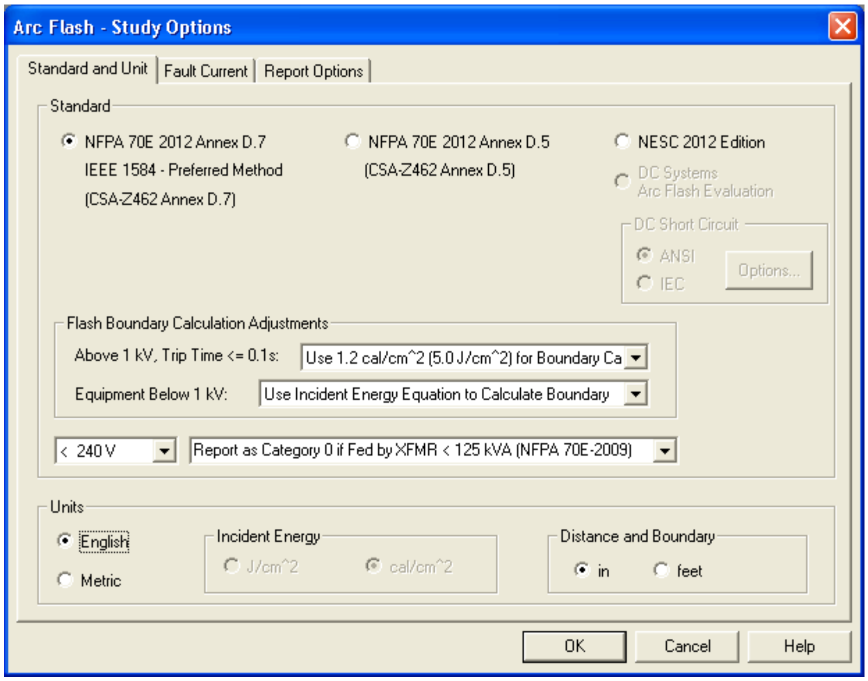
GROUND FAULT MODULE TRIP ADJUSTMENT DIALS

