



Power System Analysis
CBBT- SUPPORT BLDG EMG POWER SYSTEM UPGRADES
CAPE CHARLES, VA

Life Is On

Schneider
Electric

POWER SYSTEM ANALYSIS**CBBT- SUPPORT BLDG EMG POWER SYSTEM UPGRADES
CAPE CHARLES, VA**

Prepared by
Nikita Thapliyal
under the supervision and direct control of
Lauren Elizabeth Bersano, P.E.
Schneider Electric Engineering Services, LLC
Virginia Firm No. 0407005220 (Main Office Lexington, KY)

Job Number	Rev.	Date	Description	Prepared By
Q2C: 50204245	-	May 6, 2024	SC, TCC	NIT
	1	September 18, 2024	SC, TCC & AF	NIT
	2	-	-	-

This document has been authorized for release by the engineer whose seal and signature are hereto affixed. Altering this document is unlawful unless performed by or under the direction of a licensed professional engineer. Any changes shall be described and the engineer authorizing such alterations shall seal, sign, and date the revised document.

For Information, contact StudiesSupport.PSE@se.com



09/19/2024

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. 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.

The stylized trademarks "Square D" and "Schneider Electric" and any other trademarks and trade names that are the property of Schneider Electric USA, Inc are used by permission.

TABLE OF CONTENTS

1	EXECUTIVE SUMMARY	5
1.1	OVERVIEW	5
1.2	REVISION HISTORY	5
1.3	STUDY RECOMMENDATIONS	6
1.4	STUDY HIGHLIGHTS	8
1.4.1	SHORT-CIRCUIT	8
1.4.2	COORDINATION	9
1.4.3	ARC FLASH	10
2	INTRODUCTION	11
3	STUDY DATA	12
3.1	IMPORTANCE	12
3.2	ESTIMATES & ASSUMPTIONS	13
4	SHORT-CIRCUIT ANALYSIS	14
4.1	GENERAL PROCEDURE	14
4.2	DATA USED IN THE CALCULATIONS	17
4.2.1	POWER COMPANY DATA	17
4.2.2	GENERATOR DATA	17
4.2.3	TRANSFORMER DATA	17
4.2.4	MOTOR CONTRIBUTION TO SHORT-CIRCUIT CURRENT	18
4.3	SHORT-CIRCUIT ANALYSIS RESULTS	20
4.4	SHORT-CIRCUIT EVALUATION TABLE	21
5	OVERCURRENT DEVICE COORDINATION ANALYSIS	23
5.1	GENERAL PROCEDURE	23
5.2	SPECIFIC PROCEDURE	24
5.2.1	SHORT-CIRCUIT CURRENT CONSIDERATIONS	24
5.2.2	MOLDED CASE BREAKER COORDINATION	24
5.2.3	MOTOR CONTROL CENTER INSTANTANEOUS TRIP BREAKERS	25

5.2.4	LOW-VOLTAGE GROUND FAULT RELAY SETTINGS	28
5.2.5	TRANSFORMER PROTECTIVE DEVICES.....	29
5.2.6	CABLE PROTECTION	30
5.3	OVERCURRENT DEVICE COORDINATION ANALYSIS RESULTS	31
5.4	OVERCURRENT DEVICE SETTING TABLE.....	32
5.5	TIME-CURRENT COORDINATION GRAPHS	39
6	ARC FLASH HAZARD ANALYSIS.....	63
6.1	GENERAL PROCEDURE	63
6.2	SPECIFIC PROCEDURE.....	65
6.3	AF HAZARD ANALYSIS RESULTS.....	69
6.3.1	COMMON ARC FLASH HAZARD TABLE TERMS	70
6.3.2	PROTECTIVE ARC RATED (AR) CLOTHING CHARACTERISTICS.....	71
6.3.3	ARC FLASH HAZARD ANALYSIS TABLE – RECOMMENDED SETTINGS	75
6.4	POWER SYSTEM ENGINEERING ARC FLASH LABELING PRACTICE.....	77
6.4.1	ARC FLASH INFORMATION LABELS	77
6.4.2	GENERAL SAFETY LABELS.....	78
	APPENDIX A: ABBREVIATIONS AND TRADEMARKS	81
	APPENDIX B: SHORT CIRCUIT INPUT/OUTPUT DATA	84
	APPENDIX C: REFERENCES	127
	APPENDIX D: SYSTEM STUDY ONE-LINE DIAGRAM	157

1 EXECUTIVE SUMMARY

1.1 Overview

This report documents the results of a Power System Engineering analysis for CBBT-SUPPORT BLDG EMG POWER SYSTEM UPGRADES in CAPE CHARLES, VA. 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 new equipment shown on the study one-line diagram located in the back of the report. Packaged end-use equipment (e.g., elevators, HVAC, etc.) should be installed per manufacturer requirements, and the sizing of the maximum overcurrent protection (MOCP) device and wiring based on minimum circuit ampacity (MCA) is outside the scope of this study.

1.2 Revision History

Revision 1

- Updated generator data
- Updated cable lengths
- Updated Short-Circuit table and input/output report
- Updated TCC's, and Device Settings Table
- Added Arc Flash Analysis
- Updated reference documents
- Updated One-line

1.3 Study Recommendations

Priority Guidance for Recommendations:

Required – High priority issues to be resolved now involving NEC, Arc Flash, or customer specifications.

Advised – Medium priority issues that should be considered, and/or would be significant improvements.

Noted – Low priority enhancements or general comments.



POWER SYSTEM ENGINEERING

RECOMMENDATIONS TABLE

CBBT- SUPPORT BLDG EMG POWER SYSTEM UPGRADES
CAPE CHARLES, VA
REFER TO DRAWINGS

Item #	Priority	Description	Reference	BOM Change	Recommendation
1	Medium	Over 40 cal/cm2	1100 EMCC #B1 1300 EMCC #B2 1500 EMCC #B3 1700 EMCC #B4		While not required, avoidance solutions can minimize the exposure of electrical workers to arc-flash hazards without lowering the AFIE. Traditional avoidance solutions are generally limited in flexibility and scalability, therefore advanced remote monitoring (e.g., EcoStruxure Asset Advisor) is recommended, if a solution is desired.

1.4 Study Highlights

1.4.1 Short-Circuit

Of the 8 device locations evaluated for adequacy to interrupt or withstand the maximum three-phase short-circuit current to which they could be subjected, all were identified to be ADEQUATE.

1.4.2 Coordination

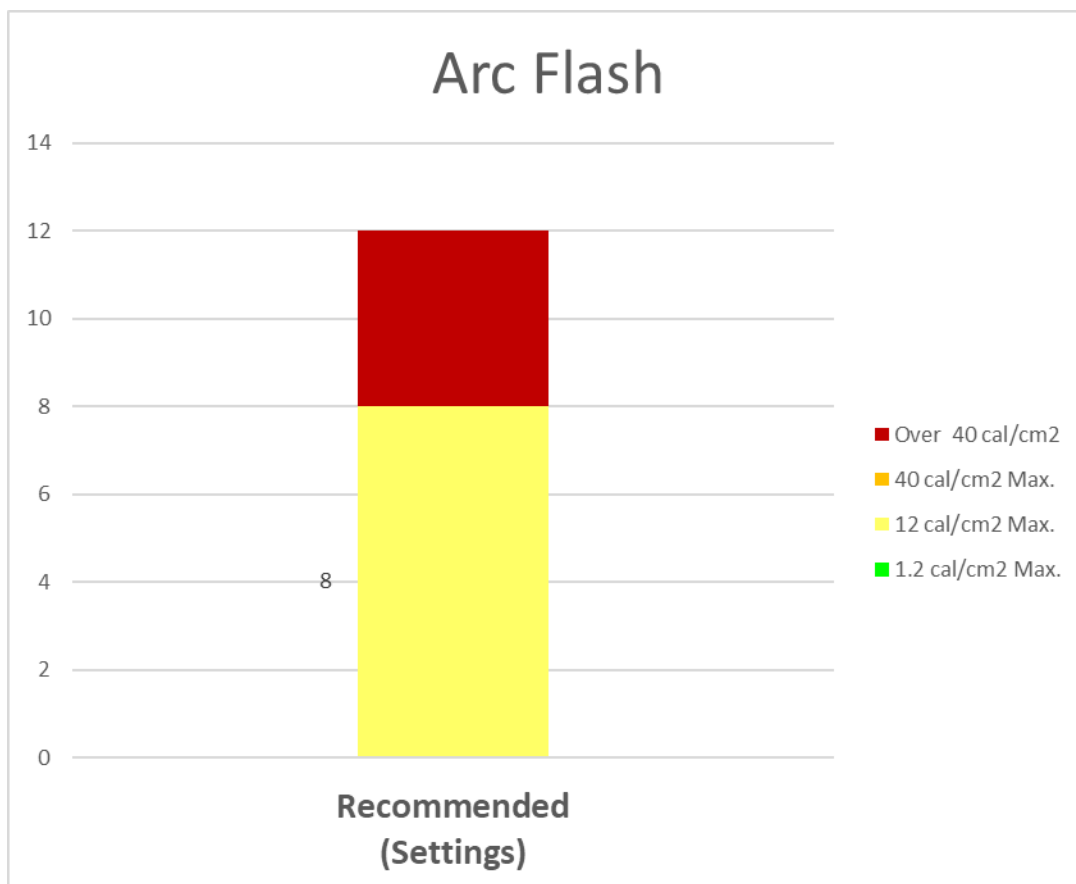
Setting recommendations have been made for adjustable devices to ensure optimum selectivity, or protect equipment. Time-current coordination (TCC) graphs were used to perform the evaluation for the overcurrent devices. Overall, the results showed that acceptable levels of selectivity were achieved among devices in the system.

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

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. When selective coordination, per NEC 700, is required, further analysis beyond the scope of this study will be necessary as well as possible equipment construction or design changes.

1.4.3 Arc Flash

Equipment was analyzed to determine the level of arc flash incident energy to which a worker might be exposed during an arc flash event. The graph below shows the number of pieces of equipment for each IE level denoted in the key. It is not recommended to perform work on energized equipment.



Graph of arc flash hazard incident energy occurrence

Regardless of which IE calorie breakpoint levels are favored, or which NFPA 70E PPE selection table is used in this facility, a common approach is to use a clothing system with protection at 8 cal/cm² and 40 cal/cm². This method simplifies what workers must select/wear as well as what companies must issue to their employees and most importantly, will comply with NFPA 70E.

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

2 INTRODUCTION

This report has the following components:

- ☑ Studies were performed using nationally recognized electrical engineering analysis software.
- ☑ 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 arc flash analysis establishes the arc flash boundary around electrical equipment within which a worker exposed to an arcing fault would expect to receive 2nd 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 STUDY DATA

3.1 Importance

The results of the study analyses are highly dependent on the accuracy of study data. Modifications or clarifications of study data will likely alter study results. This study recommends a re-evaluation actual primary utility fault current information.

3.2 Estimates & Assumptions

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. Utility fault current, (see Section 4.2.1 for details).
2. Assumed Motor ratings shown in orange color on the oneline were assumed as per the upstream breaker size.
3. BUS-1 is the preferred source of utility power to EMCC for the buildings as mentioned in the customer oneline.

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 calculates 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/IEC standards: 399 (Brown Book), 551 (Violet Book), 62271-37-013 (supersedes C37.013), C37.04, C37.13, & C37.010.

The modeling 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 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.

For equipment supplied from more than one source, there is no industry standard that defines hard requirements for whether the equipment must be rated for the short-circuit contribution from all sources. The National Electrical Code requires that “consideration shall be given to the contribution of fault currents from all interconnected power sources for the interrupting and short-circuit current ratings of equipment on interactive systems”. This does not require full rating to the sum of source short-circuit contributions, but rather consideration of the specific application. It is common industry practice to allow equipment which parallels sources for only very short windows of time – typically during closed-transition load transfers between sources – to have short-circuit/interrupting ratings suitable for the short-circuit contribution from the single source with the highest available fault current. The paralleling time may be limited to a specific value, such as 100ms, by the serving utility, or may otherwise be undefined but presumed to have no intentional paralleling delay and thus be approximately 100ms, or less. The value of 100ms is also mentioned in IEEE 1547-2018 as a paralleling time below which that standard does not apply to other than application with utility network systems.

In this analysis, equipment supplied by multiple sources where there is a reasonable expectation of “no intentional paralleling delay”, the highest single-source fault duty is given as the basis of adequacy of short-circuit withstand/interrupting ratings. This is not intended to construe that all risks due to faults in different locations relative to the equipment during a paralleled condition have been evaluated, but rather as a tool to allow the system designer to perform such evaluation. It is advised that a means of limiting the paralleling time to approximately 100ms, outside of an automation controller, PLC, or similar device, be considered in the over-all mitigation of risk. Further, this is not intended to construe that all utility restrictions on paralleling time have been met; such considerations are within the purview of the system designer and beyond the scope of this study.

For equipment supplied by multiple sources where there is not a reasonable expectation of “no intentional paralleling delay”, such as sources that are intentionally paralleled continuously or for a finite period of time for soft load transfers, the full short-circuit contribution from all sources of supply is used as the basis for adequacy of short-circuit withstand/interrupting ratings.

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

For buildings #1, #2, #3 and #4

The maximum available three-phase short-circuit current was assumed to be 80kA at 13.8kV. An X/R ratio of 12 was assumed for this current. This short-circuit current approximates an infinite utility source and determined the starting point for the short-circuit analysis. No minimum or alternate switching levels were given.

Service transformer was determined to be 1000kVA, with 5.7% impedance & assumed. X/R ratio as 7. Refer to Appendix C References for more details.

4.2.2 Generator Data

It has been assumed that the 500kW generator has a subtransient reactance of 10% with an 80% PF and an assumed X/R ratio of 20 at 600V. 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 Transformer Data

Schneider Electric transformer percent impedance and typical X/R ratio values were used for all LV transformers. The exact R and X component values used are shown in the SHORT CIRCUIT INPUT/OUTPUT DATA appendix.

4.2.4 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.

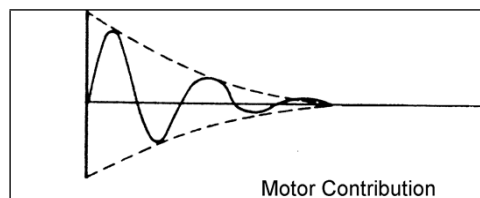


Figure 1: Example motor contribution.

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, a fault contribution of approximately 4 times rated current, is estimated. Larger motors (50 hp and above) have an estimated fault contribution of approximately 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 SC Computer Input Tabulations appendix, 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 in the appendices.

4.3 Short-Circuit Analysis Results

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. When applicable, the bolted line-to-ground fault current was considered instead. The results are listed in the "SHORT-CIRCUIT EVALUATION TABLE".

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.

- For equipment evaluation, 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 found in industry standards. Refer to the Summary of Test Power Factor and X/R Values for LV Devices table in the General Procedure section for more information.

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

A separate short-circuit analysis was not performed on the system when energized from the 500kW emergency generator. A design evaluation confirmed the distribution equipment is adequate to interrupt or withstand the generator short-circuit current.

4.4 Short-Circuit Evaluation Table



POWER SYSTEM ENGINEERING

SHORT-CIRCUIT
EVALUATION TABLE

CBBT- SUPPORT BLDG EMG POWER SYSTEM UPGRADES
CAPE CHARLES, VA
REFER TO DRAWINGS

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	#
1100	EMCC #B1	600	SCCR65	65,000	28,350	8.32			Adequate	
1110	T-ESB #B1 ECB	208	JD	25,000	4,871	1.55			Adequate	
1300	EMCC #B2	600	SCCR65	65,000	28,894	8.45			Adequate	
1310	T-ESB #B2 ECB	208	JD	25,000	4,860	1.54			Adequate	
1500	EMCC #B3	600	SCCR65	65,000	28,056	8.22			Adequate	
1510	T-ESB #B3 ECB	208	JD	25,000	4,869	1.56			Adequate	
1700	EMCC #B4	600	SCCR65	65,000	28,103	8.20			Adequate	
1710	T-ESB #B4 ECB	208	JD	25,000	4,803	1.55			Adequate	

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 establish 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.

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.

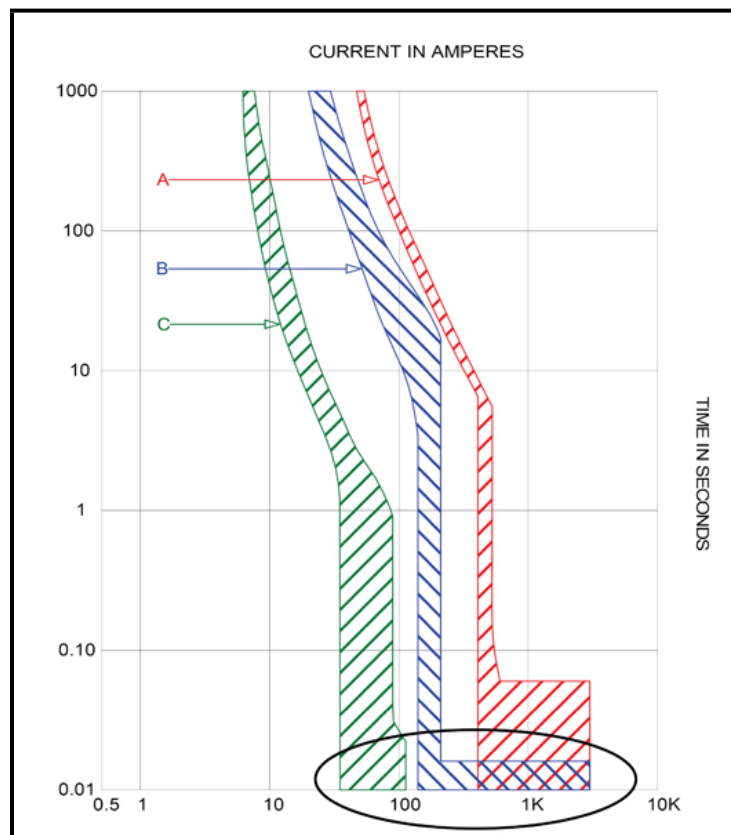


Figure 2: Example molded case breaker coordination.

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 Motor Control Center Instantaneous Trip Breakers

Specific settings are not suggested for the existing motor control center instantaneous trip circuit breakers, otherwise referred to as motor circuit protectors (MCPs). Instead, Schneider Electric Engineering Services, LLC assumes that they have been previously field adjusted per the following:

- The setting should be field adjusted just high enough to allow the motor to start without tripping the breaker and not exceed the NEC Article 430 guidelines for best protection.

Square D offers two different types of MCPs with one being a traditional type and another which is an electronic version, refer **Figure 3** below. Each one is discussed further, but both may or may not actually exist in this particular project.

Specific settings are not suggested for the motor control center MAG-GARD instantaneous trip circuit breakers. Instead, Schneider Electric Engineering Services, LLC recommends that they be field adjusted. All MAG-GARD breakers are automatically set at LO when shipped from the factory. The setting may need to be adjusted for proper motor startup. For best protection, it is suggested the final setting be field adjusted just high enough to allow the motor to start without tripping the breaker. However, when using this setting procedure, it should not be assumed a breaker tripped because of normal motor starting current - a fault or overload may indeed exist. Furthermore, the number of motor starts attempted within any time period should not exceed the motor manufacturer's recommendations. The final setting should not exceed the NEC guidelines given in Article 430.

Settings for the motor control center PowerPact electronic MCPs are shipped with default settings corresponding to the minimum FLA and **Auto 1**; however, these should be field adjusted based on the characteristics of the motor being protected.

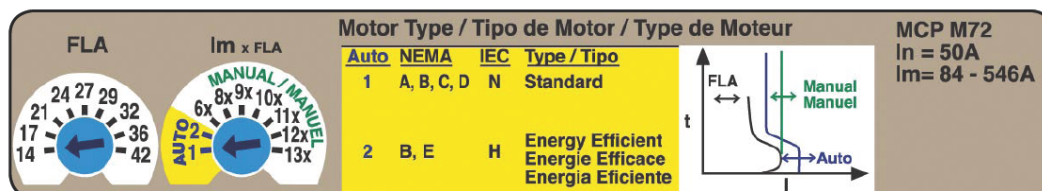


Figure 3: Example of MCP setting dial.

Schneider Electric Engineering Services, LLC recommends that the FLA dial (**Figure 3**) be set to match the nameplate data of the motor. If it does not match up exactly, then choose the next closest lower value. Additionally, the instantaneous dial ($I_m \times FLA$) can be set using either Auto settings or Manual mode.

1. Manual mode settings can be chosen for traditional motor protection from 600% to 1300% times the selected FLA and should follow the same approach described for MAG-GARD circuit breakers.

2. **Auto 1** can be used for Standard type NEMA and IEC motors whereas **Auto 2** can be used for Energy Efficient motors as indicated in **Figure 3**. Both of the Auto settings provide a dampening means to accommodate transient motor inrush currents and at the same time not resulting in an overly high adjustment. The maximum percentage of full-load current for Auto 1 will not exceed 1300%, whereas Auto 2 will not exceed 1700%.

5.2.4 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 was chosen to coordinate with small load side branch breakers rated 20A and smaller with the consideration that most of the exposure to ground faults would likely occur in the electrical system downstream of these numerous small breakers.

Coordination with larger downstream breakers does not exist for any ground fault current exceeding the pickup setting but less than the magnetic setting of the load side breaker. This is unavoidable because the larger load side protective devices are not equipped with ground fault protection. **Figure 4** illustrates this.

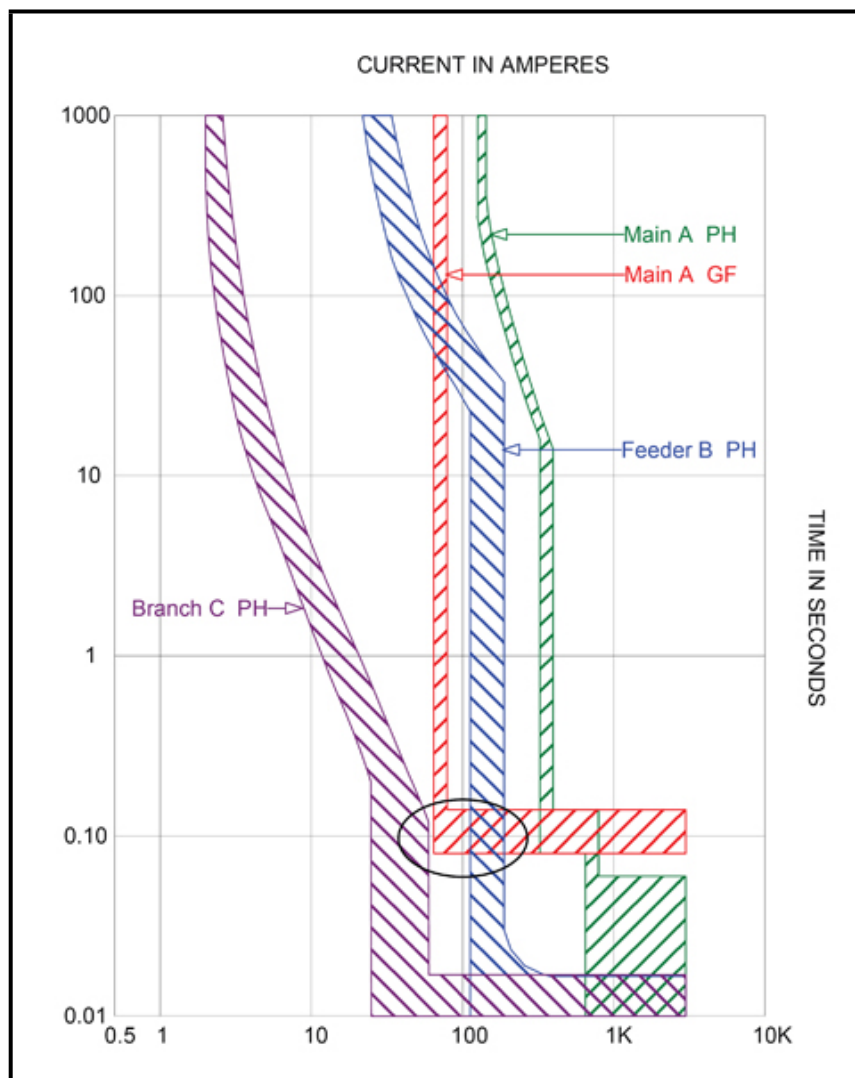


Figure 4: Example ground fault coordination (current scale X 10).

As shown in **Figure 4**, the main ground fault device A coordinates with the small branch breaker C but not with the larger feeder breaker B for ground fault currents in the range of 640A-1,900A as indicated.

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

5.2.5 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 1000V. 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 5** 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.

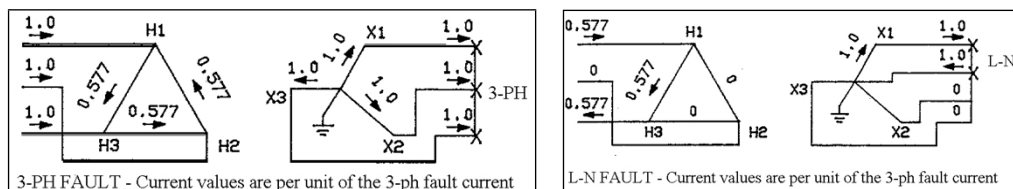


Figure 5: Delta-Wye 3-PH and L-N fault current per unit values.

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.

5.2.6 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.

However, the above analysis does not include any aspects of cable ampacity adjustment factors such as derating for conduit fill, elevated ambient temperature, and so on allowed by the NEC.

5.3 Overcurrent Device Coordination Analysis Results

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. Settings for devices which have adjustable characteristics are summarized in the appropriate overcurrent device setting tables.

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 ensuring 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. System protective zones involving transformer primary and secondary main devices, series devices in the same zone, or high current regions of molded case breakers may not show full device coordination.

Coordination issues along with equipment recommendations are discussed in the Study Recommendations section. Where existing device setting changes are recommended, those settings are shown in red in the setting table.

5.4 Overcurrent Device Setting Table



POWER SYSTEM ENGINEERING

DEVICE SETTING TABLE
LV CIRCUIT BREAKERS

CBBT- SUPPORT BLDG EMG POWER SYSTEM UPGRADES
CAPE CHARLES, VA
REFER TO DRAWINGS

Device ID	Equipment Designation	Max Voltage (kV)	Manufacturer	Frame (A)	Long-Time			Short-Time				Instantaneous	Ground			
			Model	Sensor (A)	Pickup Setting	Delay Curve	Band	Pickup Setting	Delay Curve	Band	I ² T	Pickup Setting	Pickup Setting	Delay Curve	Band	I ² T
				Rating Plug (A)	Trip (A)			Trip (A)				Trip (A)	Trip (A)			
1100-00A BUS-1 MAIN (#B1)	1100 EMCC #B1	0.6	Square-D NW16L MICROLOGIC 6.0	1600 1600	0.7 1120	8		4 4480		0.1	OUT	6 9600	F 960		0.4	OUT
1100-00A BUS-1 MAIN (#B1)	1100 EMCC #B1											ERMS 2 3200				
1100-00B BUS-2 MAIN (#B1)	1100 EMCC #B1	0.6	Square-D NW16L MICROLOGIC 6.0	1600 1600	0.7 1120	8		4 4480		0.1	OUT	6 9600	F 960		0.4	OUT
1100-00B BUS-2 MAIN (#B1)	1100 EMCC #B1											ERMS 2 3200				
1100-00C GEN MAIN (#B1)	1100 EMCC #B1	0.6	Square-D NW16L MICROLOGIC 6.0	1600 1600	0.4 640	16		6 3840		0.1	OUT	6 9600	A 500		0.4	OUT
1100-00C GEN MAIN (#B1)	1100 EMCC #B1											ERMS 2 3200				
1100-01 BSB-1 FDR	1100 EMCC #B1	0.6	Square-D LR (OR) Micrologic 5.3 A/E (PP)	400 400	400 A 400	8		5 2000		0.1	OUT	6 x In 2400				
1100-02 BSB-2 FDR	1100 EMCC #B1	0.6	Square-D LR (OR) Micrologic 5.3 A/E (PP)	400 400	400 A 400	8		5 2000		0.1	OUT	6 x In 2400				
1100-03 BSB-3 FDR	1100 EMCC #B1	0.6	Square-D LR (OR) Micrologic 5.3 A/E (PP)	400 400	400 A 400	8		5 2000		0.1	OUT	6 x In 2400				
1100-04 BSE-1 FDR	1100 EMCC #B1	0.6	Square-D LR (OR) Micrologic 5.3 A/E (PP)	400 400	400 A 400	8		5 2000		0.1	OUT	6 x In 2400				
1100-05 BSE-2 FDR	1100 EMCC #B1	0.6	Square-D LR (OR) Micrologic 5.3 A/E (PP)	400 400	400 A 400	8		5 2000		0.1	OUT	6 x In 2400				
1100-06 BSE-3 FDR	1100 EMCC #B1	0.6	Square-D LR (OR) Micrologic 5.3 A/E (PP)	400 400	400 A 400	8		5 2000		0.1	OUT	6 x In 2400				

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.