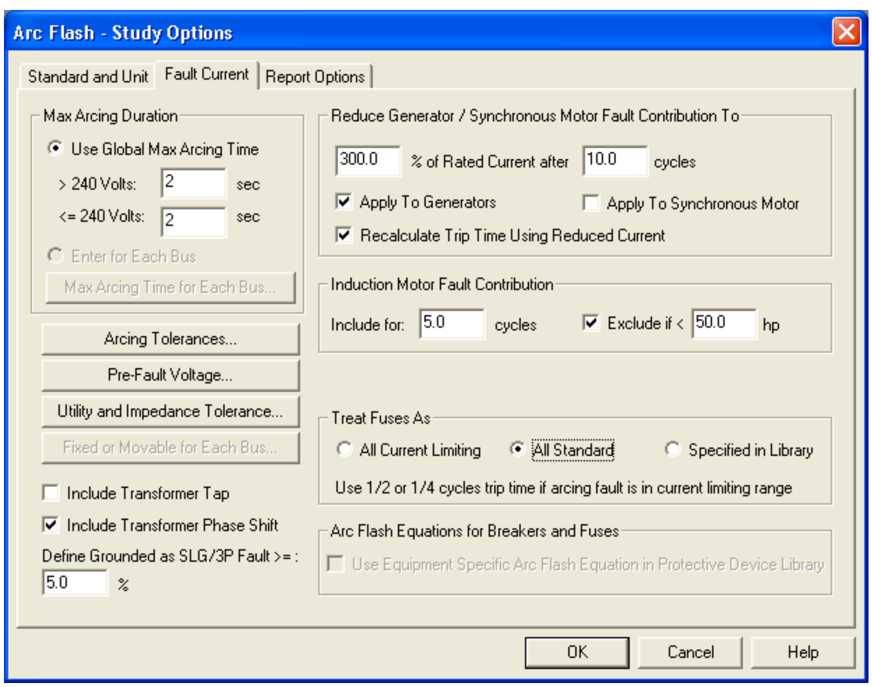


NOTE: THE MARKINGS IN PARENTHESES DO NOT APPEAR ON THE DIAL FACE

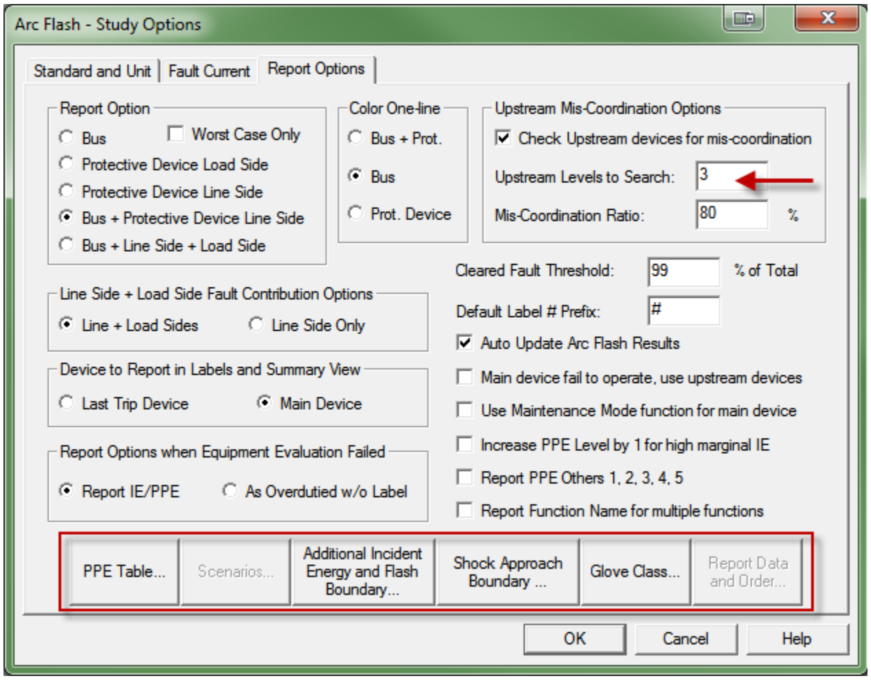
SETTINGS SHOWN ARE FOR ILLUSTRATION ONLY