. Public



POWER SYSTEM ENGINEERING

DEVICE SETTING TABLE
LV CIRCUIT BREAKERS

CBBT- SUPPORT BLDG EMG POWER SYSTEM UPGRADES
CAPE CHARLES, VA
REFER TO DRAWINGS

Device ID	Equipment Designation	Max Voltage (kV)	Manufacturer	Frame (A)	Long-Time			Short-Time				Instantaneous	Ground			
				Sensor (A)	Pickup Setting	Delay Curve	Band	Pickup Setting	Delay Curve	Band	I ² T	Pickup Setting	Pickup Setting	Delay Curve	Band	I ² T
			Model	Rating Plug (A)	Trip (A)			Trip (A)				Trip (A)	Trip (A)			
1100-07 BSP-1 FDR	1100 EMCC #B1	0.6	Square-D JR (OR)	225								10X 2250				
1100-08 BSP-2 FDR	1100 EMCC #B1	0.6	Square-D JR (OR)	225								10X 2250				
1100-09 EX T-CBW2 FDR	1100 EMCC #B1	0.6	Square-D HR (OR) Micrologic 5.2 A/E (PP)	150 150	150 A 150	4		4 600		0.1	OUT	6 x In 900				
1100-10 T-ESB #B1 FDR	1100 EMCC #B1	0.6	Square-D HR (OR) Micrologic 5.2 A/E (PP)	150 150	100 A 100.1	16		8 800.4		0.1	OUT	8 x In 1200				
1110-01 T-ESB#B1 ECB MAIN	1110 T-ESB #B1 ECB	0.24	Square-D JD (OR)	250								10X 2500				
1300-00A BUS-1 MAIN (#B2)	1300 EMCC #B2	0.6	Square-D NW16L MICROLOGIC 6.0	1600 1600	0.7 1120	8		4 4480		0.1	OUT	6 9600	F 960		0.4	OUT
1300-00A BUS-1 MAIN (#B2)	1300 EMCC #B2											ERMS 2 3200				
1300-00B BUS-2 MAIN (#B2)	1300 EMCC #B2	0.6	Square-D NW16L MICROLOGIC 6.0	1600 1600	0.7 1120	8		4 4480		0.1	OUT	6 9600	F 960		0.4	OUT
1300-00B BUS-2 MAIN (#B2)	1300 EMCC #B2											ERMS 2 3200				
1300-00C GEN MAIN (#B2)	1300 EMCC #B2	0.6	Square-D NW16L MICROLOGIC 6.0	1600 1600	0.4 640	16		6 3840		0.1	OUT	6 9600	A 500		0.4	OUT
1300-00C GEN MAIN (#B2)	1300 EMCC #B2											ERMS 2 3200				
1300-01 BSB-1 FDR	1300 EMCC #B2	0.6	Square-D LR (OR) Micrologic 5.3 A/E (PP)	400 400	400 A 400	8		5 2000		0.1	OUT	6 x In 2400				
1300-02 BSB-2 FDR	1300 EMCC #B2	0.6	Square-D LR (OR) Micrologic 5.3 A/E (PP)	400 400	400 A 400	8		5 2000		0.1	OUT	6 x In 2400				

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.



POWER SYSTEM ENGINEERING

DEVICE SETTING TABLE
LV CIRCUIT BREAKERS

CBBT- SUPPORT BLDG EMG POWER SYSTEM UPGRADES
CAPE CHARLES, VA
REFER TO DRAWINGS

Device ID	Equipment Designation	Max Voltage (kV)	Manufacturer	Frame (A)	Long-Time			Short-Time				Instantaneous	Ground			
				Sensor (A)	Pickup Setting	Delay Curve	Band	Pickup Setting	Delay Curve	Band	I ² T	Pickup Setting	Pickup Setting	Delay Curve	Band	I ² T
			Model	Rating Plug (A)	Trip (A)			Trip (A)				Trip (A)	Trip (A)			
1300-03 BSB-3 FDR	1300 EMCC #B2	0.6	Square-D LR (OR) Micrologic 5.3 A/E (PP)	400 400	400 A 400	8		5 2000		0.1	OUT	6 x In 2400				
1300-04 BSE-1 FDR	1300 EMCC #B2	0.6	Square-D LR (OR) Micrologic 5.3 A/E (PP)	400 400	400 A 400	8		5 2000		0.1	OUT	6 x In 2400				
1300-05 BSE-2 FDR	1300 EMCC #B2	0.6	Square-D LR (OR) Micrologic 5.3 A/E (PP)	400 400	400 A 400	8		5 2000		0.1	OUT	6 x In 2400				
1300-06 BSE-3 FDR	1300 EMCC #B2	0.6	Square-D LR (OR) Micrologic 5.3 A/E (PP)	400 400	400 A 400	8		5 2000		0.1	OUT	6 x In 2400				
1300-07 BSP-1 FDR	1300 EMCC #B2	0.6	Square-D JR (OR)	225								10X 2250				
1300-08 BSP-2 FDR	1300 EMCC #B2	0.6	Square-D JR (OR)	225								10X 2250				
1300-09 EX T-CBW2 FDR	1300 EMCC #B2	0.6	Square-D HR (OR) Micrologic 5.2 A/E (PP)	150 150	150 A 150	4		4 600		0.1	OUT	6 x In 900				
1300-10 T-ESB FDR	1300 EMCC #B2	0.6	Square-D HR (OR) Micrologic 5.2 A/E (PP)	150 150	100 A 100.1	16		8 800.4		0.1	OUT	8 x In 1200				
1310-01 T-ESB#B2 ECB MAIN	1310 T-ESB #B2 ECB	0.24	Square-D JD (OR)	250								10X 2500				
1500-00A BUS-1 MAIN (#B3)	1500 EMCC #B3	0.6	Square-D NW16L MICROLOGIC 6.0	1600 1600	0.7 1120	8		4 4480		0.1	OUT	6 9600	F 960		0.4	OUT
1500-00A BUS-1 MAIN (#B3)	1500 EMCC #B3											ERMS 2 3200				
1500-00B BUS-2 MAIN (#B3)	1500 EMCC #B3	0.6	Square-D NW16L MICROLOGIC 6.0	1600 1600	0.7 1120	8		4 4480		0.1	OUT	6 9600	F 960		0.4	OUT
1500-00B BUS-2 MAIN (#B3)	1500 EMCC #B3											ERMS 2 3200				

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.



POWER SYSTEM ENGINEERING

DEVICE SETTING TABLE
LV CIRCUIT BREAKERS

CBBT- SUPPORT BLDG EMG POWER SYSTEM UPGRADES
CAPE CHARLES, VA
REFER TO DRAWINGS

Device ID	Equipment Designation	Max Voltage (kV)	Manufacturer	Frame (A)	Long-Time			Short-Time				Instantaneous	Ground			
				Sensor (A)	Pickup Setting	Delay Curve	Band	Pickup Setting	Delay Curve	Band	I ² T	Pickup Setting	Pickup Setting	Delay Curve	Band	I ² T
			Model	Rating Plug (A)	Trip (A)			Trip (A)				Trip (A)	Trip (A)			
1500-00C GEN MAIN (#B3)	1500 EMCC #B3	0.6	Square-D NW16L MICROLOGIC 6.0	1600 1600	0.4 640	16		6 3840		0.1	OUT	6 9600	A 500		0.4	OUT
1500-00C GEN MAIN (#B3)	1500 EMCC #B3											ERMS 2 3200				
1500-01 BSB-1 FDR	1500 EMCC #B3	0.6	Square-D LR (OR) Micrologic 5.3 A/E (PP)	400 400	400 A 400	8		5 2000		0.1	OUT	6 x In 2400				
1500-02 BSB-2 FDR	1500 EMCC #B3	0.6	Square-D LR (OR) Micrologic 5.3 A/E (PP)	400 400	400 A 400	8		5 2000		0.1	OUT	6 x In 2400				
1500-03 BSB-3 FDR	1500 EMCC #B3	0.6	Square-D LR (OR) Micrologic 5.3 A/E (PP)	400 400	400 A 400	8		5 2000		0.1	OUT	6 x In 2400				
1500-04 BSE-1 FDR	1500 EMCC #B3	0.6	Square-D LR (OR) Micrologic 5.3 A/E (PP)	400 400	400 A 400	8		5 2000		0.1	OUT	6 x In 2400				
1500-05 BSE-2 FDR	1500 EMCC #B3	0.6	Square-D LR (OR) Micrologic 5.3 A/E (PP)	400 400	400 A 400	8		5 2000		0.1	OUT	6 x In 2400				
1500-06 BSE-3 FDR	1500 EMCC #B3	0.6	Square-D LR (OR) Micrologic 5.3 A/E (PP)	400 400	400 A 400	8		5 2000		0.1	OUT	6 x In 2400				
1500-07 BSP-1 FDR	1500 EMCC #B3	0.6	Square-D JR (OR)	225								10X 2250				
1500-08 BSP-2 FDR	1500 EMCC #B3	0.6	Square-D JR (OR)	225								10X 2250				
1500-09 EX T-CBW2 FDR	1500 EMCC #B3	0.6	Square-D HR (OR) Micrologic 5.2 A/E (PP)	150 150	150 A 150	4		4 600		0.1	OUT	6 x In 900				
1500-10 T-ESB #B3 FDR	1500 EMCC #B3	0.6	Square-D HR (OR) Micrologic 5.2 A/E (PP)	150 150	100 A 100.1	16		8 800.4		0.1	OUT	8 x In 1200				
1510-01 T-ESB#B3 ECB MAIN	1510 T-ESB #B3 ECB	0.24	Square-D JD (OR)	250								10X 2500				

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.

. Public



POWER SYSTEM ENGINEERING

DEVICE SETTING TABLE
LV CIRCUIT BREAKERS

CBBT- SUPPORT BLDG EMG POWER SYSTEM UPGRADES
CAPE CHARLES, VA
REFER TO DRAWINGS

Device ID	Equipment Designation	Max Voltage (kV)	Manufacturer	Frame (A)	Long-Time			Short-Time				Instantaneous	Ground			
				Sensor (A)	Pickup Setting	Delay Curve	Band	Pickup Setting	Delay Curve	Band	I ² T	Pickup Setting	Pickup Setting	Delay Curve	Band	I ² T
			Model	Rating Plug (A)	Trip (A)			Trip (A)				Trip (A)	Trip (A)			
1700-00A BUS-1 MAIN (#B4)	1700 EMCC #B4	0.6	Square-D NW16L MICROLOGIC 6.0	1600 1600	0.7 1120	8		4 4480		0.1	OUT	6 9600	F 960		0.4	OUT
1700-00A BUS-1 MAIN (#B4)	1700 EMCC #B4											ERMS 2 3200				
1700-00B BUS-2 MAIN (#B4)	1700 EMCC #B4	0.6	Square-D NW16L MICROLOGIC 6.0	1600 1600	0.7 1120	8		4 4480		0.1	OUT	6 9600	F 960		0.4	OUT
1700-00B BUS-2 MAIN (#B4)	1700 EMCC #B4											ERMS 2 3200				
1700-00C GEN MAIN (#B4)	1700 EMCC #B4	0.6	Square-D NW16L MICROLOGIC 6.0	1600 1600	0.4 640	16		6 3840		0.1	OUT	6 9600	A 500		0.4	OUT
1700-00C GEN MAIN (#B4)	1700 EMCC #B4											ERMS 2 3200				
1700-01 BSB-1 FDR	1700 EMCC #B4	0.6	Square-D LR (OR) Micrologic 5.3 A/E (PP)	400 400	400 A 400	8		5 2000		0.1	OUT	6 x In 2400				
1700-02 BSB-2 FDR	1700 EMCC #B4	0.6	Square-D LR (OR) Micrologic 5.3 A/E (PP)	400 400	400 A 400	8		5 2000		0.1	OUT	6 x In 2400				
1700-03 BSB-3 FDR	1700 EMCC #B4	0.6	Square-D LR (OR) Micrologic 5.3 A/E (PP)	400 400	400 A 400	8		5 2000		0.1	OUT	6 x In 2400				
1700-04 BSE-1 FDR	1700 EMCC #B4	0.6	Square-D LR (OR) Micrologic 5.3 A/E (PP)	400 400	400 A 400	8		5 2000		0.1	OUT	6 x In 2400				
1700-05 BSE-2 FDR	1700 EMCC #B4	0.6	Square-D LR (OR) Micrologic 5.3 A/E (PP)	400 400	400 A 400	8		5 2000		0.1	OUT	6 x In 2400				
1700-06 BSE-3 FDR	1700 EMCC #B4	0.6	Square-D LR (OR) Micrologic 5.3 A/E (PP)	400 400	400 A 400	8		5 2000		0.1	OUT	6 x In 2400				

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.

. Public



POWER SYSTEM ENGINEERING

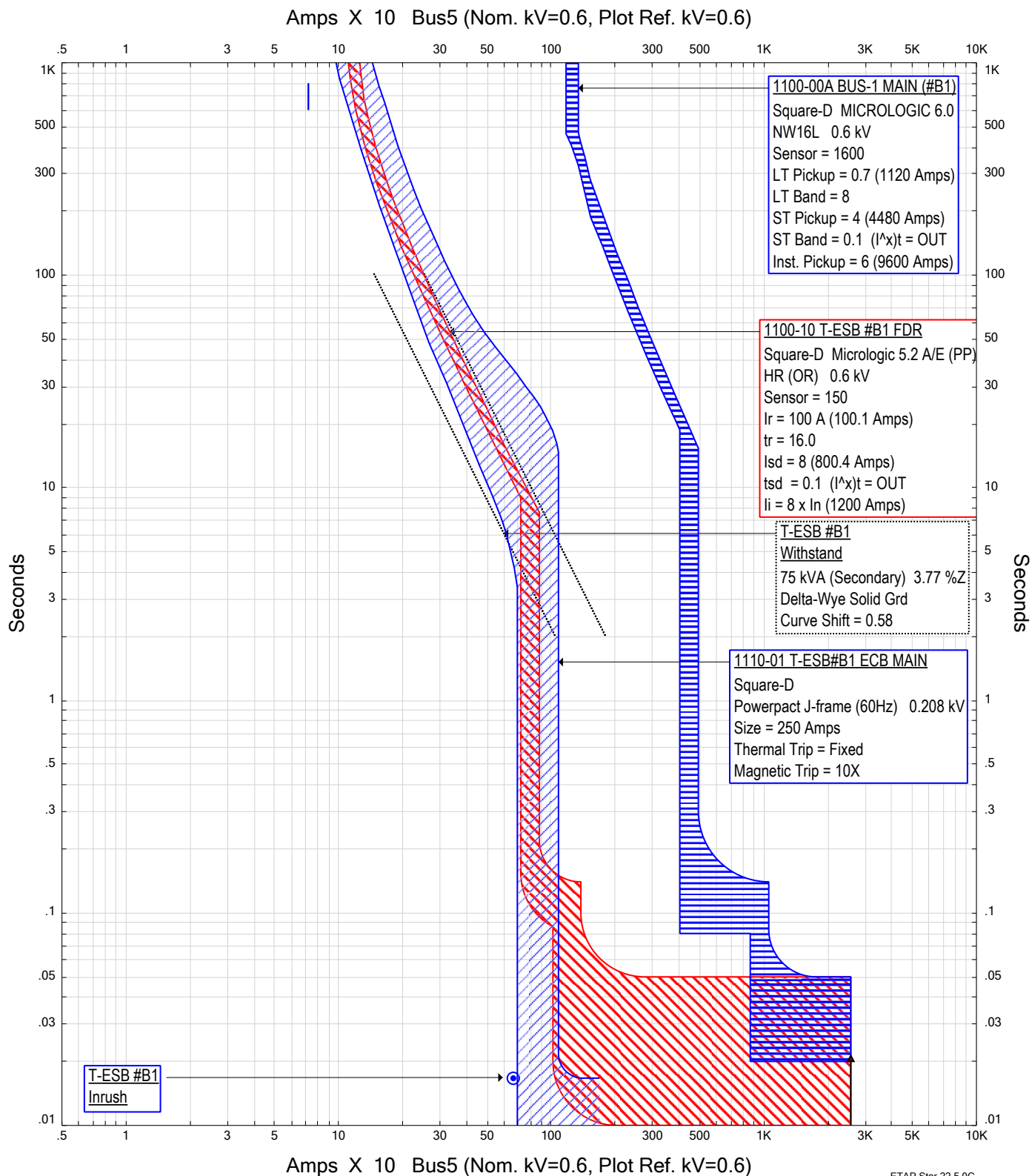
DEVICE SETTING TABLE
LV CIRCUIT BREAKERS

CBBT- SUPPORT BLDG EMG POWER SYSTEM UPGRADES
CAPE CHARLES, VA
REFER TO DRAWINGS

Device ID	Equipment Designation	Max Voltage (kV)	Manufacturer	Frame (A)	Long-Time			Short-Time				Instantaneous	Ground			
				Sensor (A)	Pickup Setting	Delay Curve	Band	Pickup Setting	Delay Curve	Band	I ² T	Pickup Setting	Pickup Setting	Delay Curve	Band	I ² T
			Model	Rating Plug (A)	Trip (A)			Trip (A)				Trip (A)	Trip (A)			
1700-07 BSP-1 FDR	1700 EMCC #B4	0.6	Square-D JR (OR)	225								10X 2250				
1700-08 BSP-2 FDR	1700 EMCC #B4	0.6	Square-D JR (OR)	225								10X 2250				
1700-09 EX T-CBW2 FDR	1700 EMCC #B4	0.6	Square-D HR (OR) Micrologic 5.2 A/E (PP)	150 150	150 A 150	4		4 600		0.1	OUT	6 x In 900				
1700-10 T-ESB #B4 FDR	1700 EMCC #B4	0.6	Square-D HR (OR) Micrologic 5.2 A/E (PP)	150 150	100 A 100.1	16		8 800.4		0.1	OUT	8 x In 1200				
1710-01 T-ESB#B4 ECB MAIN	1710 T-ESB #B4 ECB	0.24	Square-D JD (OR)	250								10X 2500				

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



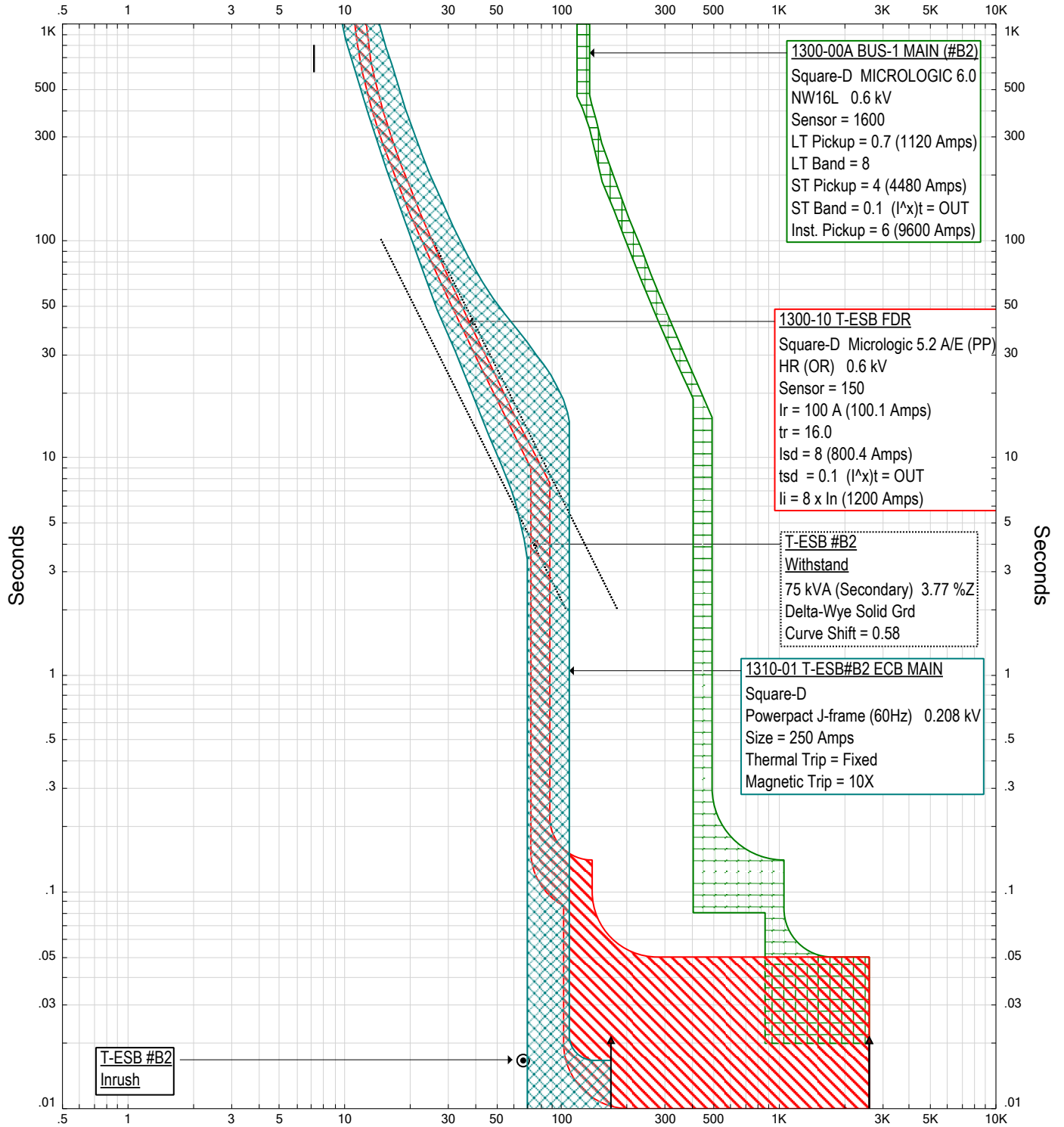
Project: CBBT-Support Bldg Emg
 Location: CAPE CHARLES, VA
 Contract: 50204245
 V22.5PSE_20231231.lib

TCC 1110

Schneider
 Electric

Rev: Base
 Fault: Phase

Amps X 10 1300 EMCC #B2 (Nom. kV=0.6, Plot Ref. kV=0.6)



Amps X 10 1300 EMCC #B2 (Nom. kV=0.6, Plot Ref. kV=0.6)

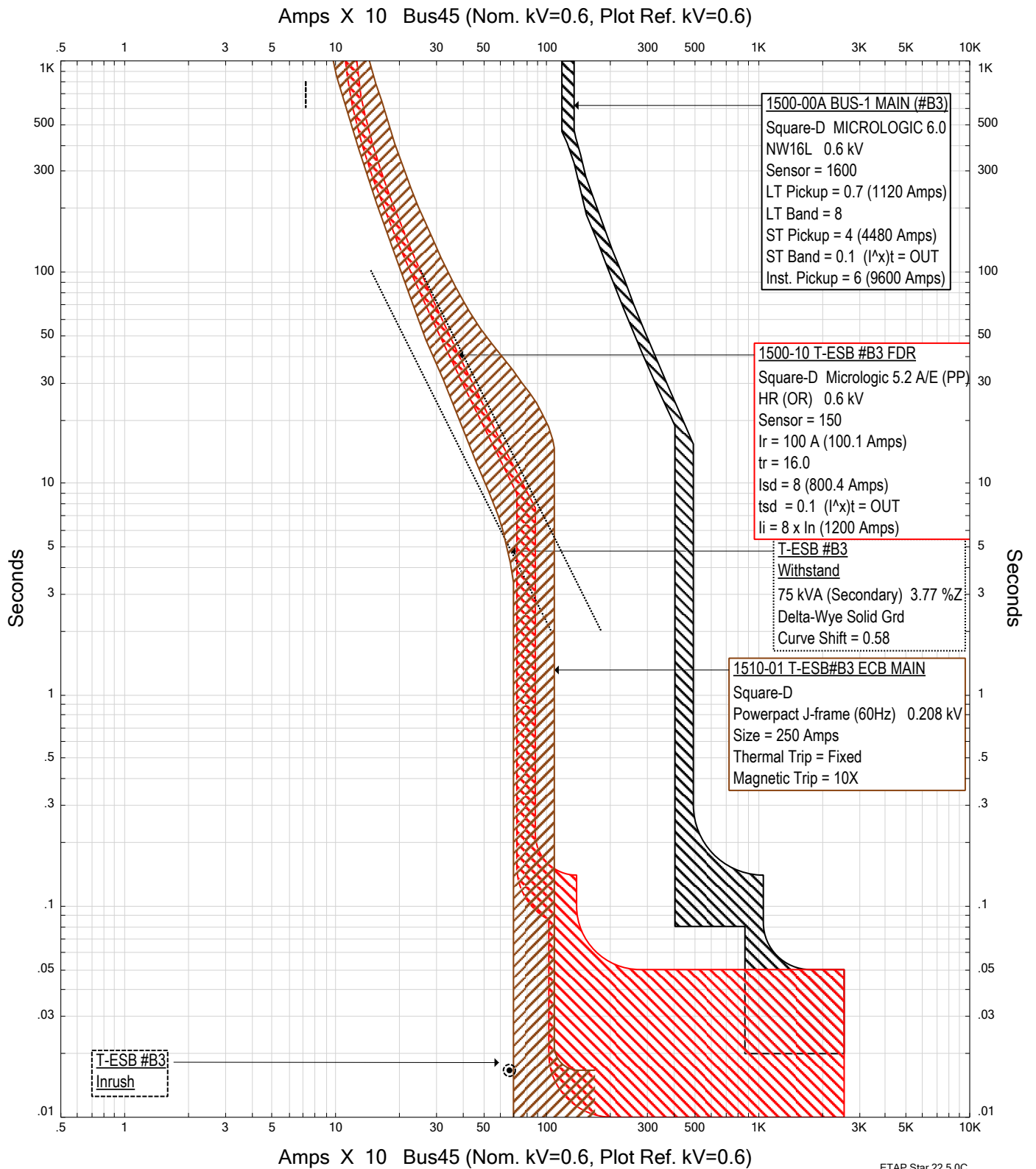
ETAP Star 22.5.0C

TCC 1310



Project: CBBT-Support Bldg Emg
 Location: CAPE CHARLES, VA
 Contract: 50204245
 V22.5PSE_20231231.lib

Rev: Base
 Fault: Phase



Project: CBBT-Support Bldg Emg
 Location: CAPE CHARLES, VA
 Contract: 50204245

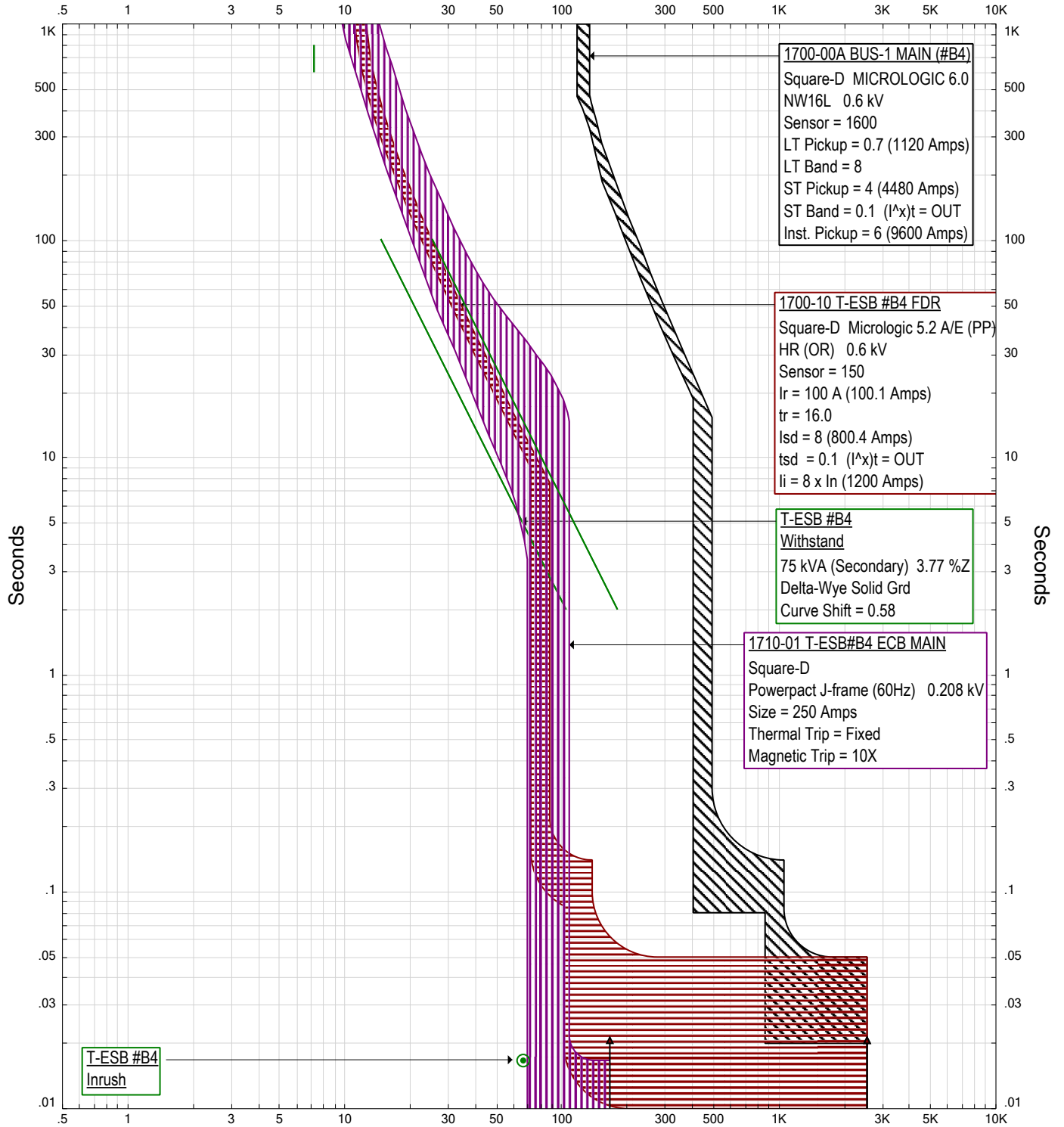
V22.5PSE_20231231.lib

TCC 1510



Rev: Base
 Fault: Phase

Amps X 10 1700 EMCC #B4 (Nom. kV=0.6, Plot Ref. kV=0.6)