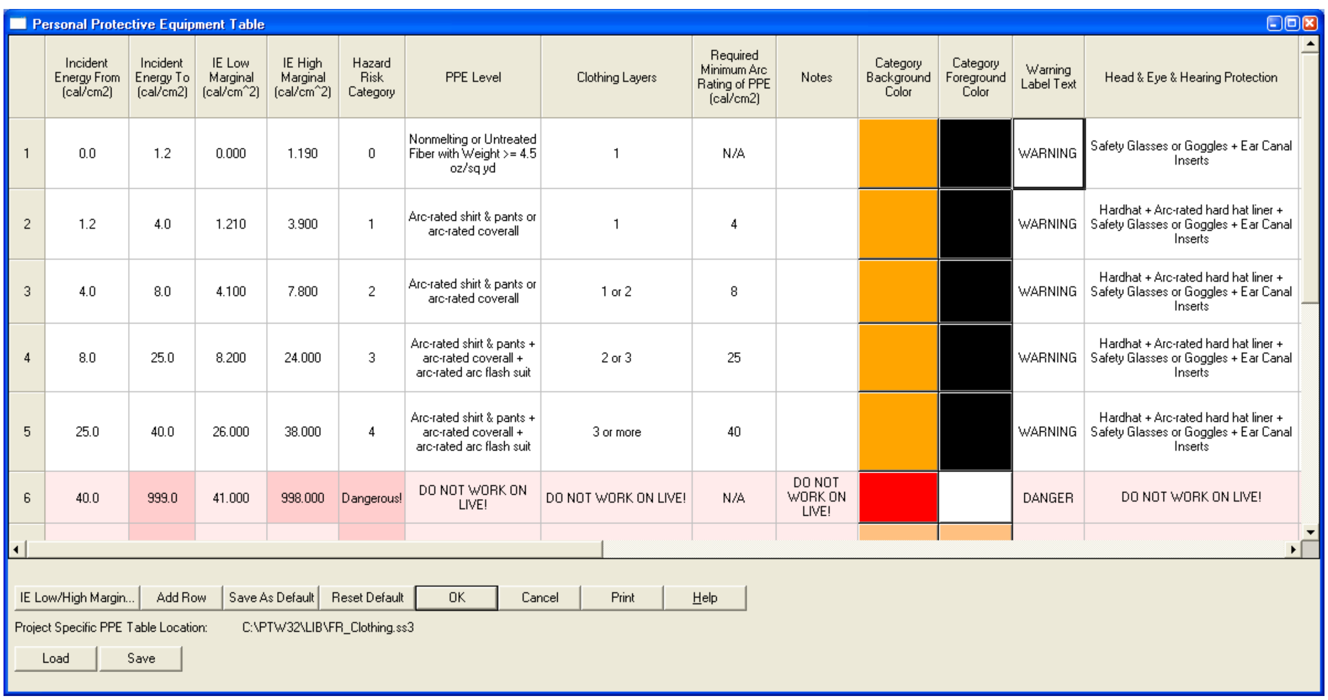
STANDARD ARC FLASH STUDY OPTIONS – SKM





Per the IEEE 1584 Standard, LV arcing fault current tolerances are -15% (Low) and 0% (High).
No Load with Tap was used for the Pre-fault voltage Option
No other tolerances were considered, unless written up in this report.





Personal Protective Equipment Table

	Incident Energy From (cal/cm2)	Incident Energy To (cal/cm2)	IE Low Marginal (cal/cm^2)	IE High Marginal (cal/cm^2)	Hazard Risk Category	PPE Level	Clothing Layers	Required Minimum Arc Rating of PPE (cal/cm2)	Notes	Category Background Color	Category Foreground Color	Warning Label Text	Head & Eye & Hearing Protection
1	0.0	1.2	0.000	1.190	0	Nonmelting or Untreated Fiber with Weight >= 4.5 oz/sq yd	1	N/A				WARNING	Safety Glasses or Goggles + Ear Canal Inserts
2	1.2	4.0	1.210	3.900	1	Arc-rated shirt & pants or arc-rated coverall	1	4				WARNING	Hardhat + Arc-rated hard hat liner + Safety Glasses or Goggles + Ear Canal Inserts
3	4.0	8.0	4.100	7.800	2	Arc-rated shirt & pants or arc-rated coverall	1 or 2	8				WARNING	Hardhat + Arc-rated hard hat liner + Safety Glasses or Goggles + Ear Canal Inserts
4	8.0	25.0	8.200	24.000	3	Arc-rated shirt & pants + arc-rated coverall + arc-rated arc flash suit	2 or 3	25				WARNING	Hardhat + Arc-rated hard hat liner + Safety Glasses or Goggles + Ear Canal Inserts
5	25.0	40.0	26.000	38.000	4	Arc-rated shirt & pants + arc-rated coverall + arc-rated arc flash suit	3 or more	40				WARNING	Hardhat + Arc-rated hard hat liner + Safety Glasses or Goggles + Ear Canal Inserts
6	40.0	999.0	41.000	998.000	Dangerous!	DO NOT WORK ON LIVE!	DO NOT WORK ON LIVE!	N/A	DO NOT WORK ON LIVE!			DANGER	DO NOT WORK ON LIVE!

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Project Specific PPE Table Location: C:\PTW32\LIB\FR_Clothing.ss3

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FROM NFPA 70E – 2012 EDITION

Table 130.4(C)(a) Approach Boundaries to Energized Electrical Conductors or Circuit Parts for Shock Protection for Alternating-Current Systems (All dimensions are distance from energized electrical conductor or circuit part to employee.)