Amps X 10 1700 EMCC #B4 (Nom. kV=0.6, Plot Ref. kV=0.6)

ETAP Star 22.5.0C

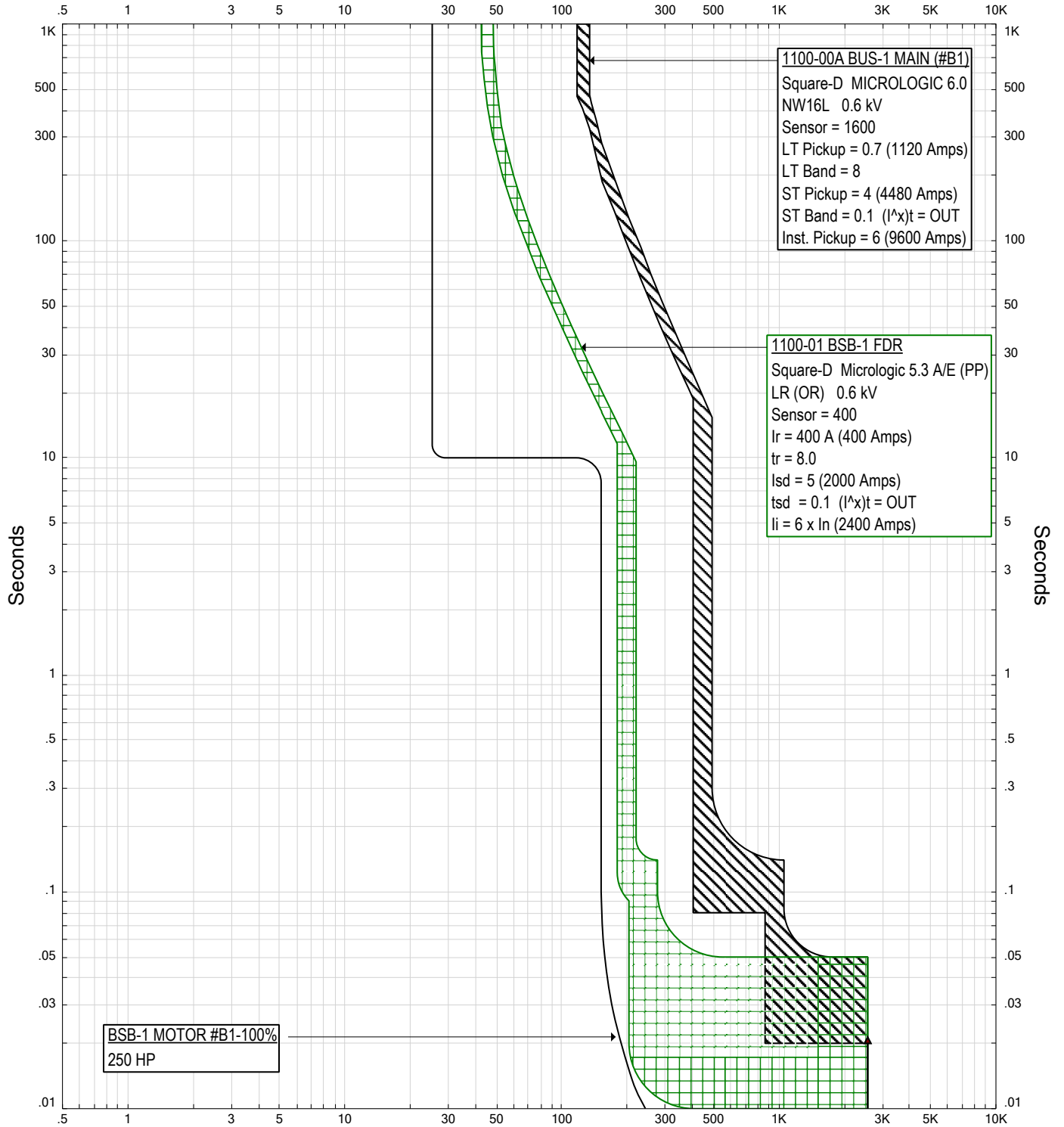
TCC 1710



Project: CBBT-Support Bldg Emg
 Location: CAPE CHARLES, VA
 Contract: 50204245
 V22.5PSE_20231231.lib

Rev: Base
 Fault: Phase

Amps X 10 1100 EMCC #B1 (Nom. kV=0.6, Plot Ref. kV=0.6)



Amps X 10 1100 EMCC #B1 (Nom. kV=0.6, Plot Ref. kV=0.6)

ETAP Star 22.5.0C

Project: CBBT-Support Bldg Emg
 Location: CAPE CHARLES, VA
 Contract: 50204245

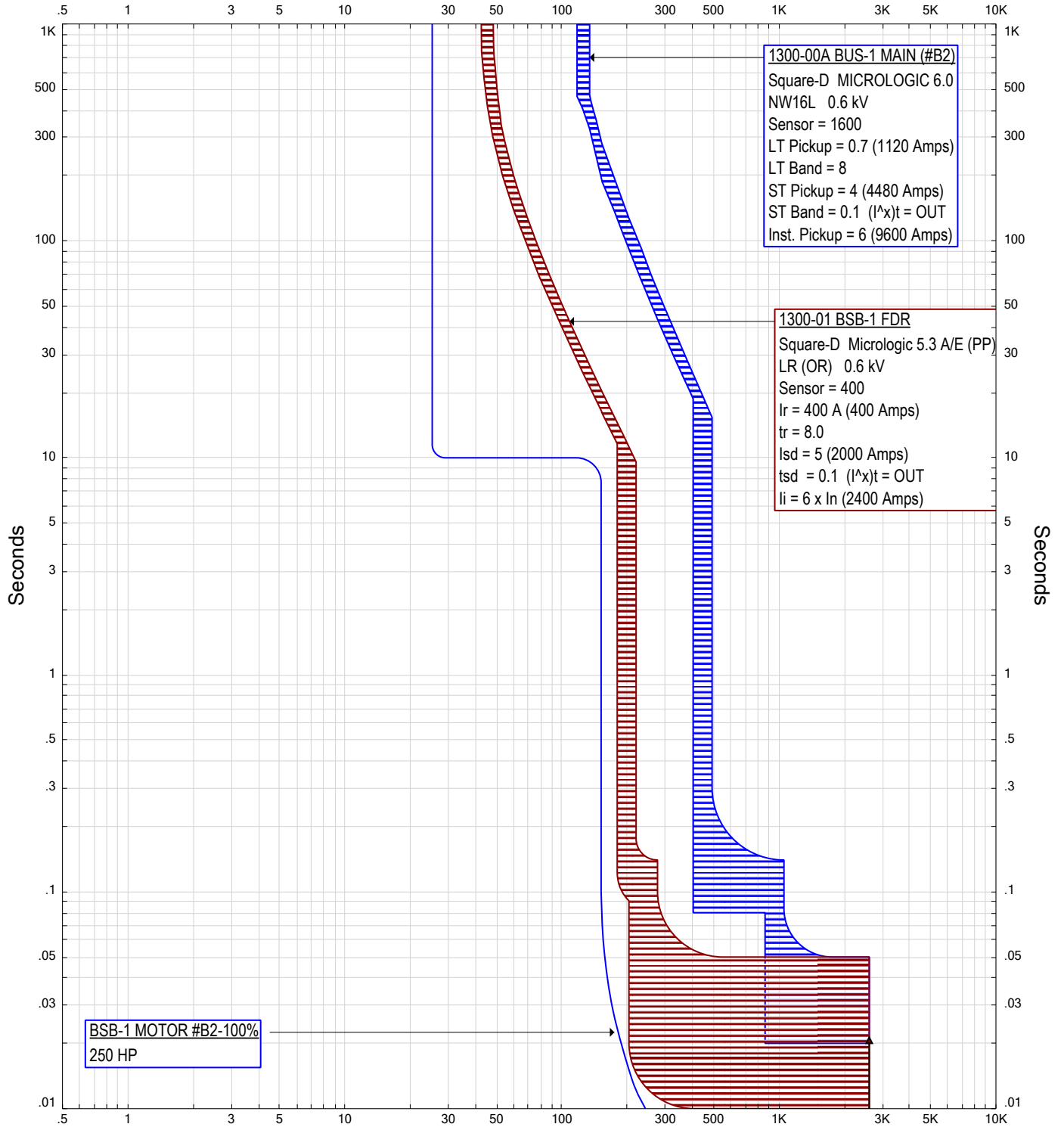
V22.5PSE_20231231.lib

TCC BSB-1 #B1



Rev: Base
 Fault: Phase

Amps X 10 1300 EMCC #B2 (Nom. kV=0.6, Plot Ref. kV=0.6)



Amps X 10 1300 EMCC #B2 (Nom. kV=0.6, Plot Ref. kV=0.6)

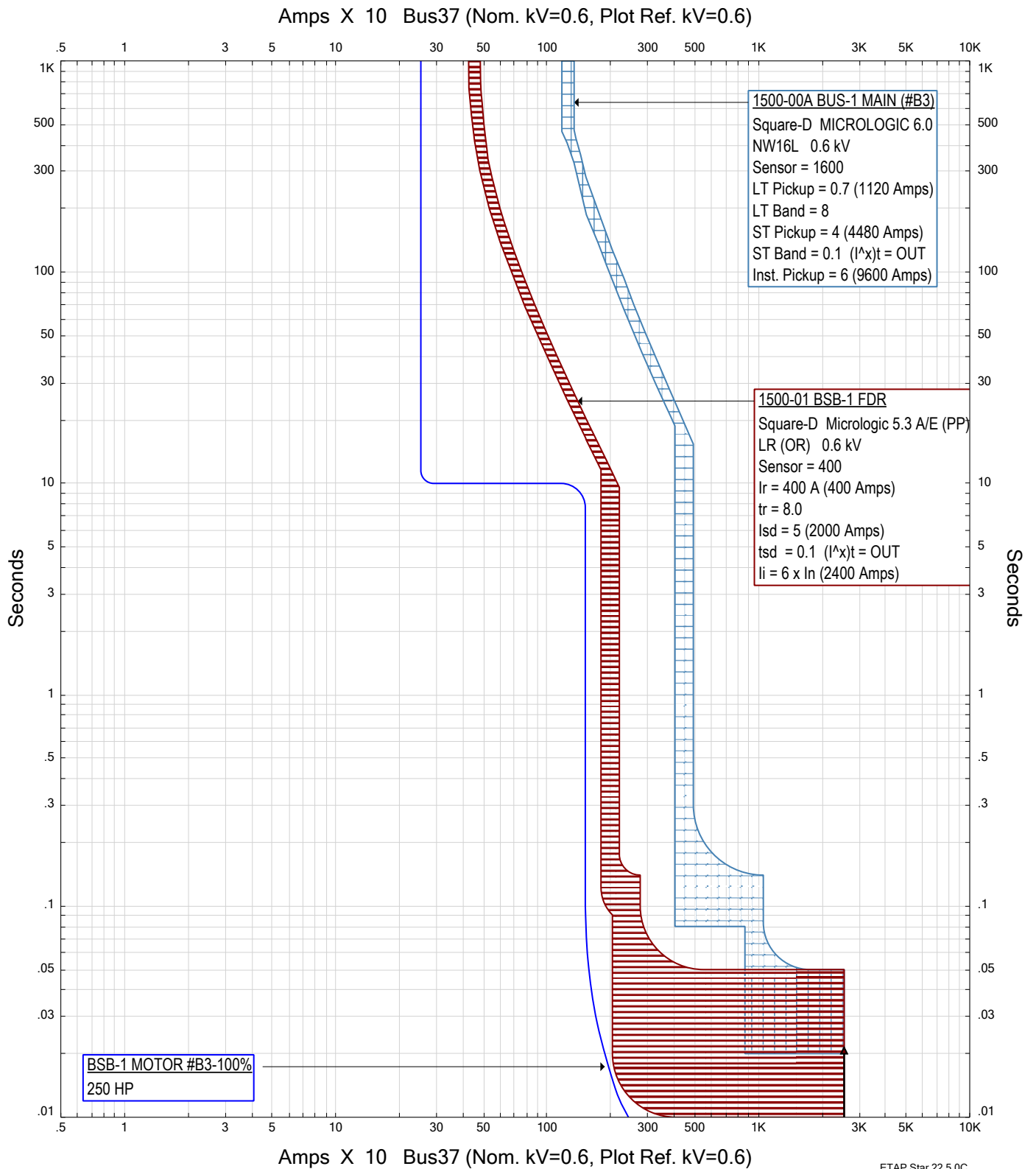
ETAP Star 22.5.0C

Project: CBBT-Support Bldg Emg
 Location: CAPE CHARLES, VA
 Contract: 50204245
 V22.5PSE_20231231.lib

TCC BSB-1 #B2



Rev: Base
 Fault: Phase



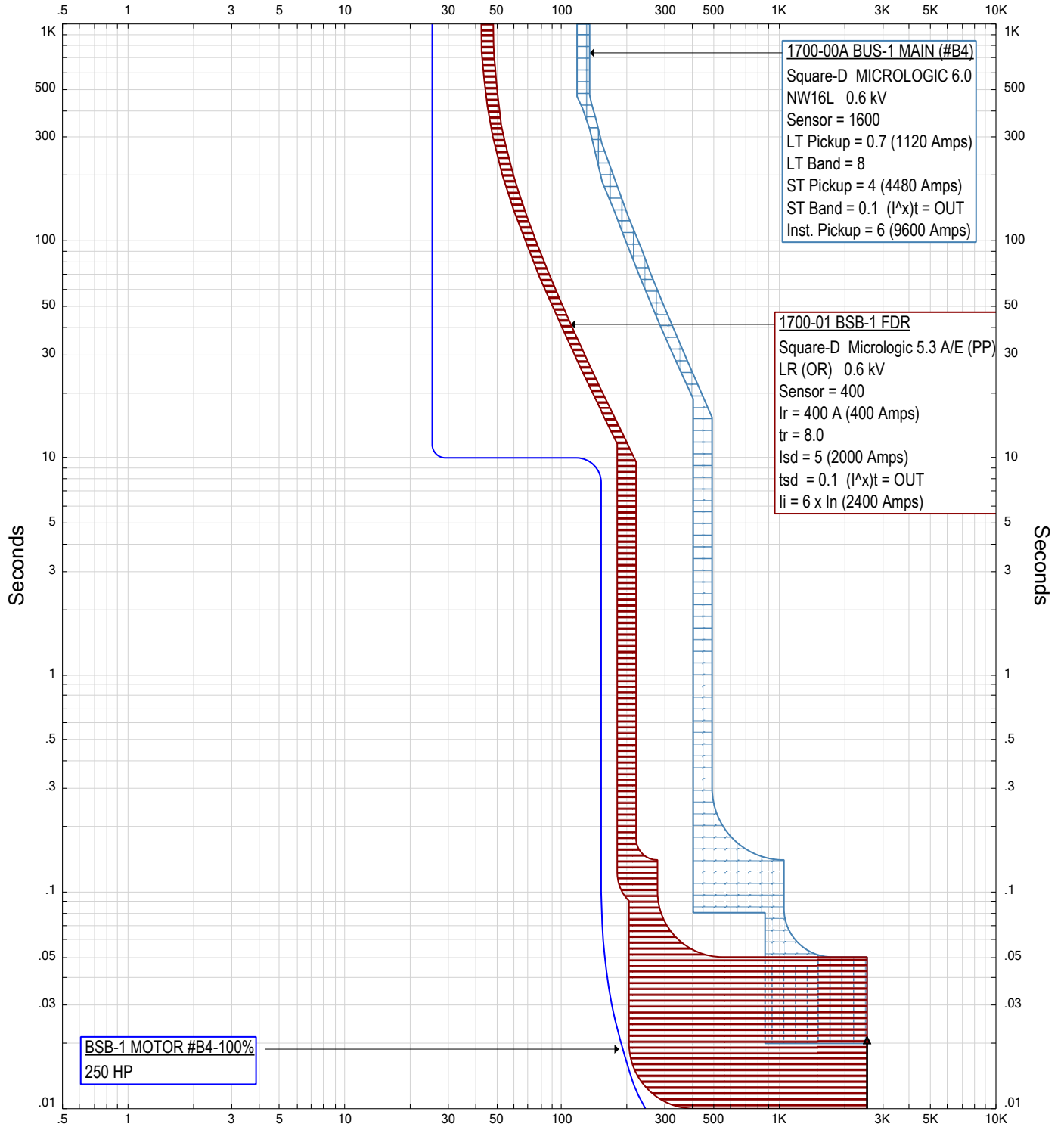
Project: CBBT-Support Bldg Emg
 Location: CAPE CHARLES, VA
 Contract: 50204245
 V22.5PSE_20231231.lib

TCC BSB-1 #B3



Rev: Base
 Fault: Phase

Amps X 10 1700 EMCC #B4 (Nom. kV=0.6, Plot Ref. kV=0.6)



Amps X 10 1700 EMCC #B4 (Nom. kV=0.6, Plot Ref. kV=0.6)

ETAP Star 22.5.0C

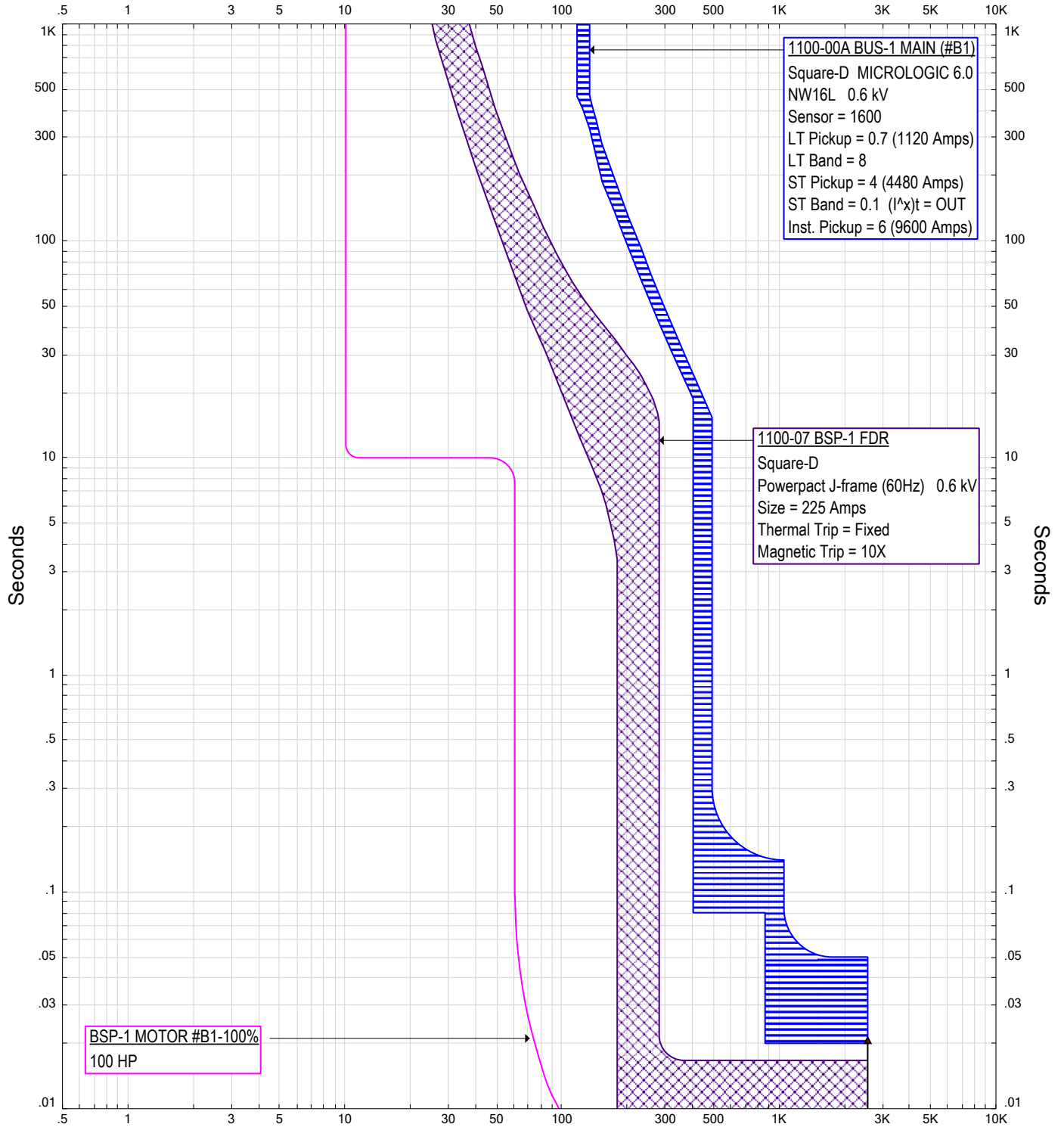
Project: CBBT-Support Bldg Emg
 Location: CAPE CHARLES, VA
 Contract: 50204245
 V22.5PSE_20231231.lib

TCC BSB-1 #B4



Rev: Base
 Fault: Phase

Amps X 10 1100 EMCC #B1 (Nom. kV=0.6, Plot Ref. kV=0.6)



Amps X 10 1100 EMCC #B1 (Nom. kV=0.6, Plot Ref. kV=0.6)

ETAP Star 22.5.0C

Project: CBBT-Support Bldg Emg
 Location: CAPE CHARLES, VA
 Contract: 50204245

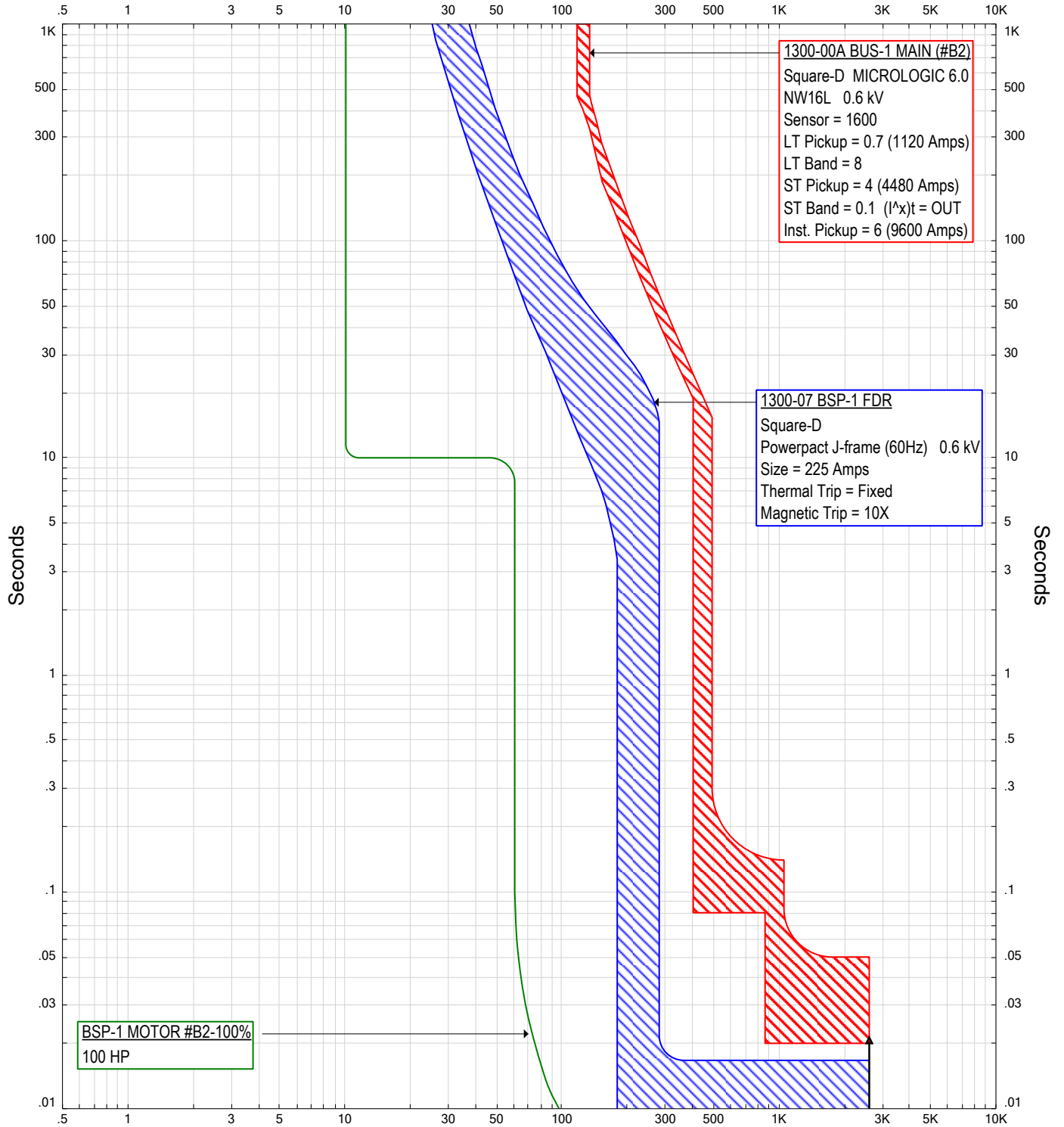
V22.5PSE_20231231.lib

TCC BSP-1 #B1



Rev: Base
 Fault: Phase

Amps X 10 1300 EMCC #B2 (Nom. kV=0.6, Plot Ref. kV=0.6)



Amps X 10 1300 EMCC #B2 (Nom. kV=0.6, Plot Ref. kV=0.6)

ETAP Star 22.5.0C

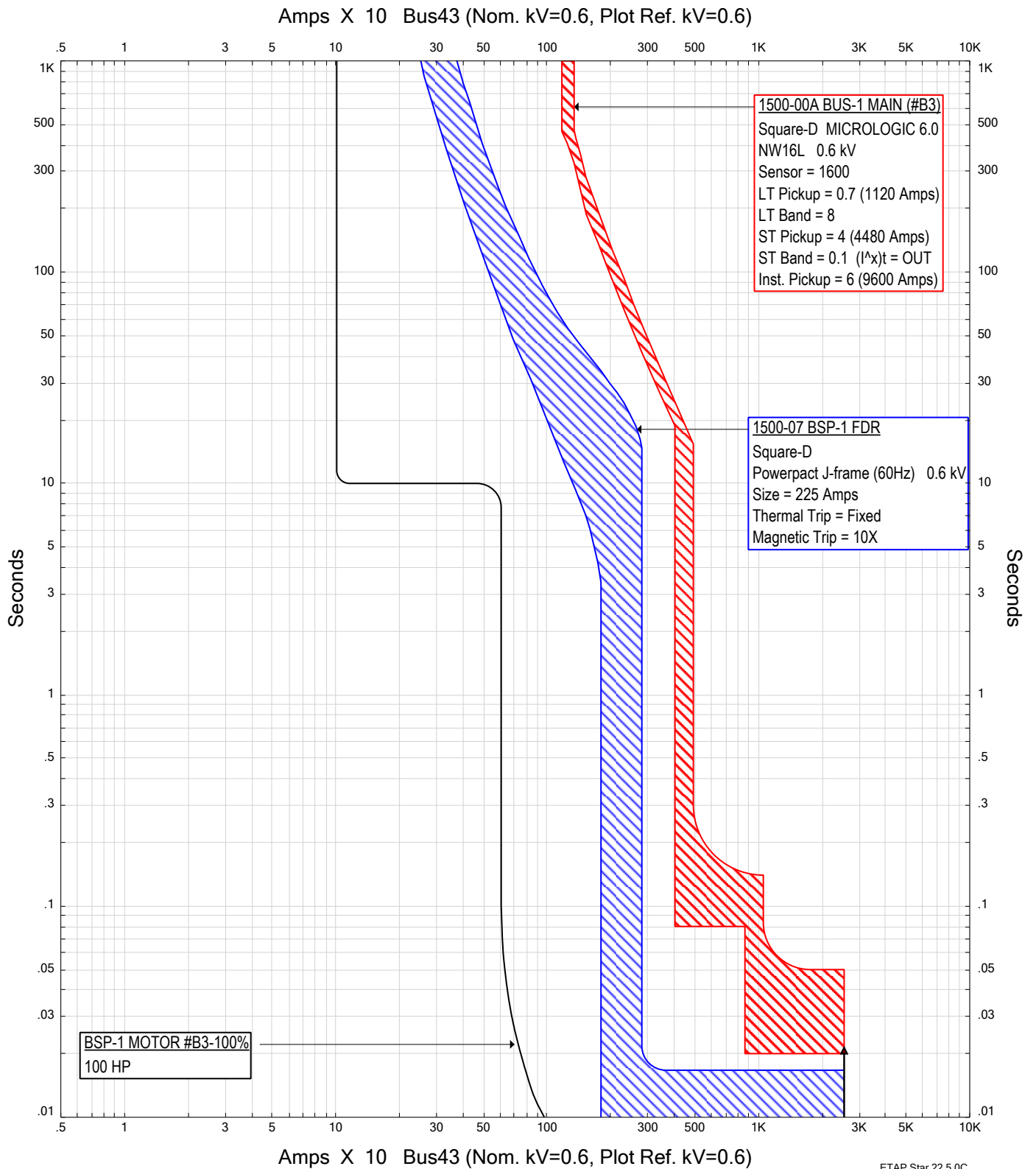
Project: CBBT-Support Bldg Emg
 Location: CAPE CHARLES, VA
 Contract: 50204245

V22.5PSE_20231231.lib

TCC BSP-1 #B2



Rev: Base
 Fault: Phase



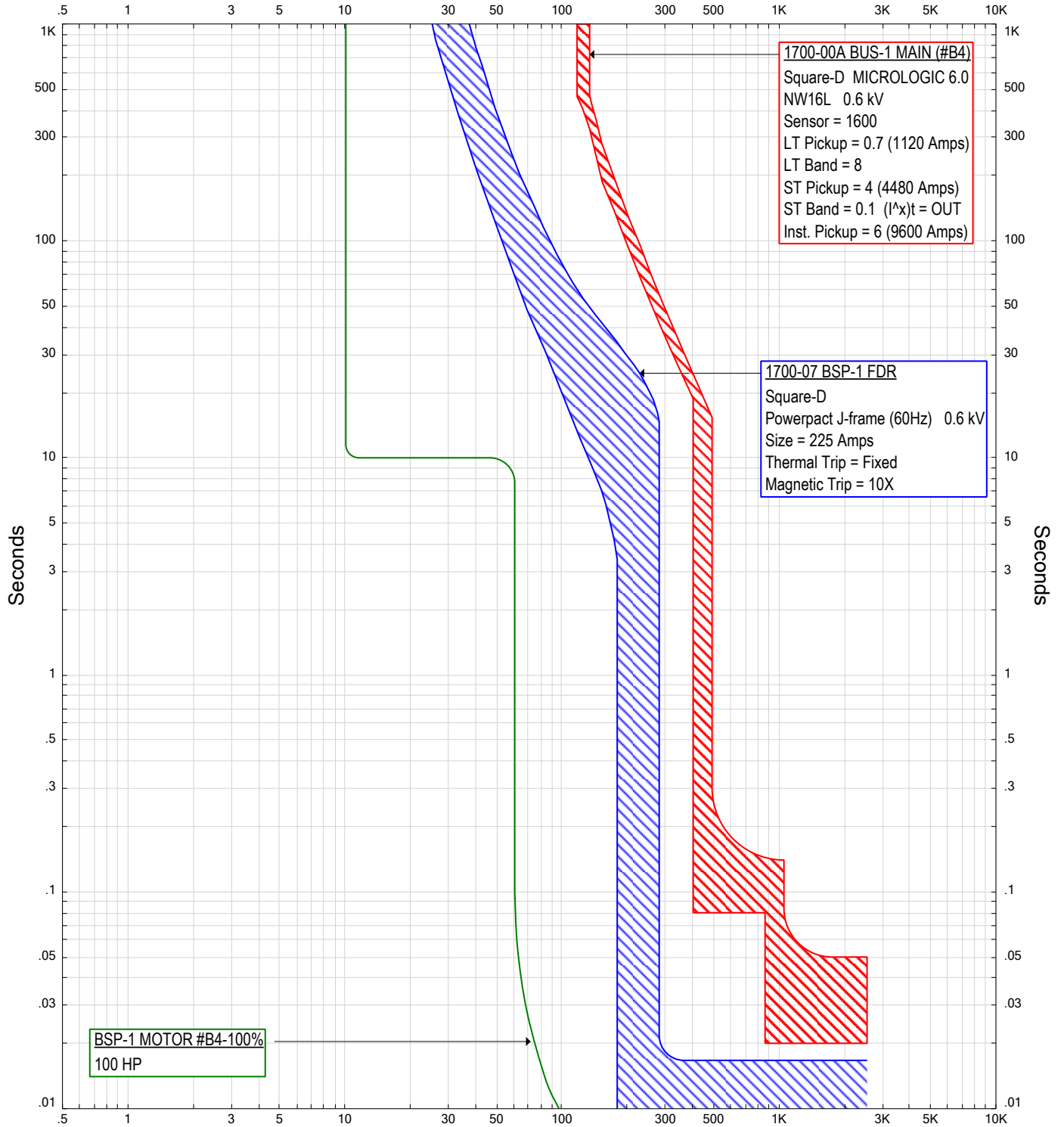
Project: CBBT-Support Bldg Emg
 Location: CAPE CHARLES, VA
 Contract: 50204245
 V22.5PSE_20231231.lib

TCC BSP-1 #B3



Rev: Base
 Fault: Phase

Amps X 10 1700 EMCC #B4 (Nom. kV=0.6, Plot Ref. kV=0.6)



Amps X 10 1700 EMCC #B4 (Nom. kV=0.6, Plot Ref. kV=0.6)

ETAP Star 22.5.0C

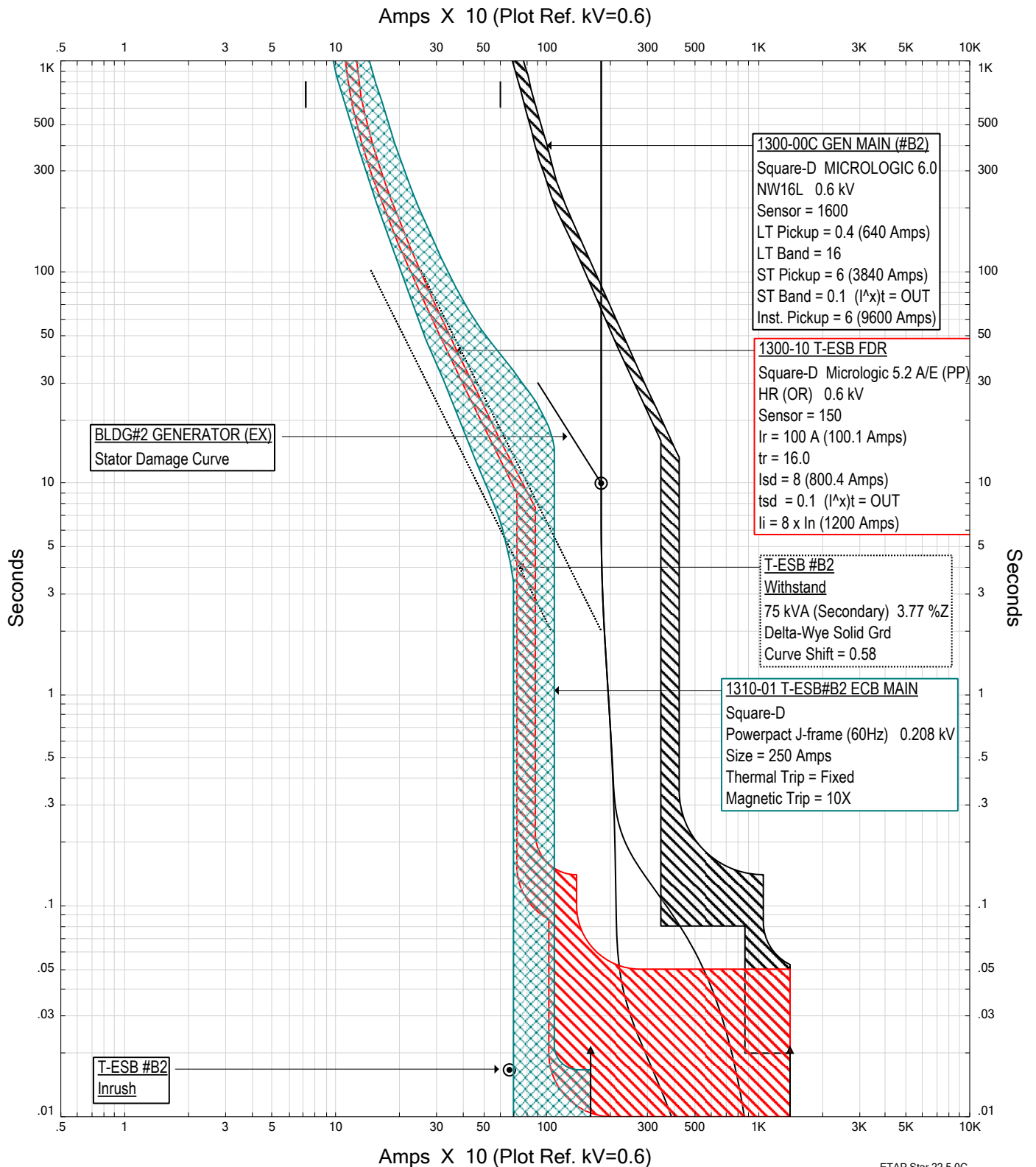
Project: CBBT-Support Bldg Emg
 Location: CAPE CHARLES, VA
 Contract: 50204245

V22.5PSE_20231231.lib

TCC BSP-1 #B4



Rev: Base
 Fault: Phase



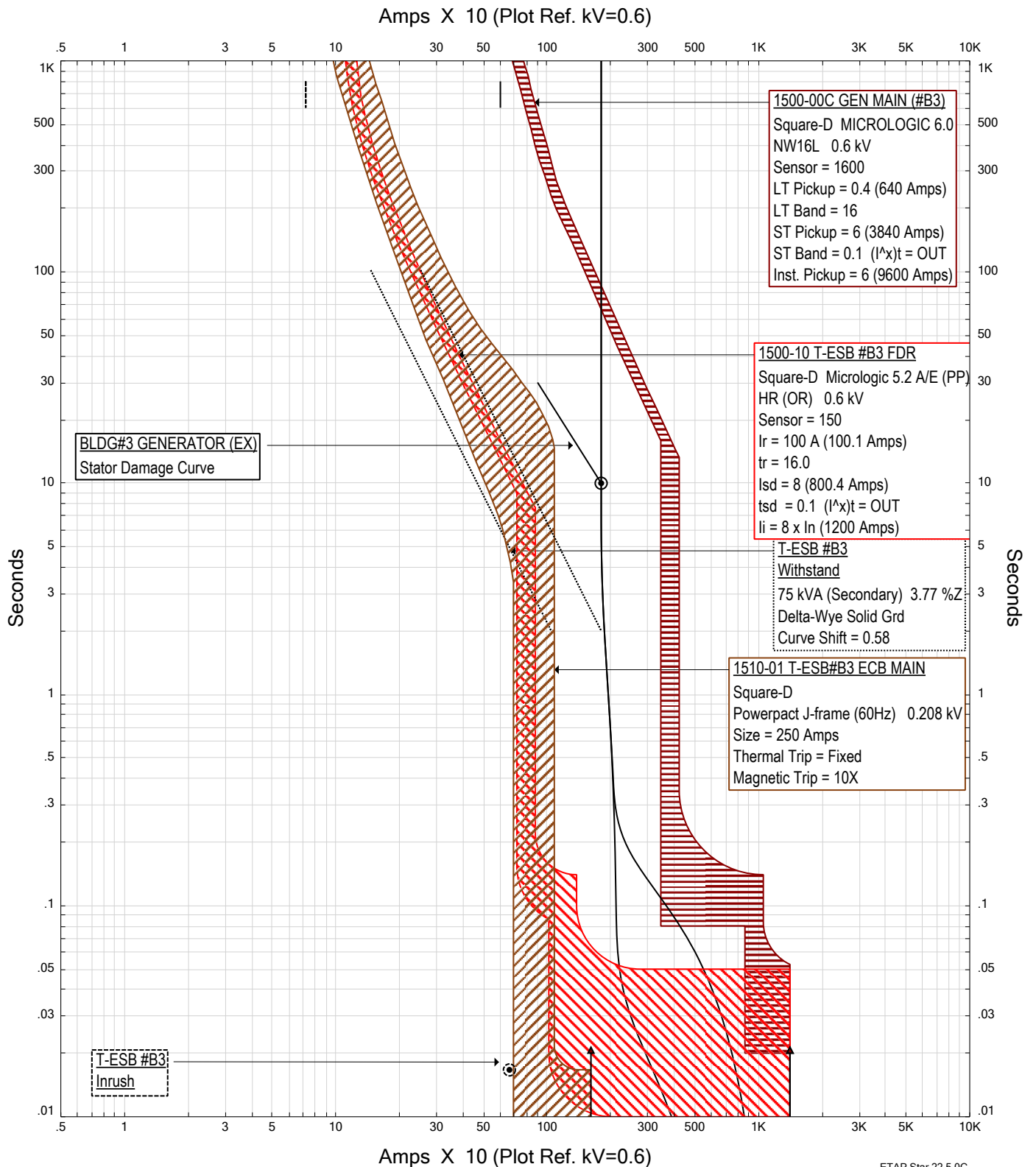
ETAP Star 22.5.0C

ETCC 1310



Project: CBBT-Support Bldg Emg
Location: CAPE CHARLES, VA
Contract: 50204245
V22.5PSE_20231231.lib

Rev: Base
Fault: Phase



ETAP Star 22.5.0C

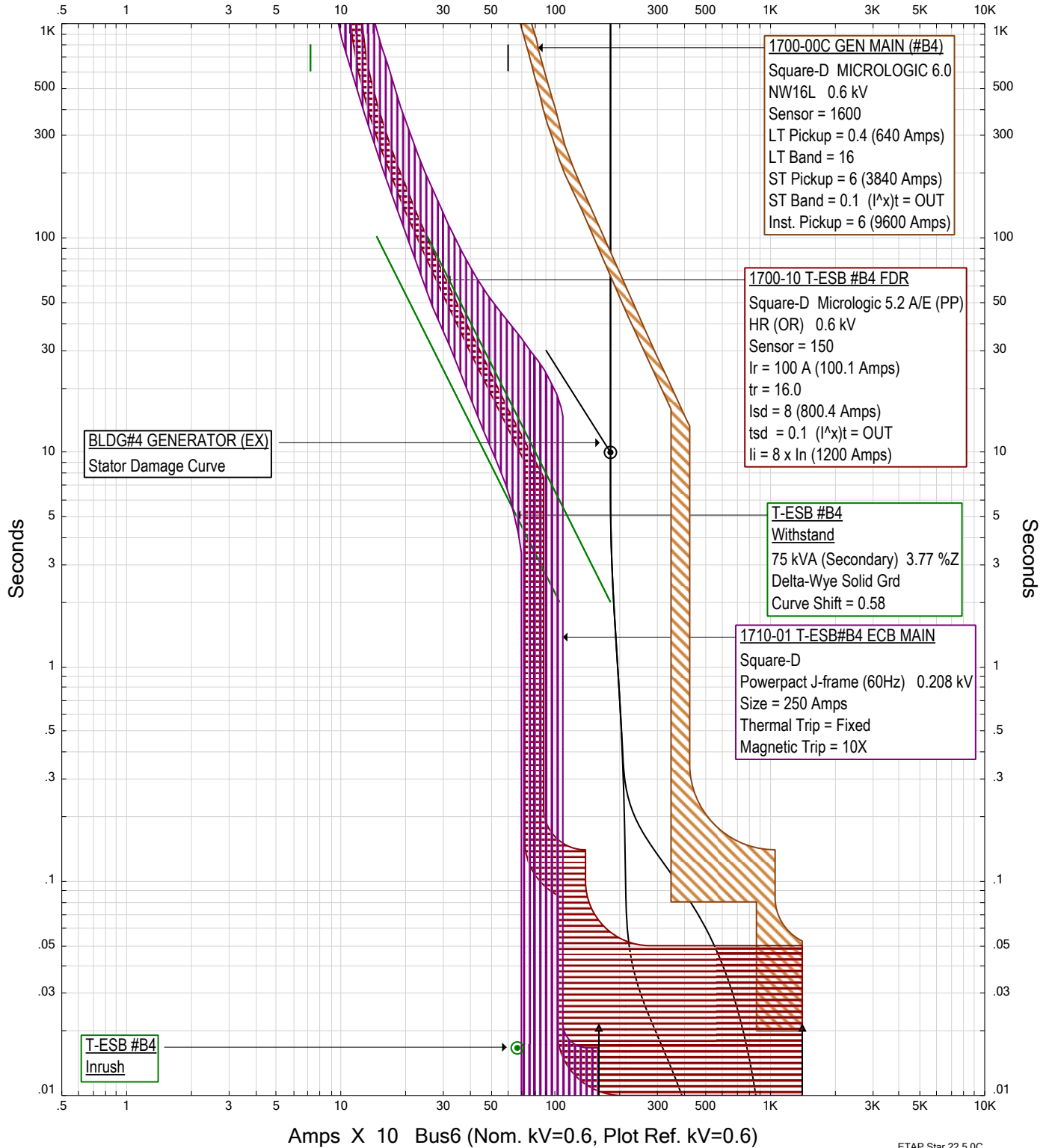
ETCC 1510



Project: CBBT-Support Bldg Emg
Location: CAPE CHARLES, VA
Contract: 50204245
V22.5PSE_20231231.lib

Rev: Base
Fault: Phase

Amps X 10 Bus6 (Nom. kV=0.6, Plot Ref. kV=0.6)



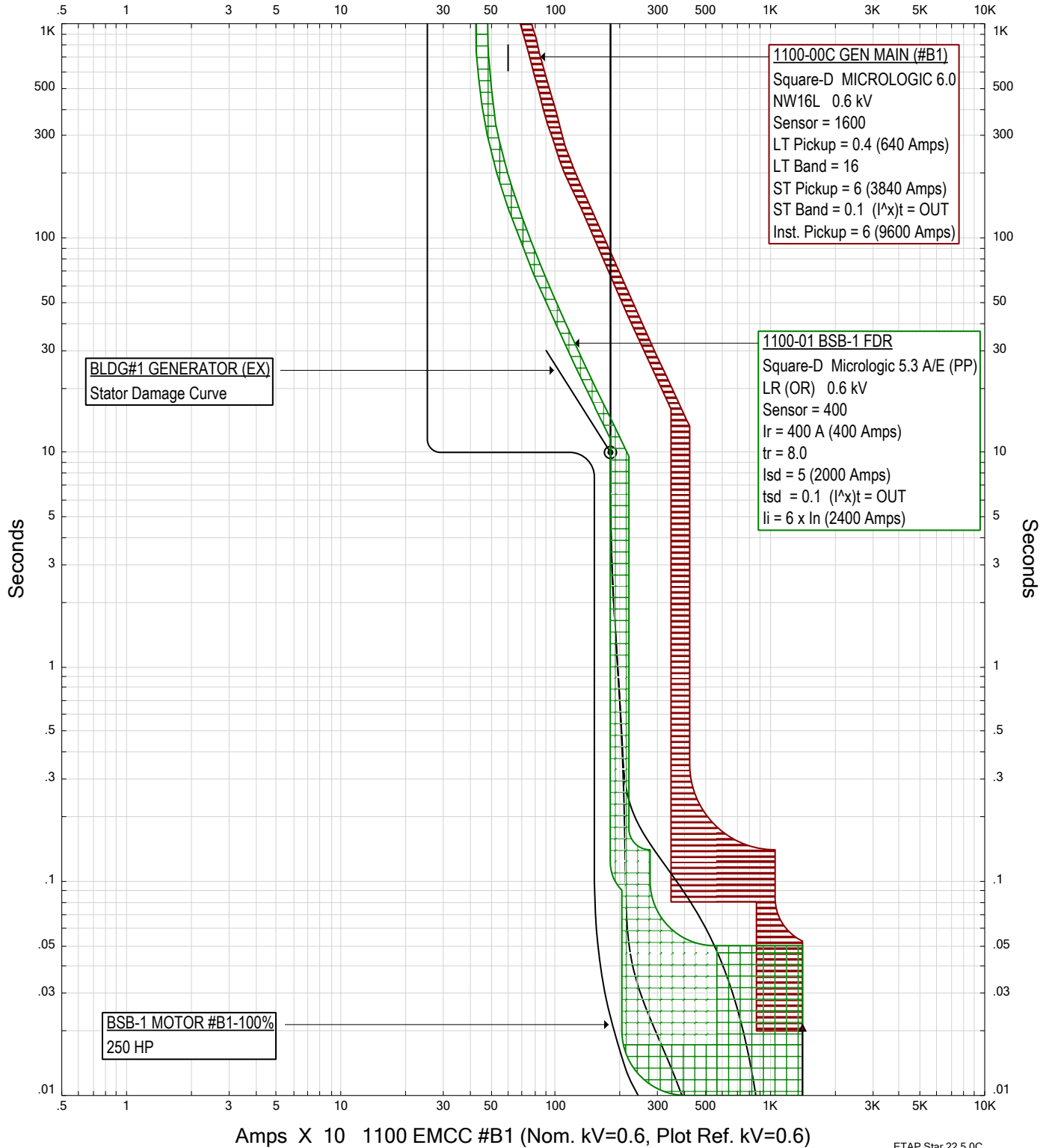
ETCC 1710



Project: CBBT-Support Bldg Emg
 Location: CAPE CHARLES, VA
 Contract: 50204245
 V22.5PSE_20231231.lib

Rev: Base
 Fault: Phase

Amps X 10 1100 EMCC #B1 (Nom. kV=0.6, Plot Ref. kV=0.6)



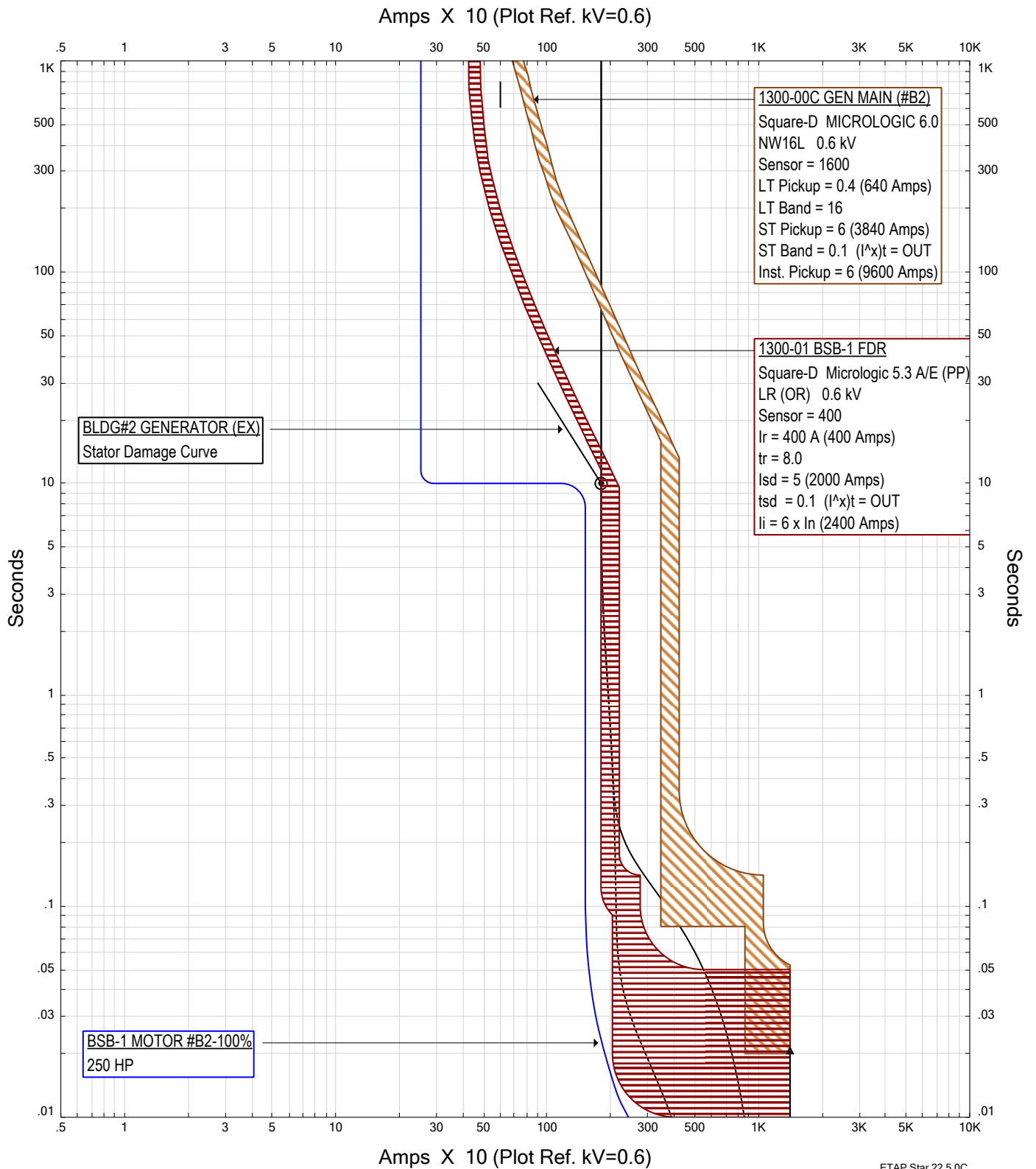
ETAP Star 22.5.0C

ETCC BSB-1 #B1



Project: CBBT-Support Bldg Emg
 Location: CAPE CHARLES, VA
 Contract: 50204245
 V22.5PSE_20231231.lib

Rev: Base
 Fault: Phase



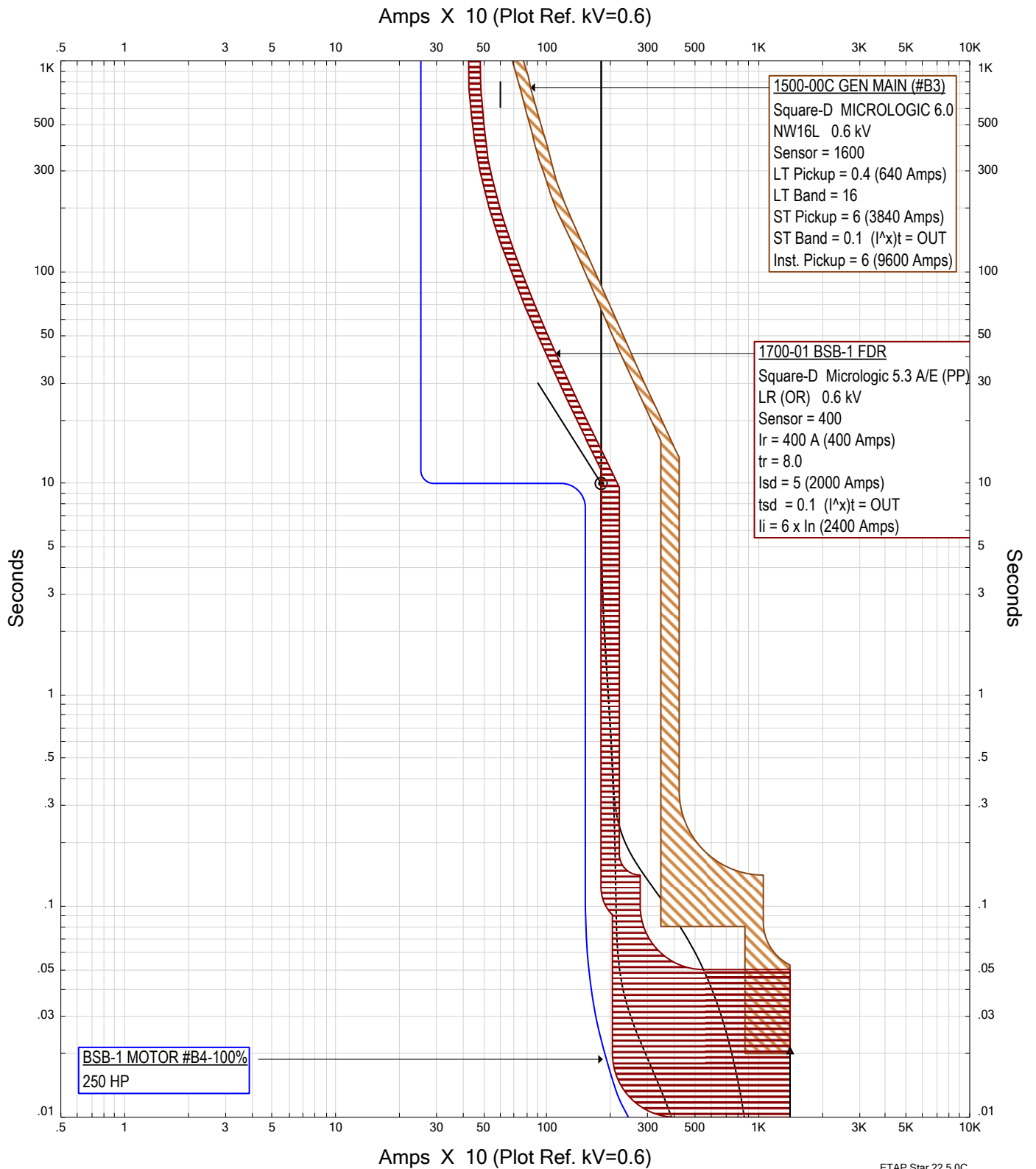
ETAP Star 22.5.0C

Project: CBBT-Support Bldg Emg
Location: CAPE CHARLES, VA
Contract: 50204245
V22.5PSE_20231231.lib