(1)	(2)	(3)	(4)	(5)
	Limited Approach Boundary[b]			
Nominal System Voltage Range, Phase to Phase[a]	Exposed Movable Conductor[c]	Exposed Fixed Circuit Part	Restricted Approach Boundary[b]; Includes Inadvertent Movement Adder	Prohibited Approach Boundary[b]
Less than 50	Not specified	Not specified	Not specified	Not specified
50 to 300	3.0 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	Avoid contact	Avoid contact
301 to 750	3.0 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	0.3 m (1 ft 0 in.)	25 mm (0 ft 1 in.)
751 to 15 kV	3.0 m (10 ft 0 in.)	1.5 m (5 ft 0 in.)	0.7 m (2 ft 2 in.)	0.2 m (0 ft 7 in.)
15.1 kV to 36 kV	3.0 m (10 ft 0 in.)	1.8 m (6 ft 0 in.)	0.8 m (2 ft 7 in.)	0.3 m (0 ft 10 in.)
36.1 kV to 46 kV	3.0 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	0.8 m (2 ft 9 in.)	0.4 m (1 ft 5 in.)
46.1 kV to 72.5 kV	3.0 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	1.0 m (3 ft 3 in.)	0.7 m (2 ft 2 in.)
72.6 kV to 121 kV	3.3 m (10 ft 8 in.)	2.5 m (8 ft 0 in.)	1.0 m (3 ft 4 in.)	0.8 m (2 ft 9 in.)
138 kV to 145 kV	3.4 m (11 ft 0 in.)	3.0 m (10 ft 0 in.)	1.2 m (3 ft 10 in.)	1.0 m (3 ft 4 in.)
161 kV to 169 kV	3.6 m (11 ft 8 in.)	3.6 m (11 ft 8 in.)	1.3 m (4 ft 3 in.)	1.1 m (3 ft 9 in.)
230 kV to 242 kV	4.0 m (13 ft 0 in.)	4.0 m (13 ft 0 in.)	1.7 m (5 ft 8 in.)	1.6 m (5 ft 2 in.)
345 kV to 362 kV	4.7 m (15 ft 4 in.)	4.7 m (15 ft 4 in.)	2.8 m (9 ft 2 in.)	2.6 m (8 ft 8 in.)
500 kV to 550 kV	5.8 m (19 ft 0 in.)	5.8 m (19 ft 0 in.)	3.6 m (11 ft 10 in.)	3.5 m (11 ft 4 in.)
765 kV to 800 kV	7.2 m (23 ft 9 in.)	7.2 m (23 ft 9 in.)	4.9 m (15 ft 11 in.)	4.7 m (15 ft 5 in.)

Note: For arc flash boundary, see 130.5(A).

[a] For single-phase systems, select the range that is equal to the system's maximum phase-to-ground voltage multiplied by 1.732.

[b] See definition in Article 100 and text in 130.4(D)(2) and Annex C for elaboration.

[c] This term describes a condition in which the distance between the conductor and a person is not under the control of the person. The term is normally applied to overhead line conductors supported by poles.

FROM INFORMATIVE ANNEX H, NFPA 70E – 2012 EDITION

Table H.3(b) Guidance on Selection of Arc-Rated Clothing and Other Personal Protective Equipment (PPE) for Use When Incident Exposure is Determined by a Hazard Analysis

Incident Energy Exposure	Protective Clothing and PPE
Less than or Equal to 1.2 cal/cm²	
Protective clothing, nonmelting (in accordance with ASTM F 1506-08) or untreated natural fiber	Shirt (long sleeve) and pants (long) or coverall
Other personal protective equipment	Face shield for projectile protection (AN) Safety glasses or safety goggles (SR) Hearing protection Heavy-duty leather gloves or rubber insulating gloves with leather protectors (AN)
Greater than 1.2 to 12 cal/cm2	
Arc-rated clothing and equipment with an arc rating equal to or greater than the incident energy determined in a hazard analysis *(See Note 3.)*	Arc-rated long-sleeve shirt and arc-rated pants or arc-rated coverall or arc flash suit (SR) *(See Note 3.)* Arc-rated face shield and arc-rated balaclava or arc flash suit hood (SR) *(See Note 1.)* Arc-rated jacket, parka, or rainwear (AN)
Other personal protective equipment	Hard hat Arc-rated hard hat liner (AN) Safety glasses or safety goggles (SR) Hearing protection Heavy-duty leather gloves or rubber insulating gloves with leather protectors (SR) *(See Note 4.)* Leather work shoes
Greater than 12 cal/cm² Task tables in 70E list requirements for protective clothing and other protective equipment when working within the arc flash boundary for incident energy equaling **40 cal/cm²**, and below.	
Arc-rated clothing and equipment with an arc rating equal to or greater than the incident energy determined in a hazard analysis *(See Note 3.)*	Arc-rated long-sleeve shirt and arc-rated pants or arc-rated coverall and/or arc flash suit (SR) Arc-rated arc flash suit hood Arc-rated gloves Arc-rated jacket, parka, or rainwear (AN)
Other personal protective equipment	Hard hat Arc-rated hard hat liner (AN) Safety glasses or safety goggles (SR) Hearing protection Arc-rated gloves or rubber insulating gloves with leather protectors (SR) *(See Note 4.)* Leather work shoes

AN: As needed [in addition to the protective clothing and PPE required by 130.5(B)(l)].

SR: Selection of one in group is required by 130,5(B)(l).

Notes:

(1) Face shields with a wrap-around guarding to protect the face, chin, forehead, ears, and neck area are required by 130.8(C)(10)(c). For full head and neck protection, use a balaclava or an arc flash hood.

(2) All items not designated "AN" are required by 130.7(C).

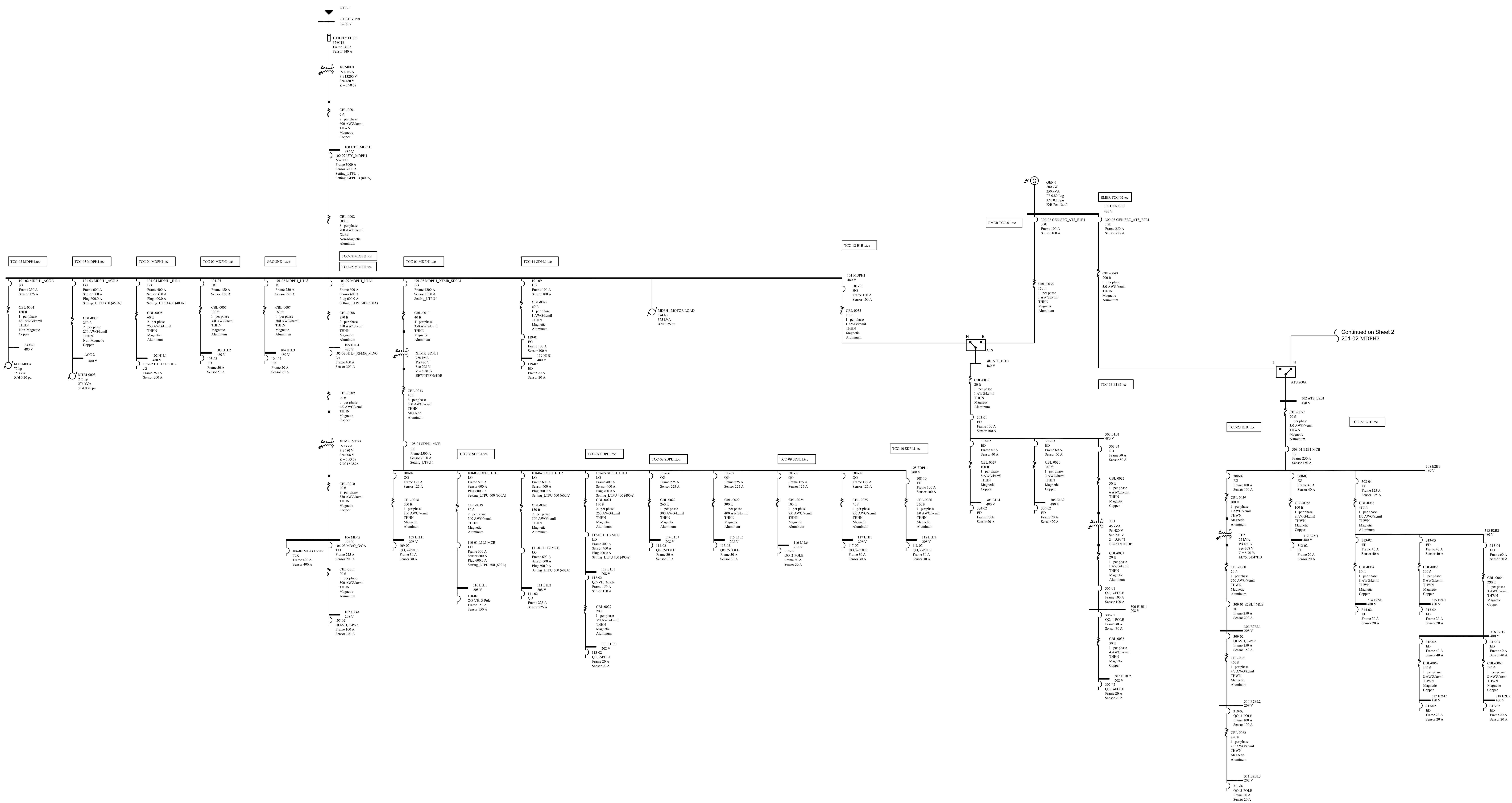
(3) Arc ratings can be for a single layer, such as an arc-rated shirt and pants or a coverall, or for an arc flash suit or a multi-layer system consisting of a combination of arc-rated shirt and pants, coverall, and arc flash suit.
(4) Rubber insulating gloves with leather protectors provide arc flash protection in addition to shock protection. Higher class rubber insulating gloves with leather protectors, due to their increased material thickness, provide increased arc flash protection.