ETCC BSB-1 #B2



Rev: Base
Fault: Phase

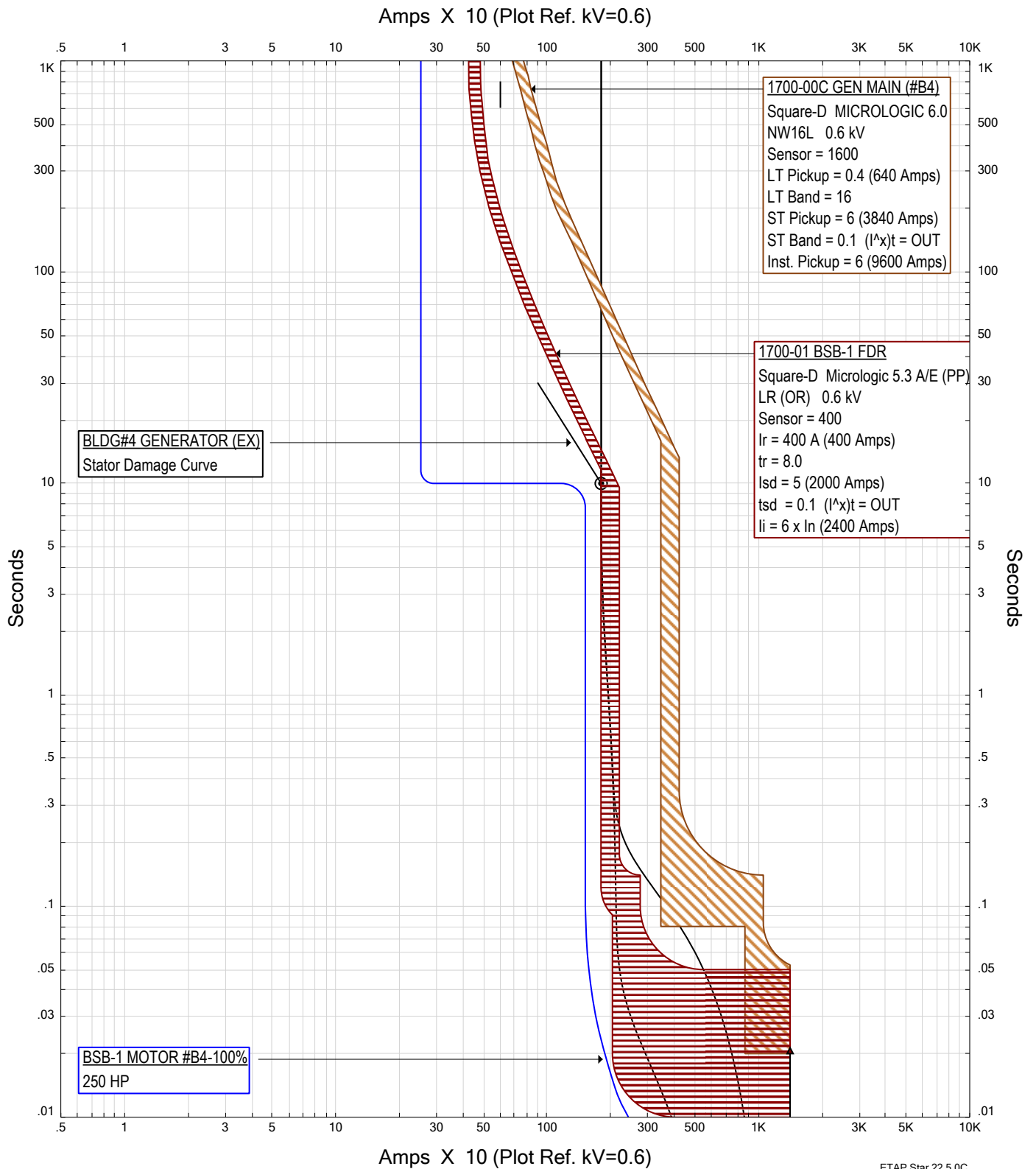


Project: CBBT-Support Bldg Emg
 Location: CAPE CHARLES, VA
 Contract: 50204245
 V22.5PSE_20231231.lib

ETCC BSB-1 #B3



Rev: Base
 Fault: Phase



ETAP Star 22.5.0C

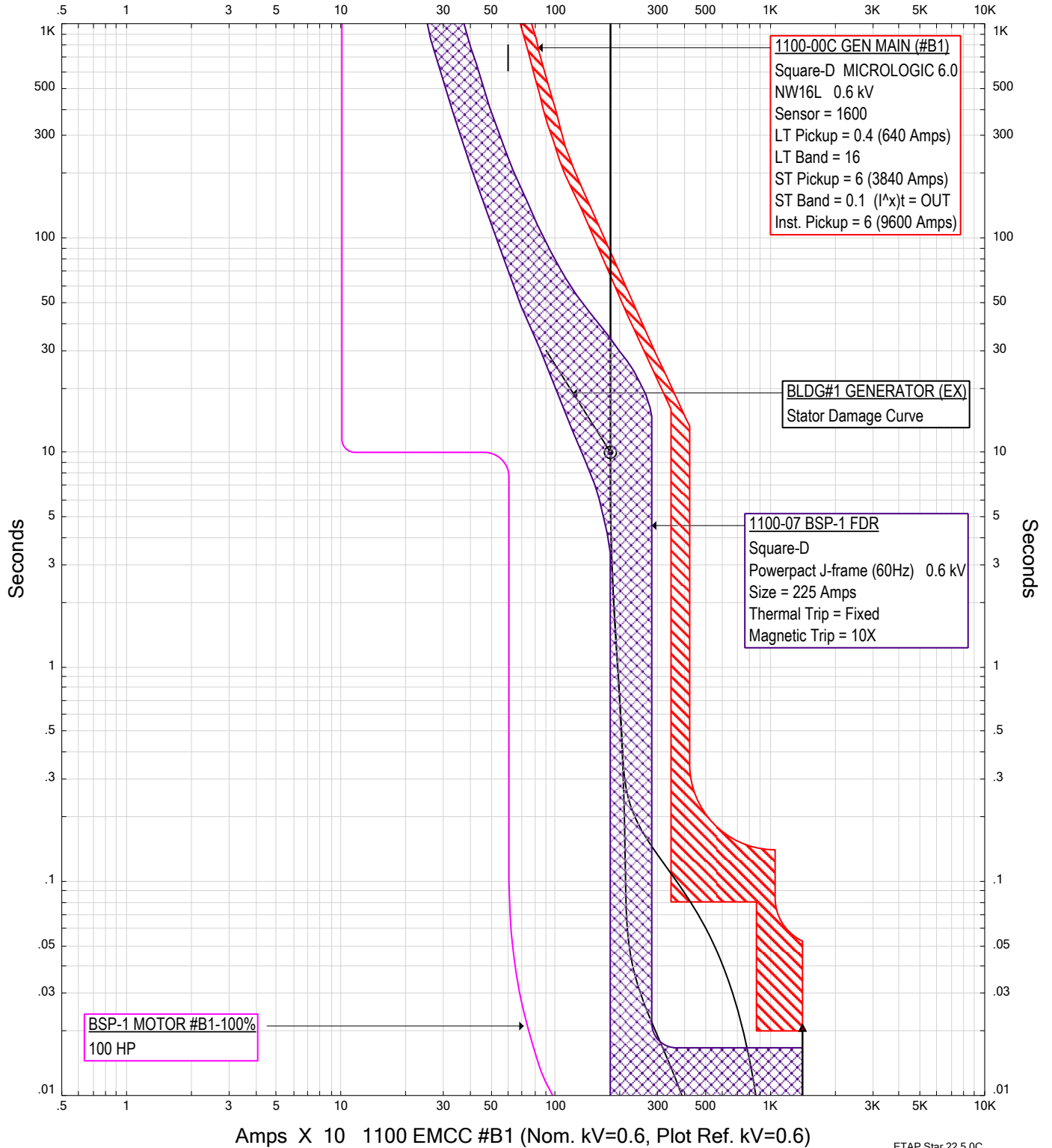
Project: CBBT-Support Bldg Emg
Location: CAPE CHARLES, VA
Contract: 50204245
V22.5PSE_20231231.lib

ETCC BSB-1 #B4



Rev: Base
Fault: Phase

Amps X 10 1100 EMCC #B1 (Nom. kV=0.6, Plot Ref. kV=0.6)



ETAP Star 22.5.0C

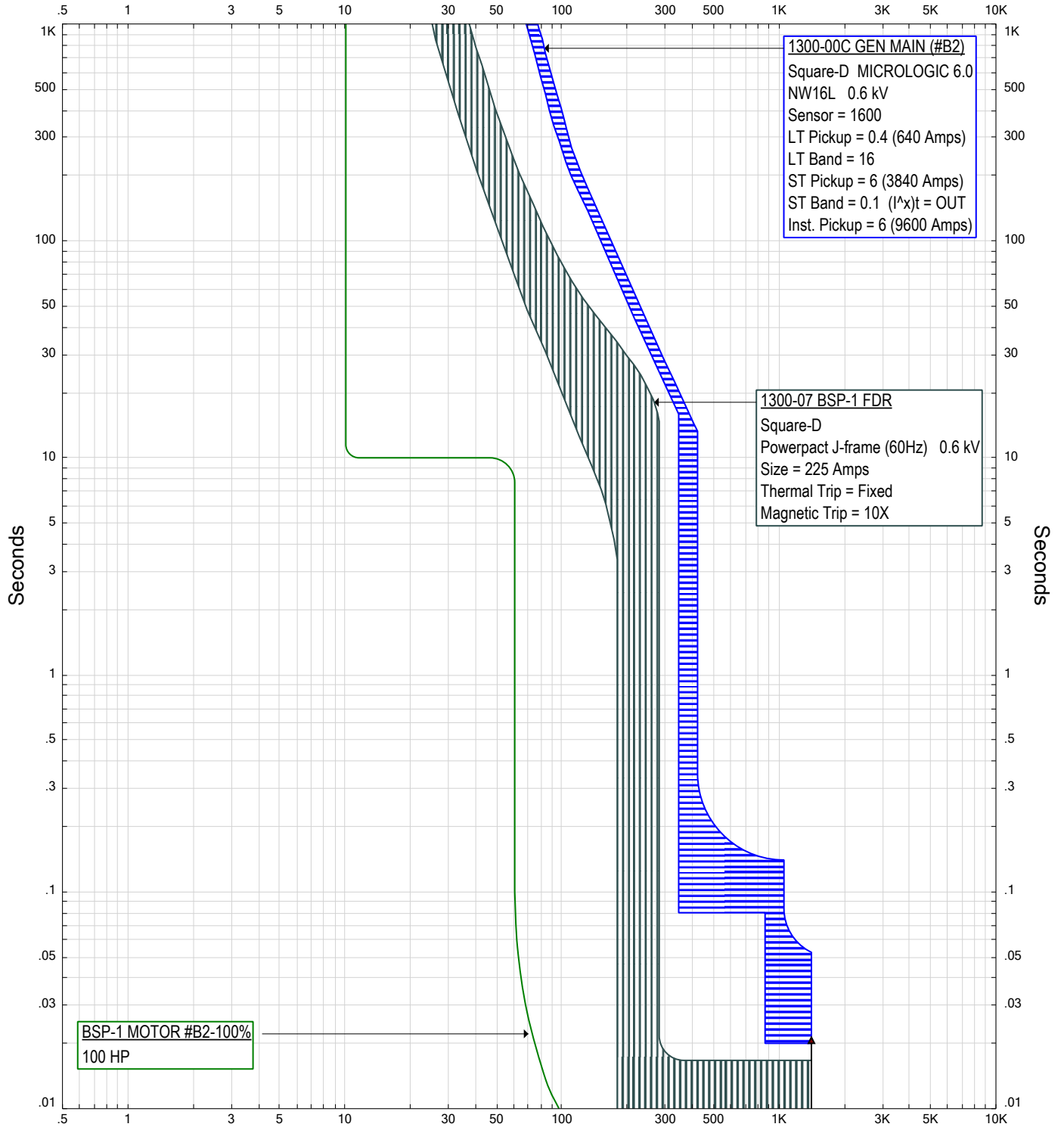
ETCC BSP-1 #B1



Project: CBBT-Support Bldg Emg
 Location: CAPE CHARLES, VA
 Contract: 50204245
 V22.5PSE_20231231.lib

Rev: Base
 Fault: Phase

Amps X 10 1300 EMCC #B2 (Nom. kV=0.6, Plot Ref. kV=0.6)



Amps X 10 1300 EMCC #B2 (Nom. kV=0.6, Plot Ref. kV=0.6)

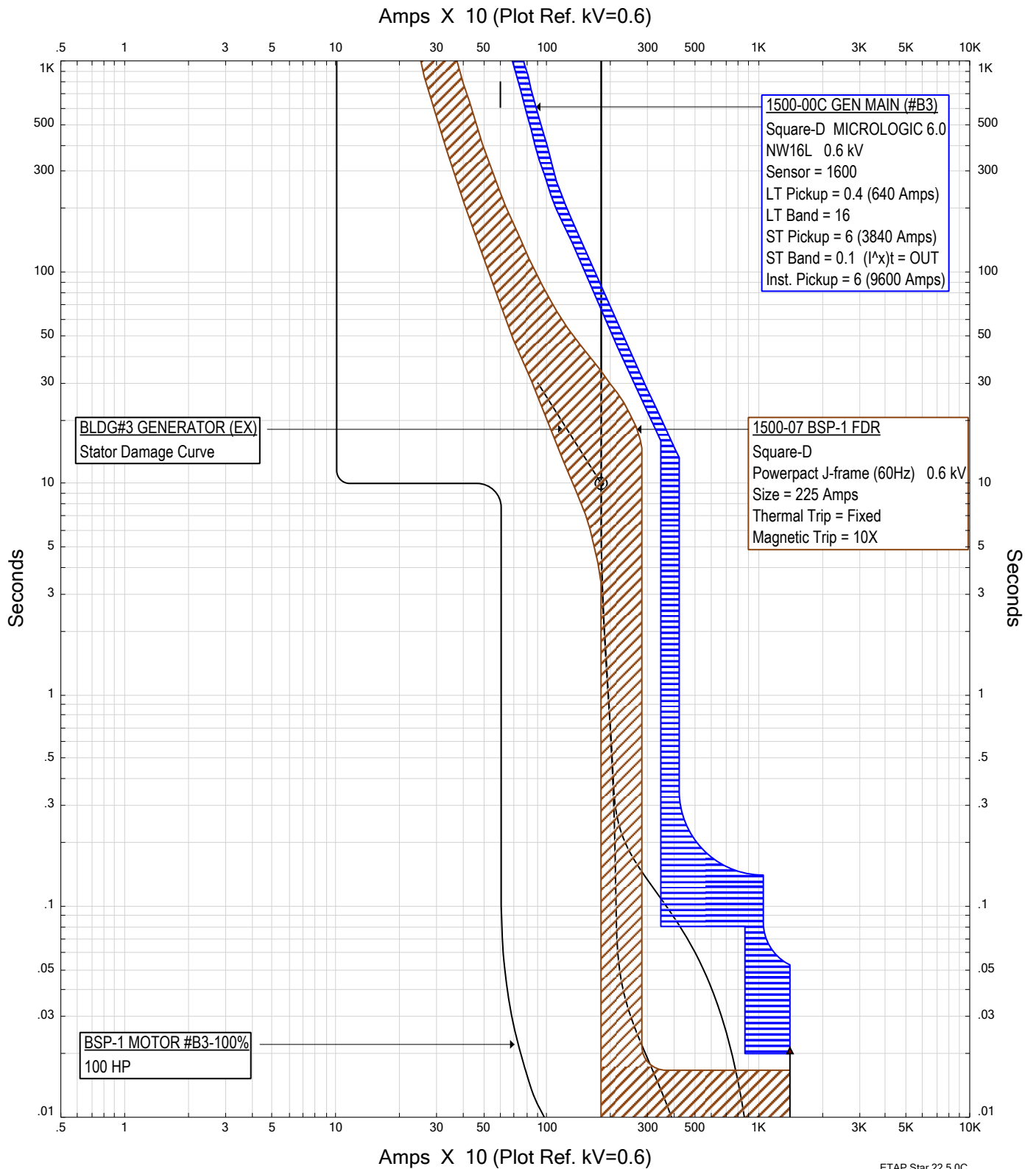
ETAP Star 22.5.0C

Project: CBBT-Support Bldg Emg
 Location: CAPE CHARLES, VA
 Contract: 50204245
 V22.5PSE_20231231.lib

ETCC BSP-1 #B2

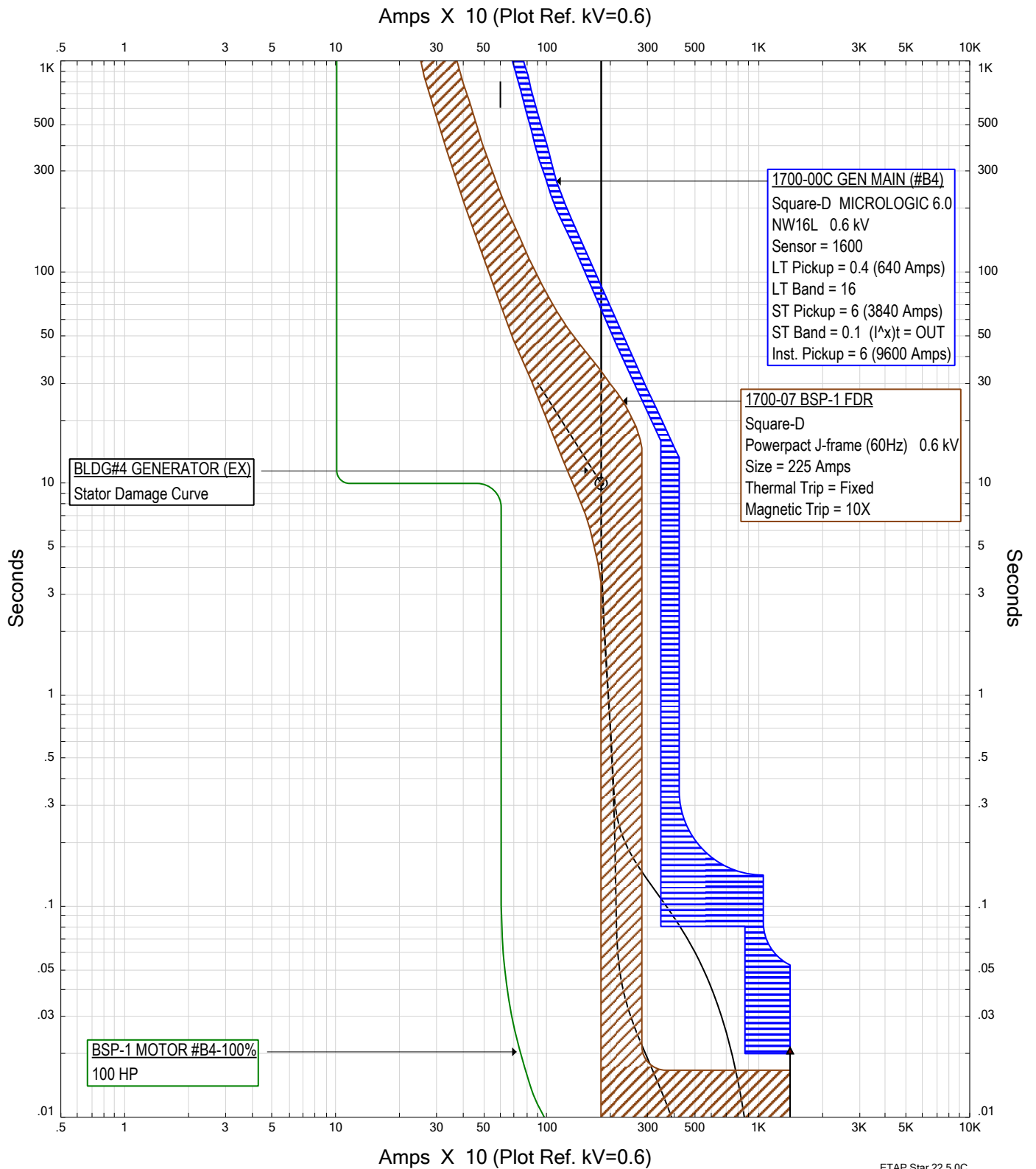


Rev: Base
 Fault: Phase



ETAP Star 22.5.0C

	ETCC BSP-1 #B3	
Project: CBBT-Support Bldg Emg Location: CAPE CHARLES, VA Contract: 50204245 V22.5PSE_20231231.lib		Rev: Base Fault: Phase



ETAP Star 22.5.0C

Project: CBBT-Support Bldg Emg
Location: CAPE CHARLES, VA
Contract: 50204245

V22.5PSE_20231231.lib

ETCC BSP-1 #B4



Rev: Base
Fault: Phase

6 ARC FLASH HAZARD ANALYSIS

6.1 General Procedure

Arc flash and electrical shock are the primary safety hazards for personnel working near exposed, energized electrical conductors or equipment. Analysis of arc-flash incident energy levels in a power distribution system dates back to the early 1980s, when Ralph Lee presented a theoretical model for evaluating the distance-energy relationship for electrical exposure, as described 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. Beginning in the mid-1990s, the arc-flash hazard was further quantified through lab testing of arcs in enclosures that were intended to model actual power distribution equipment enclosures. This testing eventually led to the development of IEEE Std. 1584TM-2002, *IEEE Guide for Performing Arc-Flash Hazard Calculations*. This standard defines a calculation model for arc-flash incident energy and arc-flash boundary levels based on "in box" and "open air" configurations in three-phase AC systems operating from 208V to 15kV.

Further testing on additional equipment configurations, and across a wider range of fault currents, has led to the release of an updated calculation model in the 2nd edition of the arc-flash calculation standard, IEEE 1584TM-2018. Compared to the 2002 model, the IEEE 1584-2018 model considers additional input variables such as the electrode configuration and the enclosure size. The range of other variables, such as the electrode gap, is increased. For some parameters, including system voltage and bolted fault current, the ranges have expanded some, but the additional data used to develop the arc flash equations is believed to yield greater accuracy within the model range.

The results presented in this report are based on the IEEE 1584 calculation procedures, as well as on guidance provided in IEEE Std. 1584.1-2013, *IEEE Guide for the Specification of Scope and Deliverable Requirements for an Arc-Flash Hazard Calculation Study in Accordance with IEEE Std. 1584TM*. 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 most 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.

Equipment should not be worked on unless it has been placed into an electrically safe work condition. Additional discussion of buses with incident energy over 40 cal/cm^2 is given in the Arc Flash Analysis of Results, if applicable. Even though PPE with arc ratings of at least 140 cal/cm^2 is commercially available, NFPA 70E does not define protective clothing classes with arc ratings above 40 cal/cm^2 , and many employers have used this level as a threshold above which no energized work is allowed under any conditions, due to the increased risk of non-burn injuries (e.g., concussions, hearing damage, or other internal injuries) at such high-energy locations.

The arc flash hazard analysis is no substitute for safe work practices. As stated in 130.7(A), Informational Note No. 1 of NFPA 70E, burn injuries can occur even when adequate PPE is employed, and arc rated 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 has been placed in an electrically safe work condition.

6.2 Specific Procedure

Arc-flash calculations are based primarily on the IEEE 1584-2018 model, with the key exceptions being locations operating above 15kV or for DC systems. First, the 2018 calculation model is applied to calculate the arcing fault current at each bus in the system based on the available three-phase bolted fault current determined during the short-circuit analysis. The arcing current level and the characteristics of the applicable phase overcurrent protective device are used to determine the arcing duration, i.e., the clearing time of the arcing fault, at each location. When applicable, clearing times are modified when there are special situations that may cause them to either speed up (e.g., presence of fast-acting optical arc-flash relays) or slow down (e.g., presence of a lockout relay, or communication delays that increase the total clearing time). The arcing fault current and clearing time values are then used to calculate an incident energy (IE) value. An Arcing Current Variation factor is applied to determine a minimum arcing current level for each bus. This is intended to account for typical variations in the characteristics of the arcs themselves. The minimum arcing current values are used to calculate a second clearing time and IE level. The result reported for each bus is the higher of the two values. Arc-flash boundary distances, which define the distance from the source of the arc where IE is equal to 1.2 cal/cm² and within which arc-rated PPE is required, are estimated by a similar process.

As with the 2002 model, arc-flash levels under the 2018 calculation model are influenced by the selection of the bus gap, i.e., the distance between phase conductors or busbars, and the working distance, i.e., the distance from the source of the arc to the worker. Gap values can vary within equipment, and so standard values based on IEEE 1584-2018 Table 8 were used. Standard working distance values of 36" for MV equipment, 24" for LV switchgear, and 18" for other LV equipment were used.

The equipment electrode configuration, original to the 2018 model, can significantly affect calculation results. In the 2002 model, locations were defined as either "in box" or "open air", with the "box" referring to an equipment enclosure, such as an MCC starter bucket. "In box" arcing faults produce higher IE values than "open air" arcs since the enclosure tends to focus energy towards the worker standing in front of an open equipment door or panel. In the 2018 model, there are five possible configurations – two open air (VOA or HOA) and three in-box (VCB, VCBB, or HCB). The difference between the two open-air configurations is the orientation of conductors relative to the worker – the VOA (vertical open air) configuration assumes electrodes oriented parallel to the worker, while the HOA (horizontal open air) assumes electrodes perpendicular to the worker. The horizontal configuration would tend to eject energy towards the worker and result in higher IE exposure – see Figure 6.

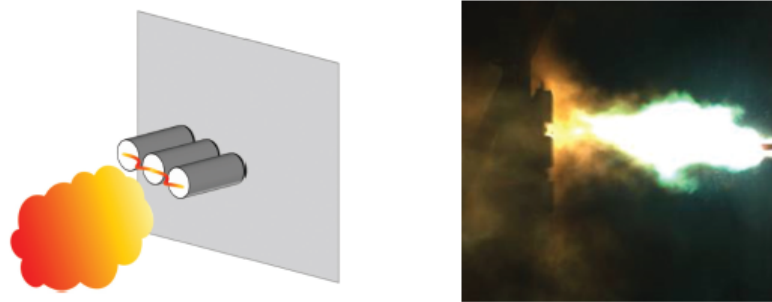


Figure 6: Diagram Showing HOA Electrode Configuration (L) and Horizontal Electrodes Under Test (R). (From IEEE 1584-2018)

The three in-box configurations include two with vertical electrodes (VCB, VCBB) and one with horizontal electrodes (HCB). VCB and HCB are similar to VOA and HOA, except that the electrodes are inside a metallic enclosure. The second “B” in VCBB denotes that the conductors are terminated in an insulating barrier. This is a common situation – for example, consider conductors run to the top of a circuit breaker, in which case the breaker itself would be the insulating barrier. In some types of equipment, multiple electrode configurations are possible. When HCB is possible, it will represent the worst-case incident energy level, so no other cases are run. Where equipment can contain VCB and VCBB orientations, either one could produce worst-case incident energy, depending on other system parameters. For those buses, two study cases are run and the higher IE level is reported.

As discussed above, for arcs in an enclosure such as a switchgear breaker cubicle, more incident energy is directed at the worker due to the “focusing” effect of the enclosure. While this effect is considered in both versions of IEEE 1584, the 2018 model goes a step beyond 2002 in that it allows for adjustment of IE results based on enclosure opening size. Larger opening sizes indicate that less energy is focused towards the worker. The model adjustment is done by consideration of an Enclosure Correction Factor (ECF), which allows enclosure dimensions up to 49”. The effects of the ECF can be significant – a 49” x 49” opening would result in a 25% reduction in IE when the ECF is applied, though the actual effect varies slightly depending on the electrode configuration and system nominal voltage. While IEEE 1584-2018 provides default enclosure sizes that may be used in calculations, the ECF in this study is calculated from the typical enclosure dimension values determined based on review of several classes of equipment from multiple manufacturers per the following table.

A summary of study input parameters – electrode configurations, dimensions, gap, and working distances – are shown in Table 2 below.

Table 2: Default Study Input Parameters.

Equipment Type	Electrode Config.	Height (in.)	Width (in.)	Depth (in.)	Working Dist. (in.)	Gap (mm)
LV Equipment	VCB + VCBB	20	20	20	18	25
LV Power Panel	VCB + VCBB	48	26	8	18	25
LV Switchboard	HCB	49	24	36	18	25
LV Switchgear	HCB	20	20	20	24	32
5kV Equipment	VCB + VCBB	20	20	20	36	104
5kV Switchgear	HCB	45	36	36	36	104
5kV MCC	VCB + VCBB	49	20	36	36	104
15kV Equipment	VCB + VCBB	20	20	20	36	152
15kV Switchgear	HCB	45	36	36	36	152

The “generic” types (e.g., LV Equipment, 5kV Equipment, and 15kV Equipment) include equipment that does not readily fit into the other categories, or particularly for the LV equipment, LV panelboard enclosures that are not appreciably different than the default 20x20x20 dimension. LV Power Panels include larger distribution panels like Square D I-Line panelboards. LV MCCs, where many MCC starter buckets of varying size may be present, would be analyzed as “LV Equipment” for the sake of simplicity.

For buses that represent low-voltage switchboards, panelboards, and most 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.

- Note: For most motor control centers it is assumed that the fault is cleared by the upstream protective device; however, for specific designs and conditions, some Model 6 MCCs may use the main breaker as the clearing device for certain distribution sections. This equipment is reviewed on a case by case basis at the time of the study.