PROJECT RECOMMENDATION & ACTION TABLE

Action No.	Recommendation	Action	Person Assigned	Due Date
1	De-energize Equipment	Create a policy to only work on electrical equipment when the system has been de-energized.		
2	Establish Arc Flash Training Program	1) Develop training routine for each employee. 2) Train employees to know the difference between a qualified and an unqualified employee. 3) Post and enforce all arc flash policies based upon customer's training program.		
3	Project Management	Recommend keeping accurate records on system changes and re-evaluate arc flash results every 5 years. Failure to do this may invalidate the arc flash results.		
4	Provide and Train Employees on PPE	Equip all employees with proper PPE and train them about the various types of required PPE to work on energized equipment where an arc flash hazard may be present.		
5	Implement a Formal Maintenance Program	Inspect, test, and maintain all electrical equipment based upon O&M manuals provided with each individual piece of equipment.		
6	System One-Line Diagram Management Program	Establish a routine program of updating all one-line diagrams associated with the electrical system to be used for future reference as well as lockout-tagout procedures and other system maintenance.		

This table is a summary of various recommendations to implement a training and maintenance program for an electrical system. It is to be used in conjunction with NFPA, OSHA, and other industry recommendations for safety and maintenance of an electrical system.

APPENDIX E: SYSTEM STUDY ONE-LINE DIAGRAM



Schneider Electric

SCHNEIDER ELECTRIC
ENGINEERING SERVICES, LLC
106 MERCER RD
LEXINGTON, KY 40511

NOTES:

1) ALL LOW-VOLTAGE CABLES WERE CONSIDERED TO BE TYPE THHN, SINGLE CONDUCTOR COPPER, RUN IN STEEL CONDUIT, UNLESS OTHERWISE NOTED.
2) ALL DEVICES WERE CONSIDERED TO BE THREE-POLE UNLESS OTHERWISE NOTED.
3) * = DENOTES THE VALUE WAS ASSUMED.
4) KVAm = CONNECTED MOTOR KVA USED FOR FAULT CALCULATIONS (1 HP=1 KVAm).
5) AF DENOTES AMPERE FRAME RATING
AS DENOTES AMPERE SENSOR RATING
AP DENOTES AMPERE PLUG RATING
AT DENOTES AMPERE TRIP RATING
6) L DENOTES LONG TIME FUNCTION
S DENOTES SHORT TIME FUNCTION
I DENOTES INSTANTANEOUS FUNCTION
G DENOTES GROUND FUNCTION

REVISIONS

REV	DATE	DESCRIPTION	DRAWN	CHKD
8				
7				
6				
5				
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Kelly Walsh HS