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. Clause 6.9 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 that two seconds is a reasonable maximum arcing duration. 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.

For medium-voltage protective relays, additional time is added to the time-current curve to account for relay accuracy and minimum operating time of relay contacts during operation of instantaneous overcurrent elements.

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 can work on or near energized equipment. NFPA 70E 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 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 to minimize the possibility of electric shock. In addition to the Limited Approach Boundary, the Restricted Approach Boundary is also applicable to situations in which qualified personnel are exposed to live parts. See NFPA 70E Tables 130.4(D)(a) and 130.4(D)(b) for the boundary distances associated with various system voltages.

6.3 AF Hazard Analysis Results

The results of the arc flash hazard analysis are presented in the “ARC FLASH HAZARD ANALYSIS TABLE.” The parameters that the analysis is based upon—fault current, arc duration, electrode configuration and working distance—are presented along with the incident energy, and arc flash boundary for each piece of equipment. The electrode configuration shown is the one that resulted in the highest incident energy and arc-flash boundary levels.

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.

A conservative fault current value may not reveal the worst-case AFIE values that may be present. A small change in fault current, perhaps due to utility switching, may cause a large change in AFIE. Lower fault current sometimes results in higher arc flash energy because a protective device may take longer to operate and extinguish the arc. Therefore, multiple arc flash fault current scenarios were considered as follows:

For buildings #1, #2, #3 and #4 (BUS-1 is the preferred source of utility power to EMCC’s)

- The first consisted of 80 kA at 13.8kV, a maximum/high source based on an assumed fault current.
- The second consisted of 1.464 kA at 13.8kV, a minimum/low source based on assumed fault current.
- The third was for equipment fed by a permanent onsite generator.

IEEE 1584-2018 states that sustainable arcs are less likely in systems operating at 240V or less with less than 2kA available bolted fault current. Based on this, the incident energy level was assumed to be 1.2 cal/cm² or less at such locations. The arc flash boundary at these locations is a maximum of 1 ft 6 in. A simplified label approach is sometimes adopted which uses 8 cal/cm² and 40 cal/cm² maximum breaks for labeling. The minimum 8 cal/cm² incident energy level would use 5 ft 0 in. for the arc flash boundary distance.

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 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.

Equipment should not be worked on unless it has been placed into an electrically safe work condition. While NFPA 70E does not explicitly prohibit work at locations with energy levels above 40 cal/cm², 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.

6.3.1 Common Arc Flash Hazard Table Terms

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 common arc flash hazard analysis terms.

- Connected Bus (Bus Name): The designation for the equipment for which the arc-flash calculations are presented.
- Location: the location within the equipment where the arc-flash results apply. For most locations, the location will be “Bus” and the values will apply for the entire equipment enclosure. For equipment with an isolated main protective device, separate results will be provided for the “Source PD”.
- Type (Eqpt Type): This indicates the type of equipment in which the arc is assumed to occur, such as switchgear, panelboard, cable, or open air.
- Electrode (Busbar) Configuration: The electrode configuration (VOA, HOA, VCB, VCB, or HCB) upon which the calculation results are based. In locations where multiple electrode configurations are considered, this column will show which configuration resulted in worst-case incident energy levels.
- Conductor (Arc) Gap: This is the gap between conductors. Since IEEE 1584-2018 considers three-phase faults, the phase-phase gap rather than the phase-ground gap is considered. Standard gap distances are defined in IEEE 1584.
- 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.
- Output Rpt (Eqpt Configuration): Identifies the analysis scenario upon which the reported values are based – e.g., “Generator Source” or “Alternate Utility”. In most cases, the levels are reported based on the scenario that results in the highest incident energy.
- Incident Energy (Total Energy): The thermal energy density to which a person at the working distance is exposed.
- Arc Flash Boundary (AFB): This is the working distance at which incident energy equals 1.2 cal/cm², 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.

- Final FCT (sec) or Trip/Delay Time: Fault Clearing Time (FCT); accounts for the device trip time plus the opening time of the device to clear the arc.
- Protective Device Name (Source PD ID): 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 sometimes reported.
- Prot. Dev. Arcing Fault / I_a at FCT (kA): The calculated bus arcing fault current associated with the bolted fault current.
- Bus Bolted Fault (kA) / Total I_{bf} : The calculated three-phase bolted fault current, RMS symmetrical amperes.

6.3.2 Protective Arc Rated (AR) Clothing Characteristics

One fundamental principle of NFPA 70E is that work should not be performed on or near electrical equipment until it has been placed in an electrically safe work condition. Nevertheless, testing to verify equipment is “dead”, or energized work justified by exceptions in 70E, may still result in exposure of workers to electrical hazards. Selection of personal protective equipment (PPE) to help guard against hazards 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. Being in the same room with energized equipment does not necessarily constitute exposure; and in fact, it may be possible to perform some common tasks without being exposed. Refer to Table 130.5(C) Estimate of the Likelihood of Occurrence of an Arc Flash Incident for ac and dc Systems which is permitted to be used per the Risk Assessment Procedure specified in 70E, Article 110, when an incident energy analysis method has been performed.

Using PPE categories has been a convenient way to determine arc-rated (AR) clothing and other PPE, but there are other ways to decide what level of AR clothing is required. A simplified approach is to use a *two-level* clothing system, with protection at 8 cal/cm² and 40 cal/cm². This makes it easier for workers and companies by reducing the type of PPE issued and selected/worn.

Simplified AR clothing characteristics are based on NFPA 70E, Annex H, as shown in Table 2. Consult 70E and manufacturers’ AR specifications for additional requirements for hearing, face, and eye protection. The latest edition of 70E should be followed regarding limitations and requirements for working on equipment. Energized work requirements are restrictive and include mandatory energized work permits.

Table 3: Simplified AR Clothing Characteristics

Simplified AR Clothing	Minimum Required cal/cm ²
Arc-rated long-sleeve shirt with arc-rated pants (minimum arc rating of 8) <i>or</i> Arc-rated coveralls (minimum arc rating of 8)	8
Arc Flash Suit A total clothing system consisting of arc rated shirt and pants and/or arc-rated coveralls and/or arc flash coat and pants (clothing system minimum arc rating of 40)	40
Note: Depending on the task, other required PPE may include arc-rated face shields or arc flash suit hoods, arc-rated hard hat liners, safety glasses or safety goggles, hard hats, hearing protection, heavy-duty leather gloves, rubber insulating gloves, and insulating or insulated hand tools. The arc rating for a garment is expressed in cal/cm ² .	

NFPA 70E has transformed over the years reflecting different approaches used to determine estimated incident energy and permits alternative choices for selecting PPE based on different incident energy levels. PPE categories have simplified and reduced over time as shown by the following tables. Many employers simplify things further to avoid giving each employee four or five different sets of PPE; and instead, use a two-level PPE approach as defined in Table H.2. A similar approach is possible for the incident energy analysis method. In 2017, NFPA 70E introduced Table 130.5(G), a two-level system used with a breakpoint of 12 cal/cm²; however, PPE with protection at 8 cal/cm² and 40 cal/cm² remains the most common AR clothing combination used. Site-specific PPE levels are permitted to be defined by an owner's electrical safe work practices per 70E – break points can be based on the PPE categories, or other PPE level break points. **For selection of PPE, refer to the latest edition of NFPA 70E.**

NFPA 70E Selection of Protective Clothing (Past and Present) PPE Category Method Allowable Categories	
2009 Table 130.7(C)(11) and 2012 Table 130.7(C)(16) Personal Protective Equipment (PPE)	2015 Table 130.7(C)(16) and 2018 & 2021 Table 130.7(C)(15)(c) Personal Protective Equipment (PPE)
(Category 0) 1.2 cal/cm ²	(Category 1) 4 cal/cm ²
(Category 1) 4 cal/cm ²	
(Category 2) 8 cal/cm ²	(Category 2) 8 cal/cm ²
(Category 3) 25 cal/cm ²	(Category 3) 25 cal/cm ²
(Category 4) 40 cal/cm ²	(Category 4) 40 cal/cm ²
Over 40 cal/cm ² not defined	Over 40 cal/cm ² not defined

NFPA 70E Selection of Protective Clothing (Past and Present)
2018 & 2021 Table 130.5(G) Selection of Arc-Rated Clothing and Other PPE (permitted when incident energy analysis method is used)
Less than 1.2 cal/cm ² not defined
1.2 cal/cm ² to 12 cal/cm ²
Greater than 12 cal/cm ²
Over 40 cal/cm ² not defined

NFPA 70E Selection of Protective Clothing (Past and Present) Annex H - PPE Category Method Allowable Categories	
2009 Table H.1 and 2012 - 2021 Table H.2 Simplified, Two-Category, Arc-Rated Clothing System	
Less than 1.2 cal/cm ² not defined	
Everyday Work Clothing 8 cal/cm ² minimum arc rating	
Arc Flash Suit Greater than 8 cal/cm ² to 40 cal/cm ²	
Over 40 cal/cm ² not defined	

NFPA 70E Selection of Protective Clothing (Past and Present) Annex H - Incident Energy Analysis Method Permitted Levels	
2012 & 2015 Table H.3(b) Guidance on Selection of Arc-Rated Clothing and Other PPE for Use When Incident Energy Exposure is Determined	
Less than or equal to 1.2 cal/cm ²	Removed from NFPA 70E in 2018
1.2 cal/cm ² to 12 cal/cm ²	
Greater than 12 cal/cm ²	
Over 40 cal/cm ² not defined	

6.3.3 Arc Flash Hazard Analysis Table – Recommended Settings



POWER SYSTEM ENGINEERING

ARC FLASH HAZARD
ANALYSIS TABLE

Connected Bus	Location	kV	Type	Electrode Configuration	Conduct or Gap LL (mm)	Working Distance LL (in)	Output Rpt.	Total Energy (cal/cm²)	AFB (ft-in)	Final FCT (sec)	Source PD ID	Ia at FCT (kA)	Total Ibf'' (kA)
1100 EMCC #B1 [FEEDER]	Bus Arc Fault	0.600	Panelboard	VCBB	25	18	AF-G	7.11	4' 0"	2.000	1100-00C GEN MAIN (#B1)	1.483	5.720
1100 EMCC #B1 [MAIN]	Source PD Line-side	0.600	LV CB	VCBB	25	18	AF-H	91	16' 5"	2.000		15.037	25.679
1110 T-ESB #B1 ECB	Bus Arc Fault	0.208	Panelboard	VCBB	25	18	AF-H	10.01	4' 10"	2.000	1100-10 T-ESB #B1 FDR	2.249	4.871
1300 EMCC #B2 [FEEDER]	Bus Arc Fault	0.600	Panelboard	VCBB	25	18	AF-G	7.09	4' 0"	2.000	1300-00C GEN MAIN (#B2)	1.481	5.695
1300 EMCC #B2 [MAIN]	Source PD Line-side	0.600	LV CB	VCBB	25	18	AF-H	94	16' 8"	2.000		15.431	26.108
1310 T-ESB #B2 ECB	Bus Arc Fault	0.208	Panelboard	VCBB	25	18	AF-H	10.00	4' 10"	2.000	1300-10 T-ESB FDR	2.247	4.860
1500 EMCC #B3 [FEEDER]	Bus Arc Fault	0.600	Panelboard	VCBB	25	18	AF-G	7.08	4' 0"	2.000	1500-00C GEN MAIN (#B3)	1.479	5.670
1500 EMCC #B3 [MAIN]	Source PD Line-side	0.600	LV CB	VCBB	25	18	AF-H	90	16' 3"	2.000		14.847	25.458
1510 T-ESB #B3 ECB	Bus Arc Fault	0.208	Panelboard	VCBB	25	18	AF-H	9.99	4' 10"	2.000	1500-10 T-ESB #B3 FDR	2.246	4.869
1700 EMCC #B4 [FEEDER]	Bus Arc Fault	0.600	Panelboard	VCBB	25	18	AF-G	7.10	4' 0"	2.000	1700-00C GEN MAIN (#B4)	1.482	5.708
1700 EMCC #B4 [MAIN]	Source PD Line-side	0.600	LV CB	VCBB	25	18	AF-H	90	16' 4"	2.000		14.910	25.512
1710 T-ESB #B4 ECB	Bus Arc Fault	0.208	Panelboard	VCBB	25	18	AF-H	9.84	4' 10"	2.000	1700-10 T-ESB #B4 FDR	2.216	4.803

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 white polyester label stock (2 mil $\pm 10\%$) using a thermal transfer printer. The labels have a pressure sensitive permanent acrylic adhesive backing (1 mil $\pm 10\%$) and are 4.0-inches by 6.0-inches. Clear acrylic overlaminates (2 mil $\pm 10\%$) are available for outdoor application where UV resistance is required. The following information is included on each label:

- “Arc Flash Information” banner on the top of the label
- Incident Energy in cal/cm^2
- Arc Flash Boundary distance
- Working Distance
- Shock hazard when cover is open
- Limited Approach distance
- Restricted Approach distance
- Equipment name
- Arc Flash Analysis study (Q2C) number
- Arc Flash Analysis study date

The Arc Flash Information label (typical labels shown in Figure 7) will report the calculated incident energy and arc flash boundary for a given piece of equipment. Equipment names are on these labels as well as the information previously listed.

Arc Flash Information	
Use this information in accordance with applicable OSHA standards, NFPA 70E and other required safe electrical work practices.	
1.71 cal/cm ² Incident Energy at a Working Distance of 1 ft 6 in. 1 ft 10 in. Arc Flash Boundary	
208V Shock hazard when cover is open 3 ft 6 in. Limited Approach 1 ft 0 in. Restricted Approach	
Eqpt Name: L1A	Job: 12345678 Date: 09/10/19
Values produced by a Schneider Electric engineering analysis. Any system modification, adjustment of protective device settings, or failure to properly maintain equipment will invalidate this label. For more information, contact Schneider Electric at 1-888-778-2733.	
Copyright©2017 Schneider Electric All Rights Reserved	

Arc Flash Information	
Use this information in accordance with applicable OSHA standards, NFPA 70E and other required safe electrical work practices.	
63 cal/cm ² Incident Energy at a Working Distance of 2 ft 0 in. 30 ft 2 in. Arc Flash Boundary	
480V Shock hazard when cover is open 3 ft 6 in. Limited Approach 1 ft 0 in. Restricted Approach	
Eqpt Name: SWGR-1	Job: 12345678 Date: 09/10/19
Values produced by a Schneider Electric engineering analysis. Any system modification, adjustment of protective device settings, or failure to properly maintain equipment will invalidate this label. For more information, contact Schneider Electric at 1-888-778-2733.	
Copyright©2017 Schneider Electric All Rights Reserved	

Figure 7: Typical Arc Flash Information Labels – Actual sizes are 4" x 6".
Under 40 cal/cm² (shown top); Over 40 cal/cm² (shown bottom).

Once authorized, 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.

6.4.2 General Safety Labels

General safety labels (typical label shown in Figure 8) 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 $\pm 10\%$) with UV resistant lamination (3 mil $\pm 10\%$). The labels have a pressure sensitive permanent acrylic adhesive backing (1 mil $\pm 10\%$) 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. In 2014, REV 01 was issued which added "or CSA Z462" to the label.

For older Square D brand equipment lacking appropriate general safety labels, or for equipment manufactured by others, affix Schneider Electric general safety labels (Figure 8) 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).

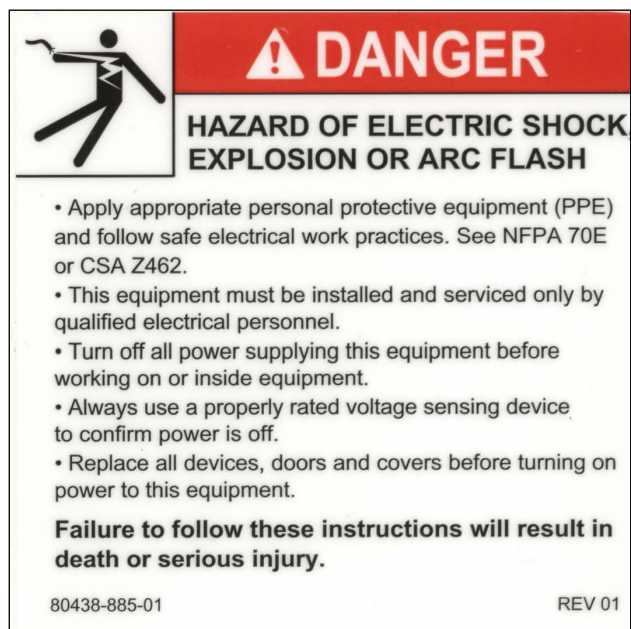


Figure 8: Typical General Safety Label for Electrical Equipment (Actual size is 3.6" x 3.6").

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
NFPA	National Fire Protection Association
UL	Underwriters' Laboratories, Inc.

Other Abbreviations

1P	1-Pole or single-phase
3P	3-Pole or three-phase
A	Amperes (RMS symmetrical)
AFB	Arc Flash Boundary
AFIE	Arc Flash Incident Energy (cal/cm ²)
AIC	Amperes Interrupting Capacity (Three-Phase RMS sym.)
AMS	Alternate Maintenance Setting (switch)
ASD	Adjustable Speed ac Drive
ATPV	Protective Clothing Arc Rating
ATS	Automatic Transfer Switch
BOM	Bill of Materials
CB	Circuit Breaker
CHP	Combined Horsepower
CFLA	Combined Full Load Amperes
CT	Current Transformer
DC	Direct Current
FLA	Full Load Amperes
ERMS	Energy Reduction Maintenance Switch
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
LV	Low Voltage
LSIG	L = Long Time, S = Short time, I = Instantaneous, G = Ground fault protection
MCC	Motor Control Center
MCS	Molded Case Switch
MDGF	Modified-Differential Ground Fault
Mohms	Milliohms
MTS	Manual Transfer Switch
MV	Medium Voltage
OCPD	Overcurrent Protective Device
OL	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
SF	Service Factor
SLG	Single Line to Ground
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.)
VFD	Variable Frequency Drive
WCR	Withstand Current Rating
X	Reactance
Z	Impedance
ZSI	Zone Selective Interlocking
%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, SORDEL, 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
Schneider Electric	SE
Schweitzer Engr. Labs	SEL
Siemens	SIE
Square D	SQD
Thomas Betts	T-B
Toshiba	TOS
Westinghouse	WEST
Zenith	Z

APPENDIX B: SHORT CIRCUIT INPUT/OUTPUT DATA

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC UTILITY

Page: 1

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG UTIL

V22.5PSE_20231231.lib

Electrical Transient Analyzer Program

Short-Circuit Analysis

ANSI Standard

3-Phase, LG, LL, & LLG Fault Currents

1/2 Cycle Network

	Swing	V-Control	Load	Total			
Number of Buses:	4	0	60	64			
					Line/Cable/ Busway	Impedance	Tie PD
	XFMR2	XFMR3	Reactor				Total
Number of Branches:	8	0	0	52	0	0	60
	Synchronous Generator	Power Grid	Synchronous Motor	Induction Machines	Lumped Load	Inverter	Total
Number of Machines:	0	4	0	32	0	0	36

System Frequency:

Unit System:

Project Filename:

Output Filename:

60.00

English

50204245- CBBT Support Bldg

C:\Schneider\Scriptingpath\Nikita Projects\2024\July\Revisions\50204245 - CBBT Study\ETAP\SC.SA2S

Project: CBBT-Support Bldg Emg

ETAP

Page: 2

Location: CAPE CHARLES, VA

22.5.0C

Date: 09-18-2024

Contract: 50204245

SN: SCHNDR-CA2

Engineer:

Study Case: SC UTILITY

Revision: Base

Filename: 50204245- CBBT Support Bldg

Config.: CFG UTIL

V22.5PSE_20231231.lib

Adjustments

<u>Tolerance</u>	<u>Apply Adjustments</u>	<u>Individual /Global</u>	<u>Percent</u>
Transformer Impedance:	Yes	Individual	
Reactor Impedance:	No		
Overload Heater Resistance:	No		
Transmission Line Length:	No		
Cable / Busway Length:	No		
<u>Temperature Correction</u>	<u>Apply Adjustments</u>	<u>Individual /Global</u>	<u>Degree C</u>
Transmission Line Resistance:	No		
Cable / Busway Resistance:	Yes	Global	25

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC UTILITY

Page: 3

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG UTIL

V22.5PSE_20231231.lib

Bus Input Data

Bus					Initial Voltage	
ID	Type	Nom. kV	Base kV	Sub-sys	%Mag.	Ang.
1100 EMCC #B1	Load	0.600	0.600	1	100.00	-30.00
1110 T-ESB #B1 ECB	Load	0.208	0.208	1	100.00	-60.00
1300 EMCC #B2	Load	0.600	0.600	3	100.00	-30.00
1310 T-ESB #B2 ECB	Load	0.208	0.208	3	100.00	-60.00
1500 EMCC #B3	Load	0.600	0.600	5	100.00	-30.00
1510 T-ESB #B3 ECB	Load	0.208	0.208	5	100.00	-60.00
1700 EMCC #B4	Load	0.600	0.600	7	100.00	-30.00
1710 T-ESB #B4 ECB	Load	0.208	0.208	7	100.00	-60.00
Bus4	Load	0.480	0.600	1	100.00	-30.00
Bus5	Load	0.600	0.600	1	100.00	-30.00
Bus12	Load	0.208	0.208	1	100.00	-60.00
Bus13	Load	0.600	0.600	1	100.00	-30.00
Bus14	Load	0.600	0.600	1	100.00	-30.00
Bus15	Load	0.600	0.600	1	100.00	-30.00
Bus16	Load	0.600	0.600	1	100.00	-30.00
Bus17	Load	0.600	0.600	1	100.00	-30.00
Bus18	Load	0.600	0.600	1	100.00	-30.00
Bus19	Load	0.600	0.600	1	100.00	-30.00
Bus20	Load	0.600	0.600	1	100.00	-30.00
Bus22	Load	0.480	0.600	3	100.00	-30.00
Bus25	Load	0.600	0.600	3	100.00	-30.00
Bus26	Load	0.600	0.600	3	100.00	-30.00
Bus27	Load	0.600	0.600	3	100.00	-30.00
Bus28	Load	0.600	0.600	3	100.00	-30.00
Bus29	Load	0.600	0.600	3	100.00	-30.00
Bus30	Load	0.600	0.600	3	100.00	-30.00
Bus31	Load	0.600	0.600	3	100.00	-30.00
Bus32	Load	0.208	0.208	3	100.00	-60.00
Bus33	Load	0.600	0.600	3	100.00	-30.00
Bus34	Load	0.600	0.600	3	100.00	-30.00
Bus37	Load	0.600	0.600	5	100.00	-30.00
Bus38	Load	0.600	0.600	5	100.00	-30.00
Bus39	Load	0.600	0.600	5	100.00	-30.00
Bus40	Load	0.600	0.600	5	100.00	-30.00
Bus41	Load	0.600	0.600	5	100.00	-30.00
Bus42	Load	0.600	0.600	5	100.00	-30.00
Bus43	Load	0.600	0.600	5	100.00	-30.00
Bus44	Load	0.208	0.208	5	100.00	-60.00
Bus45	Load	0.600	0.600	5	100.00	-30.00
Bus46	Load	0.600	0.600	5	100.00	-30.00
Bus47	Load	0.480	0.600	5	100.00	-30.00

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC UTILITY

Page: 4

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG UTIL

V22.5PSE_20231231.lib

Bus					Initial Voltage	
ID	Type	Nom. kV	Base kV	Sub-sys	%Mag.	Ang.
Bus51	Load	0.600	0.600	7	100.00	-30.00
Bus52	Load	0.600	0.600	7	100.00	-30.00
Bus53	Load	0.600	0.600	7	100.00	-30.00
Bus54	Load	0.600	0.600	7	100.00	-30.00
Bus55	Load	0.600	0.600	7	100.00	-30.00
Bus56	Load	0.600	0.600	7	100.00	-30.00
Bus57	Load	0.600	0.600	7	100.00	-30.00
Bus58	Load	0.208	0.208	7	100.00	-60.00
Bus59	Load	0.600	0.600	7	100.00	-30.00
Bus60	Load	0.600	0.600	7	100.00	-30.00
Bus61	Load	0.480	0.600	7	100.00	-30.00
EX ESSENTIAL SB #B1	Load	0.208	0.208	1	100.00	-60.00
EX ESSENTIAL SB #B2	Load	0.208	0.208	3	100.00	-60.00
EX ESSENTIAL SB #B3	Load	0.208	0.208	5	100.00	-60.00
EX ESSENTIAL SB #B4	Load	0.208	0.208	7	100.00	-60.00
EX T-CBW2 #B1	Load	0.600	0.600	1	100.00	-30.00
EX T-CBW2 #B3	Load	0.600	0.600	5	100.00	-30.00
EX T-CBW2 #B4	Load	0.600	0.600	7	100.00	-30.00
EX T-CBW2 BLDG#2	Load	0.600	0.600	3	100.00	-30.00
UTIL BLDG#1 BUS-1 (P)	SWNG	13.800	13.800	1	100.00	0.00
UTIL BLDG#2 BUS-1 (P)	SWNG	13.800	13.800	3	100.00	0.00
UTIL BLDG#3 BUS-1 (P)	SWNG	13.800	13.800	5	100.00	0.00
UTIL BLDG#4 BUS-1 (P)	SWNG	13.800	13.800	7	100.00	0.00

64 Buses Total

All voltages reported by ETAP are in % of bus Nominal kV.

Base kV values of buses are calculated and used internally by ETAP.

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC UTILITY

Page: 5

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG UTIL

V22.5PSE_20231231.lib

Line/Cable/Busway Input Data

ohms or siemens per 1000 ft per Conductor (Cable) or per Phase (Line/Busway)

Line/Cable/Busway			Length		#/Phase	T (°C)	R1	X1	Y1	R0	X0	Y0
ID	Library	Size	Adj. (ft)	% Tol.								
Cable 24	0.6MCUN1	600	45.0	0.0	3	25	0.0209612	0.048		0.0660279	0.11808	
Cable 29	0.6MCUN1	500	110.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 30	0.6MCUN1	500	65.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 31	0.6MCUN1	500	75.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 32	0.6MCUN1	500	100.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 33	0.6MCUN1	500	65.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 34	0.6MCUN1	500	55.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 35	0.6MCUN1	3/0	120.0	0.0	1	25	0.0662375	0.052		0.2086481	0.12792	
Cable 36	0.6MCUN1	2	25.0	0.0	1	25	0.1676898	0.057		0.5282229	0.14022	
Cable 37	0.6MCUN1	250	15.0	0.0	1	25	0.0452763	0.052		0.1426202	0.12792	
Cable 38	0.6MCUN1	250	25.0	0.0	1	25	0.0452763	0.052		0.1426202	0.12792	
Cable 39	0.6MCUN1	3/0	125.0	0.0	1	25	0.0662375	0.052		0.2086481	0.12792	
Cable 40	0.6MCUN1	1/0	45.0	0.0	1	25	0.1006139	0.055		0.3169338	0.1353	
Cable 45	0.6MCUN1	500	120.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 46	0.6MCUN1	500	100.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 47	0.6MCUN1	500	80.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 48	0.6MCUN1	500	100.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 49	0.6MCUN1	500	65.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 50	0.6MCUN1	500	80.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 51	0.6MCUN1	3/0	140.0	0.0	1	25	0.0662375	0.052		0.2086481	0.12792	
Cable 52	0.6MCUN1	250	40.0	0.0	1	25	0.0452763	0.052		0.1426202	0.12792	
Cable 53	0.6MCUN1	250	15.0	0.0	1	25	0.0452763	0.052		0.1426202	0.12792	
Cable 54	0.6MCUN1	2	30.0	0.0	1	25	0.1676898	0.057		0.5282229	0.14022	
Cable 55	0.6MCUN1	2/0	140.0	0.0	1	25	0.0838449	0.054		0.2641115	0.13284	
Cable 56	0.6MCUN1	1/0	50.0	0.0	1	25	0.1006139	0.055		0.3169338	0.1353	
Cable 57	0.6MCUN1	600	15.0	0.0	3	25	0.0209612	0.048		0.0660279	0.11808	
Cable 61	0.6MCUN1	500	110.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 62	0.6MCUN1	500	100.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 63	0.6MCUN1	500	70.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 64	0.6MCUN1	500	100.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 65	0.6MCUN1	500	60.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 66	0.6MCUN1	500	50.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 67	0.6MCUN1	3/0	120.0	0.0	1	25	0.0662375	0.052		0.2086481	0.12792	
Cable 68	0.6MCUN1	250	35.0	0.0	1	25	0.0452763	0.052		0.1426202	0.12792	
Cable 69	0.6MCUN1	250	15.0	0.0	1	25	0.0452763	0.052		0.1426202	0.12792	

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC UTILITY

Page: 6

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG UTIL

V22.5PSE_20231231.lib

ohms or siemens per 1000 ft per Conductor (Cable) or per Phase (Line/Busway)

Line/Cable/Busway		Size	Length		#/Phase	T (°C)	R1	X1	Y1	R0	X0	Y0
			Adj. (ft)	% Tol.								
Cable 70	0.6MCUN1	2	25.0	0.0	1	25	0.1676898	0.057		0.5282229	0.14022	
Cable 71	0.6MCUN1	2/0	130.0	0.0	1	25	0.0838449	0.054		0.2641115	0.13284	
Cable 72	0.6MCUN1	1/0	55.0	0.0	1	25	0.1006139	0.055		0.3169338	0.1353	
Cable 73	0.6MCUN1	600	60.0	0.0	3	25	0.0209612	0.048		0.0660279	0.11808	
Cable 78	0.6MCUN1	500	120.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 79	0.6MCUN1	500	100.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 80	0.6MCUN1	500	80.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 81	0.6MCUN1	500	100.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 82	0.6MCUN1	500	65.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 83	0.6MCUN1	500	100.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 84	0.6MCUN1	3/0	145.0	0.0	1	25	0.0662375	0.052		0.2086481	0.12792	
Cable 85	0.6MCUN1	250	40.0	0.0	1	25	0.0452763	0.052		0.1426202	0.12792	
Cable 86	0.6MCUN1	250	20.0	0.0	1	25	0.0452763	0.052		0.1426202	0.12792	
Cable 87	0.6MCUN1	2	25.0	0.0	1	25	0.1676898	0.057		0.5282229	0.14022	
Cable 88	0.6MCUN1	2/0	140.0	0.0	1	25	0.0838449	0.054		0.2641115	0.13284	
Cable 89	0.6MCUN1	1/0	55.0	0.0	1	25	0.1006139	0.055		0.3169338	0.1353	
Cable 90	0.6MCUN1	600	55.0	0.0	3	25	0.0209612	0.048		0.0660279	0.11808	

Line / Cable / Busway resistances are listed at the specified temperatures.