Casper,WY

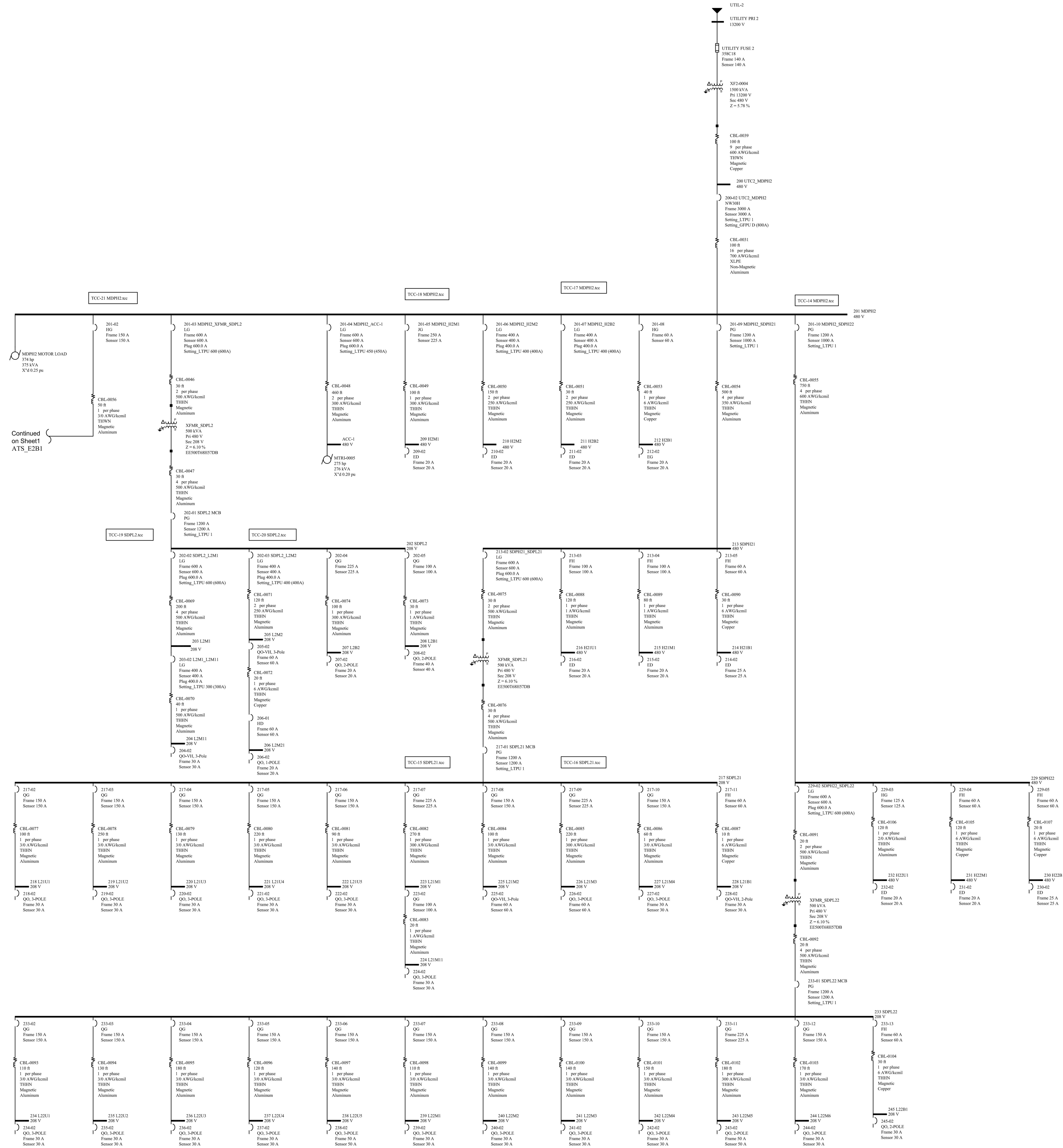
Additional Info

DRAWN BY:	CB
CHECKED BY:	CB
DATE:	07-18-2014
SCALE:	NTS

PROJECT NO.
34765053

ONE-LINE DIAGRAM

SHEET NO.
1 OF 2



Continued on Sheet1 ATS_E2B1

SCHNEIDER ELECTRIC ENGINEERING SERVICES, LLC
106 MERCER RD
LEXINGTON, KY 40511

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ONE-LINE DIAGRAM

SHEET NO.
2 OF 2