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC UTILITY

Page: 7

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG UTIL

V22.5PSE_20231231.lib

2-Winding Transformer Input Data

Transformer ID	Rating					Z Variation			% Tap Setting		Adjusted	Phase Shift	
	MVA	Prim. kV	Sec. kV	% Z	X/R	+ 5%	- 5%	% Tol.	Prim.	Sec.	% Z	Type	Angle
BLDG#1 BUS1 XFMR	1.000	13.800	0.600	5.75	7.00	0	0	-7.5	0	0	5.32	Dyn	30.00
BLDG#3 BUS1 XFMR	1.000	13.800	0.600	5.75	7.00	0	0	-7.5	0	0	5.32	Dyn	30.00
BLDG #4 BUS1 XFMR	1.000	13.800	0.600	5.75	7.00	0	0	-7.5	0	0	5.32	Dyn	30.00
BUS1 BLDG#2 XFMR	1.000	13.800	0.600	5.75	7.00	0	0	-7.5	0	0	5.32	Dyn	30.00
T-ESB #B1	0.075	0.600	0.208	3.77	1.52	0	0	0	0	0	3.77	Dyn	30.00
T-ESB #B2	0.075	0.600	0.208	3.77	1.52	0	0	0	0	0	3.77	Dyn	30.00
T-ESB #B3	0.075	0.600	0.208	3.77	1.52	0	0	0	0	0	3.77	Dyn	30.00
T-ESB #B4	0.075	0.600	0.208	3.77	1.52	0	0	0	0	0	3.77	Dyn	30.00

2-Winding Transformer Grounding Input Data

Transformer ID	Rating			Grounding								
	MVA	Prim. kV	Sec. kV	Conn.	Primary				Secondary			
				Type	Type	kV	Amp	ohm	Type	kV	Amp	ohm
BLDG#1 BUS1 XFMR	1.000	13.800	0.600	D/Y					Solid			
BLDG#3 BUS1 XFMR	1.000	13.800	0.600	D/Y					Solid			
BLDG #4 BUS1 XFMR	1.000	13.800	0.600	D/Y					Solid			
BUS1 BLDG#2 XFMR	1.000	13.800	0.600	D/Y					Solid			
T-ESB #B1	0.075	0.600	0.208	D/Y					Solid			
T-ESB #B2	0.075	0.600	0.208	D/Y					Solid			
T-ESB #B3	0.075	0.600	0.208	D/Y					Solid			
T-ESB #B4	0.075	0.600	0.208	D/Y					Solid			

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC UTILITY

Page: 8

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG UTIL

V22.5PSE_20231231.lib

Branch Connections

CKT/Branch		Connected Bus ID		% Impedance, Pos. Seq., 100 MVA _b			
ID	Type	From Bus	To Bus	R	X	Z	Y
BLDG#1 BUS1 XFMR	2W XFMR	UTIL BLDG#1 BUS-1 (P)	Bus4	75.22	526.53	531.88	
BLDG#3 BUS1 XFMR	2W XFMR	UTIL BLDG#3 BUS-1 (P)	Bus47	75.22	526.53	531.88	
BLDG #4 BUS1 XFMR	2W XFMR	UTIL BLDG#4 BUS-1 (P)	Bus61	75.22	526.53	531.88	
BUS1 BLDG#2 XFMR	2W XFMR	UTIL BLDG#2 BUS-1 (P)	Bus22	75.22	526.53	531.88	
T-ESB #B1	2W XFMR	Bus5	Bus12	2762.74	4199.36	5026.67	
T-ESB #B2	2W XFMR	Bus33	Bus32	2762.74	4199.36	5026.67	
T-ESB #B3	2W XFMR	Bus45	Bus44	2762.74	4199.36	5026.67	
T-ESB #B4	2W XFMR	Bus59	Bus58	2762.74	4199.36	5026.67	
Cable 24	Cable	Bus4	1100 EMCC #B1	8.73	20.00	21.82	
Cable 29	Cable	1100 EMCC #B1	Bus13	74.30	146.67	164.41	
Cable 30	Cable	1100 EMCC #B1	Bus14	43.90	86.67	97.15	
Cable 31	Cable	1100 EMCC #B1	Bus15	50.66	100.00	112.10	
Cable 32	Cable	1100 EMCC #B1	Bus16	67.54	133.33	149.46	
Cable 33	Cable	1100 EMCC #B1	Bus17	43.90	86.67	97.15	
Cable 34	Cable	1100 EMCC #B1	Bus18	37.15	73.33	82.21	
Cable 35	Cable	1100 EMCC #B1	Bus19	220.79	173.33	280.70	
Cable 36	Cable	1100 EMCC #B1	Bus5	116.45	39.58	122.99	
Cable 37	Cable	Bus12	1110 T-ESB #B1 ECB	156.98	180.29	239.05	
Cable 38	Cable	1110 T-ESB #B1 ECB	EX ESSENTIAL SB #B1	261.63	300.48	398.42	
Cable 39	Cable	1100 EMCC #B1	Bus20	229.99	180.56	292.40	
Cable 40	Cable	1100 EMCC #B1	EX T-CBW2 #B1	125.77	68.75	143.33	
Cable 45	Cable	1300 EMCC #B2	Bus25	81.05	160.00	179.36	
Cable 46	Cable	1300 EMCC #B2	Bus26	67.54	133.33	149.46	
Cable 47	Cable	1300 EMCC #B2	Bus27	54.03	106.67	119.57	
Cable 48	Cable	1300 EMCC #B2	Bus28	67.54	133.33	149.46	
Cable 49	Cable	1300 EMCC #B2	Bus29	43.90	86.67	97.15	
Cable 50	Cable	1300 EMCC #B2	Bus30	54.03	106.67	119.57	
Cable 51	Cable	1300 EMCC #B2	Bus31	257.59	202.22	327.49	
Cable 52	Cable	1310 T-ESB #B2 ECB	EX ESSENTIAL SB #B2	418.60	480.77	637.47	
Cable 53	Cable	Bus32	1310 T-ESB #B2 ECB	156.98	180.29	239.05	
Cable 54	Cable	1300 EMCC #B2	Bus33	139.74	47.50	147.59	
Cable 55	Cable	1300 EMCC #B2	Bus34	326.06	210.00	387.84	
Cable 56	Cable	1300 EMCC #B2	EX T-CBW2 BLDG#2	139.74	76.39	159.26	
Cable 57	Cable	Bus22	1300 EMCC #B2	2.91	6.67	7.27	
Cable 61	Cable	1500 EMCC #B3	Bus37	74.30	146.67	164.41	
Cable 62	Cable	1500 EMCC #B3	Bus38	67.54	133.33	149.46	
Cable 63	Cable	1500 EMCC #B3	Bus39	47.28	93.33	104.63	

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC UTILITY

Page: 9

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG UTIL

V22.5PSE_20231231.lib

CKT/Branch		Connected Bus ID		% Impedance, Pos. Seq., 100 MVAb			
ID	Type	From Bus	To Bus	R	X	Z	Y
Cable 64	Cable	1500 EMCC #B3	Bus40	67.54	133.33	149.46	
Cable 65	Cable	1500 EMCC #B3	Bus41	40.53	80.00	89.68	
Cable 66	Cable	1500 EMCC #B3	Bus42	33.77	66.67	74.73	
Cable 67	Cable	1500 EMCC #B3	Bus43	220.79	173.33	280.70	
Cable 68	Cable	1510 T-ESB #B3 ECB	EX ESSENTIAL SB #B3	366.28	420.67	557.79	
Cable 69	Cable	Bus44	1510 T-ESB #B3 ECB	156.98	180.29	239.05	
Cable 70	Cable	1500 EMCC #B3	Bus45	116.45	39.58	122.99	
Cable 71	Cable	1500 EMCC #B3	Bus46	302.77	195.00	360.13	
Cable 72	Cable	1500 EMCC #B3	EX T-CBW2 #B3	153.72	84.03	175.18	
Cable 73	Cable	Bus47	1500 EMCC #B3	11.65	26.67	29.10	
Cable 78	Cable	1700 EMCC #B4	Bus51	81.05	160.00	179.36	
Cable 79	Cable	1700 EMCC #B4	Bus52	67.54	133.33	149.46	
Cable 80	Cable	1700 EMCC #B4	Bus53	54.03	106.67	119.57	
Cable 81	Cable	1700 EMCC #B4	Bus54	67.54	133.33	149.46	
Cable 82	Cable	1700 EMCC #B4	Bus55	43.90	86.67	97.15	
Cable 83	Cable	1700 EMCC #B4	Bus56	67.54	133.33	149.46	
Cable 84	Cable	1700 EMCC #B4	Bus57	266.79	209.44	339.18	
Cable 85	Cable	1710 T-ESB #B4 ECB	EX ESSENTIAL SB #B4	418.60	480.77	637.47	
Cable 86	Cable	Bus58	1710 T-ESB #B4 ECB	209.30	240.38	318.74	
Cable 87	Cable	1700 EMCC #B4	Bus59	116.45	39.58	122.99	
Cable 88	Cable	1700 EMCC #B4	Bus60	326.06	210.00	387.84	
Cable 89	Cable	1700 EMCC #B4	EX T-CBW2 #B4	153.72	84.03	175.18	
Cable 90	Cable	Bus61	1700 EMCC #B4	10.67	24.44	26.67	

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC UTILITY

Page: 10

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG UTIL

V22.5PSE_20231231.lib

Power Grid Input Data

Power Grid	Connected Bus	Rating		% Positive Seq. Impedance 100 MVA Base			Grounding	% Zero Seq. Impedance 100 MVA Base		
		MVASC	kV	X/R	R	X		X/R	R0	X0
UTIL BLDG#1 BUS-1 SC/AF-H	UTIL BLDG#1 BUS-1 (P)	1912.184	13.800	12.00	0.43430	5.21156	Wye - Solid	12.00	0.434296	5.21156
UTIL BLDG#2 BUS-1 SC/AF-H	UTIL BLDG#2 BUS-1 (P)	1912.184	13.800	12.00	0.43430	5.21156	Wye - Solid	12.00	0.434296	5.21156
UTIL BLDG#3 BUS-1 SC/AF-H	UTIL BLDG#3 BUS-1 (P)	1912.184	13.800	12.00	0.43430	5.21156	Wye - Solid	12.00	0.434296	5.21156
UTIL BLDG#4 BUS-1 SC/AF-H	UTIL BLDG#4 BUS-1 (P)	1912.184	13.800	12.00	0.43430	5.21156	Wye - Solid	12.00	0.434296	5.21156

Total Power Grids (= 4) 7648.736 MVA

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC UTILITY

Page: 11

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG UTIL

V22.5PSE_20231231.lib

Induction Machine Input Data

Induction Machine			Rating (Base)			Positive Seq. Imp.				Grounding			Zero Seq. Imp.		
ID	Type	Qty	kVA	kV	RPM	X"/R	% R	% X"	% X'	Conn.	Type	Amp	X/R	% R0	% X0
BSB-1 MOTOR #B1	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSB-2 MOTOR #B1	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSB-3 MOTOR #B1	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSE-1 MOTOR #B1	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSE-2 MOTOR #B1	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSE-3 MOTOR #B1	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSP-1 MOTOR #B1	Motor	1	105.11	0.600	1800	8.10	2.469	20.00	50.00	Wye	Open		8.10	2.47	20.00
BSP-2 MOTOR #B1	Motor	1	105.11	0.600	1800	8.10	2.469	20.00	50.00	Wye	Open		8.10	2.47	20.00
BSB-1 MOTOR #B2	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSB-2 MOTOR #B2	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSB-3 MOTOR #B2	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSE-1 MOTOR #B2	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSE-2 MOTOR #B2	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSE-3 MOTOR #B2	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSP-1 MOTOR #B2	Motor	1	105.11	0.600	1800	8.10	2.469	20.00	50.00	Wye	Open		8.10	2.47	20.00
BSP-2 MOTOR #B2	Motor	1	105.11	0.600	1800	8.10	2.469	20.00	50.00	Wye	Open		8.10	2.47	20.00
BSB-1 MOTOR #B3	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSB-2 MOTOR #B3	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSB-3 MOTOR #B3	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSE-1 MOTOR #B3	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSE-2 MOTOR #B3	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSE-3 MOTOR #B3	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSP-1 MOTOR #B3	Motor	1	105.11	0.600	1800	8.10	2.469	20.00	50.00	Wye	Open		8.10	2.47	20.00
BSP-2 MOTOR #B3	Motor	1	105.11	0.600	1800	8.10	2.469	20.00	50.00	Wye	Open		8.10	2.47	20.00
BSB-1 MOTOR #B4	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSB-2 MOTOR #B4	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSB-3 MOTOR #B4	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSE-1 MOTOR #B4	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSE-2 MOTOR #B4	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSE-3 MOTOR #B4	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSP-1 MOTOR #B4	Motor	1	105.11	0.600	1800	8.10	2.469	20.00	50.00	Wye	Open		8.10	2.47	20.00
BSP-2 MOTOR #B4	Motor	1	105.11	0.600	1800	8.10	2.469	20.00	50.00	Wye	Open		8.10	2.47	20.00

Total Connected Induction Machines (= 32): 7147.5 kVA

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC UTILITY

Page: 12

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG UTIL

V22.5PSE_20231231.lib

SHORT- CIRCUIT REPORT

Fault at bus: **1100 EMCC #B1**

Prefault voltage = 0.600 kV
= 100.00 % of nominal bus kV (0.600 kV)
= 100.00 % of base kV (0.600 kV)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus ID	To Bus ID	% V From Bus	kA Symm. rms	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
				Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
1100 EMCC #B1	Total	0.00	25.679	0.00	107.36	110.10	21.641	21.641	4.86E+001	3.72E+002	1.03E+002	5.76E+002
Bus4	1100 EMCC #B1	4.89	17.240	8.02	133.26	134.26	16.899	21.641	8.44E+001	5.52E+002	1.03E+002	5.76E+002
Bus13	1100 EMCC #B1	2.11	1.236	1.19	107.54	110.60	0.695	0.000	6.35E+002	7.76E+003		
Bus14	1100 EMCC #B1	1.26	1.246	0.71	107.47	110.40	0.700	0.000	6.05E+002	7.70E+003		
Bus15	1100 EMCC #B1	1.45	1.244	0.81	107.48	110.45	0.699	0.000	6.12E+002	7.71E+003		
Bus16	1100 EMCC #B1	1.92	1.238	1.08	107.52	110.56	0.696	0.000	6.28E+002	7.74E+003		
Bus17	1100 EMCC #B1	1.26	1.246	0.71	107.47	110.40	0.700	0.000	6.05E+002	7.70E+003		
Bus18	1100 EMCC #B1	1.07	1.248	0.60	107.45	110.36	0.701	0.000	5.98E+002	7.68E+003		
Bus19	1100 EMCC #B1	1.45	0.497	0.81	107.33	110.50	0.279	0.000	2.57E+003	1.92E+004		
Bus5	1100 EMCC #B1	0.00	0.000	0.00	107.36	110.10	0.000	0.000				
Bus20	1100 EMCC #B1	1.51	0.497	0.85	107.33	110.52	0.279	0.000	2.58E+003	1.92E+004		
EX T-CBW2 #B1	1100 EMCC #B1	0.00	0.000	0.00	107.36	110.10	0.000	0.000				

Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta- Y transformer

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC UTILITY

Page: 13

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG UTIL

V22.5PSE_20231231.lib

Fault at bus: 1110 T-ESB #B1 ECB

Prefault voltage = 0.208 kV
= 100.00 % of nominal bus kV (0.208 kV)
= 100.00 % of base kV (0.208 kV)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus ID	To Bus ID	% V From Bus	kA Symm. rms	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
				Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
1110 T-ESB #B1 ECB	Total	0.00	4.871	0.00	98.77	101.07	4.880	4.880	3.08E+003	4.79E+003	3.26E+003	4.64E+003
Bus12	1110 T-ESB #B1 ECB	4.20	4.871	6.68	98.29	99.21	4.880	4.880	3.08E+003	4.79E+003	3.26E+003	4.64E+003
EX ESSENTIAL SB #B1	1110 T-ESB #B1 ECB	0.00	0.000	0.00	98.77	101.07	0.000	0.000				

- # Indicates fault current contribution is from three-winding transformers
- * Indicates a zero sequence fault current contribution (3I0) from a grounded Delta- Y transformer

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC UTILITY

Page: 14

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG UTIL

V22.5PSE_20231231.lib

Fault at bus: 1300 EMCC #B2

Prefault voltage = 0.600 kV

= 100.00 % of nominal bus kV (0.600 kV)

= 100.00 % of base kV (0.600 kV)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus ID	To Bus ID	% V From Bus	kA Symm. rms	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
				Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
1300 EMCC #B2	Total	0.00	26.108	0.00	106.89	108.55	22.440	22.440	4.64E+001	3.66E+002	8.44E+001	5.43E+002
Bus25	1300 EMCC #B2	2.30	1.234	1.32	107.07	109.10	0.707	0.000	6.42E+002	7.77E+003		
Bus26	1300 EMCC #B2	1.92	1.238	1.10	107.04	109.01	0.710	0.000	6.28E+002	7.74E+003		
Bus27	1300 EMCC #B2	1.54	1.243	0.88	107.01	108.92	0.712	0.000	6.15E+002	7.72E+003		
Bus28	1300 EMCC #B2	1.92	1.238	1.10	107.04	109.01	0.710	0.000	6.28E+002	7.74E+003		
Bus29	1300 EMCC #B2	1.26	1.246	0.72	106.99	108.85	0.714	0.000	6.05E+002	7.70E+003		
Bus30	1300 EMCC #B2	1.54	1.243	0.88	107.01	108.92	0.712	0.000	6.15E+002	7.72E+003		
Bus31	1300 EMCC #B2	1.69	0.496	0.97	106.84	109.02	0.284	0.000	2.61E+003	1.92E+004		
Bus33	1300 EMCC #B2	0.00	0.000	0.00	106.89	108.55	0.000	0.000				
Bus34	1300 EMCC #B2	2.00	0.495	1.14	106.78	109.12	0.284	0.000	2.68E+003	1.92E+004		
EX T-CBW2 BLDG#2	1300 EMCC #B2	0.00	0.000	0.00	106.89	108.55	0.000	0.000				
Bus22	1300 EMCC #B2	1.67	17.685	2.78	133.32	134.52	17.612	22.440	7.86E+001	5.38E+002	8.44E+001	5.43E+002

Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta- Y transformer

Fault at bus: 1310 T-ESB #B2 ECB

Prefault voltage = 0.208 kV
= 100.00 % of nominal bus kV (0.208 kV)
= 100.00 % of base kV (0.208 kV)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus ID	To Bus ID	% V From Bus	kA Symm. rms	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
				Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
1310 T-ESB #B2 ECB	Total	0.00	4.860	0.00	98.82	100.94	4.872	4.872	3.11E+003	4.79E+003	3.26E+003	4.64E+003
EX ESSENTIAL SB #B2	1310 T-ESB #B2 ECB	0.00	0.000	0.00	98.82	100.94	0.000	0.000				
Bus32	1310 T-ESB #B2 ECB	4.19	4.860	6.67	98.34	99.10	4.872	4.872	3.11E+003	4.79E+003	3.26E+003	4.64E+003

Indicates fault current contribution is from three-winding transformers
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta- Y transformer

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC UTILITY

Page: 16

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG UTIL

V22.5PSE_20231231.lib

Fault at bus: 1500 EMCC #B3

Prefault voltage = 0.600 kV

= 100.00 % of nominal bus kV (0.600 kV)

= 100.00 % of base kV (0.600 kV)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus ID	To Bus ID	% V From Bus	kA Symm. rms	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
				Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
1500 EMCC #B3	Total	0.00	25.458	0.00	107.61	110.82	21.256	21.256	4.98E+001	3.75E+002	1.12E+002	5.92E+002
Bus37	1500 EMCC #B3	2.11	1.236	1.18	107.79	111.31	0.688	0.000	6.35E+002	7.76E+003		
Bus38	1500 EMCC #B3	1.92	1.238	1.07	107.77	111.27	0.689	0.000	6.28E+002	7.74E+003		
Bus39	1500 EMCC #B3	1.35	1.245	0.75	107.72	111.13	0.693	0.000	6.08E+002	7.70E+003		
Bus40	1500 EMCC #B3	1.92	1.238	1.07	107.77	111.27	0.689	0.000	6.28E+002	7.74E+003		
Bus41	1500 EMCC #B3	1.16	1.247	0.65	107.71	111.09	0.694	0.000	6.01E+002	7.69E+003		
Bus42	1500 EMCC #B3	0.97	1.250	0.54	107.69	111.04	0.696	0.000	5.95E+002	7.68E+003		
Bus43	1500 EMCC #B3	1.45	0.497	0.81	107.58	111.21	0.276	0.000	2.57E+003	1.92E+004		
Bus45	1500 EMCC #B3	0.00	0.000	0.00	107.61	110.82	0.000	0.000				
Bus46	1500 EMCC #B3	1.86	0.496	1.03	107.52	111.33	0.276	0.000	2.65E+003	1.92E+004		
EX T-CBW2 #B3	1500 EMCC #B3	0.00	0.000	0.00	107.61	110.82	0.000	0.000				
Bus47	1500 EMCC #B3	6.44	17.025	10.48	133.23	134.11	16.561	21.256	8.73E+001	5.58E+002	1.12E+002	5.92E+002

Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta- Y transformer

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC UTILITY

Page: 17

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG UTIL

V22.5PSE_20231231.lib

Fault at bus: 1510 T-ESB #B3 ECB

Prefault voltage = 0.208 kV
= 100.00 % of nominal bus kV (0.208 kV)
= 100.00 % of base kV (0.208 kV)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus ID	To Bus ID	% V From Bus	kA Symm. rms	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
				Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
1510 T-ESB #B3 ECB	Total	0.00	4.869	0.00	98.76	101.06	4.878	4.878	3.09E+003	4.79E+003	3.26E+003	4.64E+003
EX ESSENTIAL SB #B3	1510 T-ESB #B3 ECB	0.00	0.000	0.00	98.76	101.06	0.000	0.000				
Bus44	1510 T-ESB #B3 ECB	4.19	4.869	6.68	98.28	99.21	4.878	4.878	3.09E+003	4.79E+003	3.26E+003	4.64E+003

Indicates fault current contribution is from three-winding transformers
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta- Y transformer

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC UTILITY

Page: 18

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG UTIL

V22.5PSE_20231231.lib

Fault at bus: 1700 EMCC #B4

Prefault voltage = 0.600 kV

= 100.00 % of nominal bus kV (0.600 kV)

= 100.00 % of base kV (0.600 kV)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus ID	To Bus ID	% V From Bus	kA Symm. rms	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
				Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
1700 EMCC #B4	Total	0.00	25.512	0.00	107.52	110.55	21.374	21.374	4.96E+001	3.74E+002	1.09E+002	5.87E+002
Bus51	1700 EMCC #B4	2.30	1.234	1.28	107.71	111.09	0.689	0.000	6.42E+002	7.77E+003		
Bus52	1700 EMCC #B4	1.92	1.238	1.07	107.68	111.01	0.692	0.000	6.28E+002	7.74E+003		
Bus53	1700 EMCC #B4	1.54	1.243	0.86	107.65	110.92	0.694	0.000	6.15E+002	7.72E+003		
Bus54	1700 EMCC #B4	1.92	1.238	1.07	107.68	111.01	0.692	0.000	6.28E+002	7.74E+003		
Bus55	1700 EMCC #B4	1.26	1.246	0.70	107.63	110.85	0.696	0.000	6.05E+002	7.70E+003		
Bus56	1700 EMCC #B4	1.92	1.238	1.07	107.68	111.01	0.692	0.000	6.28E+002	7.74E+003		
Bus57	1700 EMCC #B4	1.75	0.496	0.98	107.48	111.03	0.277	0.000	2.62E+003	1.92E+004		
Bus59	1700 EMCC #B4	0.00	0.000	0.00	107.52	110.55	0.000	0.000				
Bus60	1700 EMCC #B4	2.00	0.495	1.12	107.43	111.11	0.277	0.000	2.68E+003	1.92E+004		
EX T-CBW2 #B4	1700 EMCC #B4	0.00	0.000	0.00	107.52	110.55	0.000	0.000				
Bus61	1700 EMCC #B4	5.92	17.096	9.67	133.23	134.13	16.673	21.374	8.63E+001	5.56E+002	1.09E+002	5.87E+002

Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta- Y transformer

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC UTILITY

Page: 19

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG UTIL

V22.5PSE_20231231.lib

Fault at bus: 1710 T-ESB #B4 ECB

Prefault voltage = 0.208 kV
= 100.00 % of nominal bus kV (0.208 kV)
= 100.00 % of base kV (0.208 kV)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus ID	To Bus ID	% V From Bus	kA Symm. rms	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
				Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
1710 T-ESB #B4 ECB	Total	0.00	4.803	0.00	98.97	101.65	4.774	4.774	3.14E+003	4.85E+003	3.42E+003	4.79E+003
EX ESSENTIAL SB #B4	1710 T-ESB #B4 ECB	0.00	0.000	0.00	98.97	101.65	0.000	0.000				
Bus58	1710 T-ESB #B4 ECB	5.52	4.803	8.72	98.31	99.24	4.774	4.774	3.14E+003	4.85E+003	3.42E+003	4.79E+003

Indicates fault current contribution is from three-winding transformers
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta- Y transformer

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC UTILITY

Page: 20

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG UTIL

V22.5PSE_20231231.lib

Short-Circuit Summary Report

1/2 Cycle - 3-Phase, LG, LL, & LLG Fault Currents

Prefault Voltage = 100 % of the Bus Nominal Voltage

Bus		3-Phase Fault			Line-to-Ground Fault			Line-to-Line Fault			*Line-to-Line-to-Ground		
ID	kV	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.
1100 EMCC #B1	0.600	3.330	-25.462	25.679	3.243	-21.397	21.641	22.051	2.884	22.239	-23.589	6.337	24.425
1110 T-ESB #B1 ECB	0.208	2.637	-4.096	4.871	2.696	-4.068	4.880	3.547	2.284	4.219	-4.924	-0.265	4.931
1300 EMCC #B2	0.600	3.285	-25.900	26.108	3.090	-22.226	22.440	22.430	2.845	22.610	-23.873	6.885	24.846
1310 T-ESB #B2 ECB	0.208	2.643	-4.079	4.860	2.699	-4.056	4.872	3.532	2.289	4.209	-4.910	-0.273	4.917
1500 EMCC #B3	0.600	3.356	-25.236	25.458	3.311	-20.997	21.256	21.855	2.907	22.047	-23.432	6.075	24.206
1510 T-ESB #B3 ECB	0.208	2.635	-4.094	4.869	2.694	-4.066	4.878	3.545	2.282	4.216	-4.922	-0.264	4.929
1700 EMCC #B4	0.600	3.356	-25.290	25.512	3.293	-21.119	21.374	21.902	2.906	22.094	-23.467	6.152	24.260
1710 T-ESB #B4 ECB	0.208	2.608	-4.033	4.803	2.655	-3.968	4.774	3.493	2.258	4.159	-4.842	-0.307	4.852

All fault currents are symmetrical (1/2 Cycle network) values in rms kA.

* LLG fault current is the larger of the two faulted line currents.

V22.5PSE_20231231.lib

Sequence Impedance Summary Report

Bus		Positive Seq. Imp. (ohm)			Negative Seq. Imp. (ohm)			Zero Seq. Imp. (ohm)			Fault Zf (ohm)		
ID	kV	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance
1100 EMCC #B1	0.600	0.00175	0.01338	0.01349	0.00175	0.01338	0.01349	0.00370	0.02073	0.02105	0.00000	0.00000	0.00000
1110 T-ESB #B1 ECB	0.208	0.01335	0.02073	0.02465	0.01335	0.02073	0.02465	0.01409	0.02009	0.02454	0.00000	0.00000	0.00000
1300 EMCC #B2	0.600	0.00167	0.01316	0.01327	0.00167	0.01316	0.01327	0.00304	0.01955	0.01978	0.00000	0.00000	0.00000
1310 T-ESB #B2 ECB	0.208	0.01344	0.02074	0.02471	0.01344	0.02074	0.02471	0.01409	0.02009	0.02454	0.00000	0.00000	0.00000
1500 EMCC #B3	0.600	0.00179	0.01349	0.01361	0.00179	0.01349	0.01361	0.00403	0.02132	0.02169	0.00000	0.00000	0.00000
1510 T-ESB #B3 ECB	0.208	0.01335	0.02074	0.02467	0.01335	0.02074	0.02467	0.01409	0.02009	0.02454	0.00000	0.00000	0.00000
1700 EMCC #B4	0.600	0.00179	0.01346	0.01358	0.00179	0.01346	0.01358	0.00392	0.02112	0.02148	0.00000	0.00000	0.00000
1710 T-ESB #B4 ECB	0.208	0.01358	0.02100	0.02500	0.01358	0.02100	0.02500	0.01481	0.02073	0.02547	0.00000	0.00000	0.00000

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC GEN

Page: 1

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG GEN

V22.5PSE_20231231.lib

Electrical Transient Analyzer Program

Short-Circuit Analysis

ANSI Standard

3-Phase, LG, LL, & LLG Fault Currents

30-Cycle Network

	Swing	V-Control	Load	Total			
Number of Buses:	4	0	56	60			
					Line/Cable/ Busway	Impedance	Tie PD
	XFMR2	XFMR3	Reactor				Total
Number of Branches:	4	0	0	52	0	0	56
	Synchronous Generator	Power Grid	Synchronous Motor	Induction Machines	Lumped Load	Inverter	Total
Number of Machines:	4	0	0	32	0	0	36

System Frequency: 60.00

Unit System: English

Project Filename: 50204245- CBBT Support Bldg

Output Filename: C:\Schneider\Scriptingpath\Nikita Projects\2024\July\Revisions\50204245 - CBBT
Study\ETAP\SC GEN.SA2S

Project: CBBT-Support Bldg Emg

ETAP

Page: 2

Location: CAPE CHARLES, VA

22.5.0C

Date: 09-18-2024

Contract: 50204245

SN: SCHNDR-CA2

Engineer: Study Case: SC GEN

Revision: Base

Filename: 50204245- CBBT Support Bldg

Config.: CFG GEN

V22.5PSE_20231231.lib

Adjustments

<u>Tolerance</u>	<u>Apply Adjustments</u>	<u>Individual /Global</u>	<u>Percent</u>
Transformer Impedance:	Yes	Individual	
Reactor Impedance:	No		
Overload Heater Resistance:	No		
Transmission Line Length:	No		
Cable / Busway Length:	No		
<u>Temperature Correction</u>	<u>Apply Adjustments</u>	<u>Individual /Global</u>	<u>Degree C</u>
Transmission Line Resistance:	No		
Cable / Busway Resistance:	Yes	Global	25

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC GEN

Page: 3

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG GEN

V22.5PSE_20231231.lib

Bus Input Data

Bus					Initial Voltage	
ID	Type	Nom. kV	Base kV	Sub-sys	%Mag.	Ang.
1100 EMCC #B1	Load	0.600	0.600	13	100.00	0.00
1110 T-ESB #B1 ECB	Load	0.208	0.208	13	100.00	-30.00
1300 EMCC #B2	Load	0.600	0.600	14	100.00	0.00
1310 T-ESB #B2 ECB	Load	0.208	0.208	14	100.00	-30.00
1500 EMCC #B3	Load	0.600	0.600	15	100.00	0.00
1510 T-ESB #B3 ECB	Load	0.208	0.208	15	100.00	-30.00
1700 EMCC #B4	Load	0.600	0.600	16	100.00	0.00
1710 T-ESB #B4 ECB	Load	0.208	0.208	16	100.00	-30.00
Bus2	SWNG	0.600	0.600	14	100.00	0.00
Bus5	Load	0.600	0.600	13	100.00	0.00
Bus6	SWNG	0.600	0.600	16	100.00	0.00
Bus7	SWNG	0.600	0.600	13	100.00	0.00
Bus9	SWNG	0.600	0.600	15	100.00	0.00
Bus12	Load	0.208	0.208	13	100.00	-30.00
Bus13	Load	0.600	0.600	13	100.00	0.00
Bus14	Load	0.600	0.600	13	100.00	0.00
Bus15	Load	0.600	0.600	13	100.00	0.00
Bus16	Load	0.600	0.600	13	100.00	0.00
Bus17	Load	0.600	0.600	13	100.00	0.00
Bus18	Load	0.600	0.600	13	100.00	0.00
Bus19	Load	0.600	0.600	13	100.00	0.00
Bus20	Load	0.600	0.600	13	100.00	0.00
Bus25	Load	0.600	0.600	14	100.00	0.00
Bus26	Load	0.600	0.600	14	100.00	0.00
Bus27	Load	0.600	0.600	14	100.00	0.00
Bus28	Load	0.600	0.600	14	100.00	0.00
Bus29	Load	0.600	0.600	14	100.00	0.00
Bus30	Load	0.600	0.600	14	100.00	0.00
Bus31	Load	0.600	0.600	14	100.00	0.00
Bus32	Load	0.208	0.208	14	100.00	-30.00
Bus33	Load	0.600	0.600	14	100.00	0.00
Bus34	Load	0.600	0.600	14	100.00	0.00
Bus37	Load	0.600	0.600	15	100.00	0.00
Bus38	Load	0.600	0.600	15	100.00	0.00
Bus39	Load	0.600	0.600	15	100.00	0.00
Bus40	Load	0.600	0.600	15	100.00	0.00
Bus41	Load	0.600	0.600	15	100.00	0.00
Bus42	Load	0.600	0.600	15	100.00	0.00
Bus43	Load	0.600	0.600	15	100.00	0.00
Bus44	Load	0.208	0.208	15	100.00	-30.00
Bus45	Load	0.600	0.600	15	100.00	0.00

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC GEN

Page: 4

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG GEN

V22.5PSE_20231231.lib

Bus					Initial Voltage	
ID	Type	Nom. kV	Base kV	Sub-sys	%Mag.	Ang.
Bus46	Load	0.600	0.600	15	100.00	0.00
Bus51	Load	0.600	0.600	16	100.00	0.00
Bus52	Load	0.600	0.600	16	100.00	0.00
Bus53	Load	0.600	0.600	16	100.00	0.00
Bus54	Load	0.600	0.600	16	100.00	0.00
Bus55	Load	0.600	0.600	16	100.00	0.00
Bus56	Load	0.600	0.600	16	100.00	0.00
Bus57	Load	0.600	0.600	16	100.00	0.00
Bus58	Load	0.208	0.208	16	100.00	-30.00
Bus59	Load	0.600	0.600	16	100.00	0.00
Bus60	Load	0.600	0.600	16	100.00	0.00
EX ESSENTIAL SB #B1	Load	0.208	0.208	13	100.00	-30.00
EX ESSENTIAL SB #B2	Load	0.208	0.208	14	100.00	-30.00
EX ESSENTIAL SB #B3	Load	0.208	0.208	15	100.00	-30.00
EX ESSENTIAL SB #B4	Load	0.208	0.208	16	100.00	-30.00
EX T-CBW2 #B1	Load	0.600	0.600	13	100.00	0.00
EX T-CBW2 #B3	Load	0.600	0.600	15	100.00	0.00
EX T-CBW2 #B4	Load	0.600	0.600	16	100.00	0.00
EX T-CBW2 BLDG#2	Load	0.600	0.600	14	100.00	0.00

60 Buses Total

All voltages reported by ETAP are in % of bus Nominal kV.

Base kV values of buses are calculated and used internally by ETAP.

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC GEN

Page: 5

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG GEN

V22.5PSE_20231231.lib

Line/Cable/Busway Input Data

ohms or siemens per 1000 ft per Conductor (Cable) or per Phase (Line/Busway)

Line/Cable/Busway			Length									
ID	Library	Size	Adj. (ft)	% Tol.	#/Phase	T (°C)	R1	X1	Y1	R0	X0	Y0
Cable 28	0.6MCUN1	350	110.0	0.0	2	25	0.0326995	0.05		0.1030035	0.123	
Cable 29	0.6MCUN1	500	110.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 30	0.6MCUN1	500	65.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 31	0.6MCUN1	500	75.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 32	0.6MCUN1	500	100.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 33	0.6MCUN1	500	65.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 34	0.6MCUN1	500	55.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 35	0.6MCUN1	3/0	120.0	0.0	1	25	0.0662375	0.052		0.2086481	0.12792	
Cable 36	0.6MCUN1	2	25.0	0.0	1	25	0.1676898	0.057		0.5282229	0.14022	
Cable 37	0.6MCUN1	250	15.0	0.0	1	25	0.0452763	0.052		0.1426202	0.12792	
Cable 38	0.6MCUN1	250	25.0	0.0	1	25	0.0452763	0.052		0.1426202	0.12792	
Cable 39	0.6MCUN1	3/0	125.0	0.0	1	25	0.0662375	0.052		0.2086481	0.12792	
Cable 40	0.6MCUN1	1/0	45.0	0.0	1	25	0.1006139	0.055		0.3169338	0.1353	
Cable 44	0.6MCUN1	350	120.0	0.0	2	25	0.0326995	0.05		0.1030035	0.123	
Cable 45	0.6MCUN1	500	120.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 46	0.6MCUN1	500	100.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 47	0.6MCUN1	500	80.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 48	0.6MCUN1	500	100.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 49	0.6MCUN1	500	65.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 50	0.6MCUN1	500	80.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 51	0.6MCUN1	3/0	140.0	0.0	1	25	0.0662375	0.052		0.2086481	0.12792	
Cable 52	0.6MCUN1	250	40.0	0.0	1	25	0.0452763	0.052		0.1426202	0.12792	
Cable 53	0.6MCUN1	250	15.0	0.0	1	25	0.0452763	0.052		0.1426202	0.12792	
Cable 54	0.6MCUN1	2	30.0	0.0	1	25	0.1676898	0.057		0.5282229	0.14022	
Cable 55	0.6MCUN1	2/0	140.0	0.0	1	25	0.0838449	0.054		0.2641115	0.13284	
Cable 56	0.6MCUN1	1/0	50.0	0.0	1	25	0.1006139	0.055		0.3169338	0.1353	
Cable 60	0.6MCUN1	350	130.0	0.0	2	25	0.0326995	0.05		0.1030035	0.123	
Cable 61	0.6MCUN1	500	110.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 62	0.6MCUN1	500	100.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 63	0.6MCUN1	500	70.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 64	0.6MCUN1	500	100.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 65	0.6MCUN1	500	60.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 66	0.6MCUN1	500	50.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 67	0.6MCUN1	3/0	120.0	0.0	1	25	0.0662375	0.052		0.2086481	0.12792	
Cable 68	0.6MCUN1	250	35.0	0.0	1	25	0.0452763	0.052		0.1426202	0.12792	

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC GEN

Page: 6

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG GEN

V22.5PSE_20231231.lib

ohms or siemens per 1000 ft per Conductor (Cable) or per Phase (Line/Busway)

Line/Cable/Busway		Size	Length		#/Phase	T (°C)	R1	X1	Y1	R0	X0	Y0
			Adj. (ft)	% Tol.								
Cable 69	0.6MCUN1	250	15.0	0.0	1	25	0.0452763	0.052		0.1426202	0.12792	
Cable 70	0.6MCUN1	2	25.0	0.0	1	25	0.1676898	0.057		0.5282229	0.14022	
Cable 71	0.6MCUN1	2/0	130.0	0.0	1	25	0.0838449	0.054		0.2641115	0.13284	
Cable 72	0.6MCUN1	1/0	55.0	0.0	1	25	0.1006139	0.055		0.3169338	0.1353	
Cable 77	0.6MCUN1	350	115.0	0.0	2	25	0.0326995	0.05		0.1030035	0.123	
Cable 78	0.6MCUN1	500	120.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 79	0.6MCUN1	500	100.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 80	0.6MCUN1	500	80.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 81	0.6MCUN1	500	100.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 82	0.6MCUN1	500	65.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 83	0.6MCUN1	500	100.0	0.0	1	25	0.024315	0.048		0.0765923	0.11808	
Cable 84	0.6MCUN1	3/0	145.0	0.0	1	25	0.0662375	0.052		0.2086481	0.12792	
Cable 85	0.6MCUN1	250	40.0	0.0	1	25	0.0452763	0.052		0.1426202	0.12792	
Cable 86	0.6MCUN1	250	20.0	0.0	1	25	0.0452763	0.052		0.1426202	0.12792	
Cable 87	0.6MCUN1	2	25.0	0.0	1	25	0.1676898	0.057		0.5282229	0.14022	
Cable 88	0.6MCUN1	2/0	140.0	0.0	1	25	0.0838449	0.054		0.2641115	0.13284	
Cable 89	0.6MCUN1	1/0	55.0	0.0	1	25	0.1006139	0.055		0.3169338	0.1353	

Line / Cable / Busway resistances are listed at the specified temperatures.

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC GEN

Page: 7

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG GEN

V22.5PSE_20231231.lib

2-Winding Transformer Input Data

Transformer	Rating					Z Variation			% Tap Setting		Adjusted	Phase Shift	
ID	MVA	Prim. kV	Sec. kV	% Z	X/R	+ 5%	- 5%	% Tol.	Prim.	Sec.	% Z	Type	Angle
T-ESB #B1	0.075	0.600	0.208	3.77	1.52	0	0	0	0	0	3.77	Dyn	30.00
T-ESB #B2	0.075	0.600	0.208	3.77	1.52	0	0	0	0	0	3.77	Dyn	30.00
T-ESB #B3	0.075	0.600	0.208	3.77	1.52	0	0	0	0	0	3.77	Dyn	30.00
T-ESB #B4	0.075	0.600	0.208	3.77	1.52	0	0	0	0	0	3.77	Dyn	30.00

2-Winding Transformer Grounding Input Data

Transformer	Rating			Grounding									
				Conn.	Primary					Secondary			
ID	MVA	Prim. kV	Sec. kV	Type	Type	kV	Amp	ohm	Type	kV	Amp	ohm	
T-ESB #B1	0.075	0.600	0.208	D/Y					Solid				
T-ESB #B2	0.075	0.600	0.208	D/Y					Solid				
T-ESB #B3	0.075	0.600	0.208	D/Y					Solid				
T-ESB #B4	0.075	0.600	0.208	D/Y					Solid				

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC GEN

Page: 8

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG GEN

V22.5PSE_20231231.lib

Branch Connections

CKT/Branch		Connected Bus ID		% Impedance, Pos. Seq., 100 MVA			
ID	Type	From Bus	To Bus	R	X	Z	Y
T-ESB #B1	2W XFMR	Bus5	Bus12	2762.74	4199.36	5026.67	
T-ESB #B2	2W XFMR	Bus33	Bus32	2762.74	4199.36	5026.67	
T-ESB #B3	2W XFMR	Bus45	Bus44	2762.74	4199.36	5026.67	
T-ESB #B4	2W XFMR	Bus59	Bus58	2762.74	4199.36	5026.67	
Cable 28	Cable	Bus7	1100 EMCC #B1	49.96	76.39	91.27	
Cable 29	Cable	1100 EMCC #B1	Bus13	74.30	146.67	164.41	
Cable 30	Cable	1100 EMCC #B1	Bus14	43.90	86.67	97.15	
Cable 31	Cable	1100 EMCC #B1	Bus15	50.66	100.00	112.10	
Cable 32	Cable	1100 EMCC #B1	Bus16	67.54	133.33	149.46	
Cable 33	Cable	1100 EMCC #B1	Bus17	43.90	86.67	97.15	
Cable 34	Cable	1100 EMCC #B1	Bus18	37.15	73.33	82.21	
Cable 35	Cable	1100 EMCC #B1	Bus19	220.79	173.33	280.70	
Cable 36	Cable	1100 EMCC #B1	Bus5	116.45	39.58	122.99	
Cable 37	Cable	Bus12	1110 T-ESB #B1 ECB	156.98	180.29	239.05	
Cable 38	Cable	1110 T-ESB #B1 ECB	EX ESSENTIAL SB #B1	261.63	300.48	398.42	
Cable 39	Cable	1100 EMCC #B1	Bus20	229.99	180.56	292.40	
Cable 40	Cable	1100 EMCC #B1	EX T-CBW2 #B1	125.77	68.75	143.33	
Cable 44	Cable	Bus2	1300 EMCC #B2	54.50	83.33	99.57	
Cable 45	Cable	1300 EMCC #B2	Bus25	81.05	160.00	179.36	
Cable 46	Cable	1300 EMCC #B2	Bus26	67.54	133.33	149.46	
Cable 47	Cable	1300 EMCC #B2	Bus27	54.03	106.67	119.57	
Cable 48	Cable	1300 EMCC #B2	Bus28	67.54	133.33	149.46	
Cable 49	Cable	1300 EMCC #B2	Bus29	43.90	86.67	97.15	
Cable 50	Cable	1300 EMCC #B2	Bus30	54.03	106.67	119.57	
Cable 51	Cable	1300 EMCC #B2	Bus31	257.59	202.22	327.49	
Cable 52	Cable	1310 T-ESB #B2 ECB	EX ESSENTIAL SB #B2	418.60	480.77	637.47	
Cable 53	Cable	Bus32	1310 T-ESB #B2 ECB	156.98	180.29	239.05	
Cable 54	Cable	1300 EMCC #B2	Bus33	139.74	47.50	147.59	
Cable 55	Cable	1300 EMCC #B2	Bus34	326.06	210.00	387.84	
Cable 56	Cable	1300 EMCC #B2	EX T-CBW2 BLDG#2	139.74	76.39	159.26	
Cable 60	Cable	Bus9	1500 EMCC #B3	59.04	90.28	107.87	
Cable 61	Cable	1500 EMCC #B3	Bus37	74.30	146.67	164.41	
Cable 62	Cable	1500 EMCC #B3	Bus38	67.54	133.33	149.46	
Cable 63	Cable	1500 EMCC #B3	Bus39	47.28	93.33	104.63	
Cable 64	Cable	1500 EMCC #B3	Bus40	67.54	133.33	149.46	
Cable 65	Cable	1500 EMCC #B3	Bus41	40.53	80.00	89.68	
Cable 66	Cable	1500 EMCC #B3	Bus42	33.77	66.67	74.73	

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC GEN

Page: 9

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG GEN

V22.5PSE_20231231.lib

CKT/Branch		Connected Bus ID		% Impedance, Pos. Seq., 100 MVAb			
ID	Type	From Bus	To Bus	R	X	Z	Y
Cable 67	Cable	1500 EMCC #B3	Bus43	220.79	173.33	280.70	
Cable 68	Cable	1510 T-ESB #B3 ECB	EX ESSENTIAL SB #B3	366.28	420.67	557.79	
Cable 69	Cable	Bus44	1510 T-ESB #B3 ECB	156.98	180.29	239.05	
Cable 70	Cable	1500 EMCC #B3	Bus45	116.45	39.58	122.99	
Cable 71	Cable	1500 EMCC #B3	Bus46	302.77	195.00	360.13	
Cable 72	Cable	1500 EMCC #B3	EX T-CBW2 #B3	153.72	84.03	175.18	
Cable 77	Cable	Bus6	1700 EMCC #B4	52.23	79.86	95.42	
Cable 78	Cable	1700 EMCC #B4	Bus51	81.05	160.00	179.36	
Cable 79	Cable	1700 EMCC #B4	Bus52	67.54	133.33	149.46	
Cable 80	Cable	1700 EMCC #B4	Bus53	54.03	106.67	119.57	
Cable 81	Cable	1700 EMCC #B4	Bus54	67.54	133.33	149.46	
Cable 82	Cable	1700 EMCC #B4	Bus55	43.90	86.67	97.15	
Cable 83	Cable	1700 EMCC #B4	Bus56	67.54	133.33	149.46	
Cable 84	Cable	1700 EMCC #B4	Bus57	266.79	209.44	339.18	
Cable 85	Cable	1710 T-ESB #B4 ECB	EX ESSENTIAL SB #B4	418.60	480.77	637.47	
Cable 86	Cable	Bus58	1710 T-ESB #B4 ECB	209.30	240.38	318.74	
Cable 87	Cable	1700 EMCC #B4	Bus59	116.45	39.58	122.99	
Cable 88	Cable	1700 EMCC #B4	Bus60	326.06	210.00	387.84	
Cable 89	Cable	1700 EMCC #B4	EX T-CBW2 #B4	153.72	84.03	175.18	

Synchronous Generator Input Data

Synchronous Generator					Positive Seq. Impedance					Grounding			Zero Seq. Impedance		
					Rating										
ID	Type	MVA	kV	RPM	X"/R	% R	Adj.	Tol.	% Xd'	Conn.	Type	Amp	X/R	% R0	% X0
BLDG#1 GENERATOR (EX)	Diesel	0.625	0.600	1800	20.00	0.500	10.00	0.0	28.00	Wye	Solid		7.00	1.000	7.00
BLDG#2 GENERATOR (EX)	Diesel	0.625	0.600	1800	20.00	0.500	10.00	0.0	28.00	Wye	Solid		7.00	1.000	7.00
BLDG#3 GENERATOR (EX)	Diesel	0.625	0.600	1800	20.00	0.500	10.00	0.0	28.00	Wye	Solid		7.00	1.000	7.00
BLDG#4 GENERATOR (EX)	Diesel	0.625	0.600	1800	20.00	0.500	10.00	0.0	28.00	Wye	Solid		7.00	1.000	7.00

Total Connected Synchronous Generators (= 4): 2.500 MVA

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC GEN

Page: 11

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG GEN

V22.5PSE_20231231.lib

Induction Machine Input Data

Induction Machine			Rating (Base)			Positive Seq. Imp.				Grounding			Zero Seq. Imp.		
ID	Type	Qty	kVA	kV	RPM	X"/R	% R	% X"	% X'	Conn.	Type	Amp	X/R	% R0	% X0
BSB-1 MOTOR #B1	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSB-2 MOTOR #B1	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSB-3 MOTOR #B1	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSE-1 MOTOR #B1	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSE-2 MOTOR #B1	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSE-3 MOTOR #B1	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSP-1 MOTOR #B1	Motor	1	105.11	0.600	1800	8.10	2.469	20.00	50.00	Wye	Open		8.10	2.47	20.00
BSP-2 MOTOR #B1	Motor	1	105.11	0.600	1800	8.10	2.469	20.00	50.00	Wye	Open		8.10	2.47	20.00
BSB-1 MOTOR #B2	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSB-2 MOTOR #B2	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSB-3 MOTOR #B2	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSE-1 MOTOR #B2	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSE-2 MOTOR #B2	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSE-3 MOTOR #B2	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSP-1 MOTOR #B2	Motor	1	105.11	0.600	1800	8.10	2.469	20.00	50.00	Wye	Open		8.10	2.47	20.00
BSP-2 MOTOR #B2	Motor	1	105.11	0.600	1800	8.10	2.469	20.00	50.00	Wye	Open		8.10	2.47	20.00
BSB-1 MOTOR #B3	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSB-2 MOTOR #B3	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSB-3 MOTOR #B3	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSE-1 MOTOR #B3	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSE-2 MOTOR #B3	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSE-3 MOTOR #B3	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSP-1 MOTOR #B3	Motor	1	105.11	0.600	1800	8.10	2.469	20.00	50.00	Wye	Open		8.10	2.47	20.00
BSP-2 MOTOR #B3	Motor	1	105.11	0.600	1800	8.10	2.469	20.00	50.00	Wye	Open		8.10	2.47	20.00
BSB-1 MOTOR #B4	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSB-2 MOTOR #B4	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSB-3 MOTOR #B4	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSE-1 MOTOR #B4	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSE-2 MOTOR #B4	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSE-3 MOTOR #B4	Motor	1	262.77	0.600	1800	13.57	1.474	20.00	50.00	Wye	Open		13.57	1.47	20.00
BSP-1 MOTOR #B4	Motor	1	105.11	0.600	1800	8.10	2.469	20.00	50.00	Wye	Open		8.10	2.47	20.00
BSP-2 MOTOR #B4	Motor	1	105.11	0.600	1800	8.10	2.469	20.00	50.00	Wye	Open		8.10	2.47	20.00

Total Connected Induction Machines (= 32): 7147.5 kVA

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC GEN

Page: 12

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG GEN

V22.5PSE_20231231.lib

SHORT- CIRCUIT REPORT

Fault at bus: **1100 EMCC #B1**

Prefault voltage = 0.600 kV

= 100.00 % of nominal bus kV (0.600 kV)

= 100.00 % of base kV (0.600 kV)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus ID	To Bus ID	% V From Bus	kA Symm. rms	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
				Va	Vb	Vc	Ia	I3I0	R1	X1	R0	X0
1100 EMCC #B1	Total	0.00	2.111	0.00	72.86	76.88	3.259	3.259	1.30E+002	4.56E+003	3.17E+002	1.31E+003
Bus7	1100 EMCC #B1	2.00	2.111	4.82	73.40	75.49	3.259	3.259	1.30E+002	4.56E+003	3.17E+002	1.31E+003
Bus13	1100 EMCC #B1	0.00	0.000	0.00	72.86	76.88	0.000	0.000				
Bus14	1100 EMCC #B1	0.00	0.000	0.00	72.86	76.88	0.000	0.000				
Bus15	1100 EMCC #B1	0.00	0.000	0.00	72.86	76.88	0.000	0.000				
Bus16	1100 EMCC #B1	0.00	0.000	0.00	72.86	76.88	0.000	0.000				
Bus17	1100 EMCC #B1	0.00	0.000	0.00	72.86	76.88	0.000	0.000				
Bus18	1100 EMCC #B1	0.00	0.000	0.00	72.86	76.88	0.000	0.000				
Bus19	1100 EMCC #B1	0.00	0.000	0.00	72.86	76.88	0.000	0.000				
Bus5	1100 EMCC #B1	0.00	0.000	0.00	72.86	76.88	0.000	0.000				
Bus20	1100 EMCC #B1	0.00	0.000	0.00	72.86	76.88	0.000	0.000				
EX T-CBW2 #B1	1100 EMCC #B1	0.00	0.000	0.00	72.86	76.88	0.000	0.000				

Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta- Y transformer

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC GEN

Page: 13

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG GEN

V22.5PSE_20231231.lib

Fault at bus: 1110 T-ESB #B1 ECB

Prefault voltage = 0.208 kV
= 100.00 % of nominal bus kV (0.208 kV)
= 100.00 % of base kV (0.208 kV)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus ID	To Bus ID	% V From Bus	kA Symm. rms	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
				Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
1110 T-ESB #B1 ECB	Total	0.00	2.916	0.00	84.96	93.84	3.592	3.592	3.17E+003	8.98E+003	3.26E+003	4.64E+003
Bus12	1110 T-ESB #B1 ECB	2.51	2.916	4.92	84.95	92.49	3.592	3.592	3.17E+003	8.98E+003	3.26E+003	4.64E+003
EX ESSENTIAL SB #B1	1110 T-ESB #B1 ECB	0.00	0.000	0.00	84.96	93.84	0.000	0.000				

- # Indicates fault current contribution is from three-winding transformers
- * Indicates a zero sequence fault current contribution (3I0) from a grounded Delta- Y transformer

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC GEN

Page: 14

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG GEN

V22.5PSE_20231231.lib

Fault at bus: 1300 EMCC #B2

Prefault voltage = 0.600 kV

= 100.00 % of nominal bus kV (0.600 kV)

= 100.00 % of base kV (0.600 kV)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus ID	To Bus ID	% V From Bus	kA Symm. rms	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
				Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
1300 EMCC #B2	Total	0.00	2.108	0.00	72.87	77.14	3.247	3.247	1.34E+002	4.56E+003	3.32E+002	1.33E+003
Bus2	1300 EMCC #B2	2.18	2.108	5.24	73.45	75.63	3.247	3.247	1.34E+002	4.56E+003	3.32E+002	1.33E+003
Bus25	1300 EMCC #B2	0.00	0.000	0.00	72.87	77.14	0.000	0.000				
Bus26	1300 EMCC #B2	0.00	0.000	0.00	72.87	77.14	0.000	0.000				
Bus27	1300 EMCC #B2	0.00	0.000	0.00	72.87	77.14	0.000	0.000				
Bus28	1300 EMCC #B2	0.00	0.000	0.00	72.87	77.14	0.000	0.000				
Bus29	1300 EMCC #B2	0.00	0.000	0.00	72.87	77.14	0.000	0.000				
Bus30	1300 EMCC #B2	0.00	0.000	0.00	72.87	77.14	0.000	0.000				
Bus31	1300 EMCC #B2	0.00	0.000	0.00	72.87	77.14	0.000	0.000				
Bus33	1300 EMCC #B2	0.00	0.000	0.00	72.87	77.14	0.000	0.000				
Bus34	1300 EMCC #B2	0.00	0.000	0.00	72.87	77.14	0.000	0.000				
EX T-CBW2 BLDG#2	1300 EMCC #B2	0.00	0.000	0.00	72.87	77.14	0.000	0.000				

Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta- Y transformer

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC GEN

Page: 15

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG GEN

V22.5PSE_20231231.lib

Fault at bus: 1310 T-ESB #B2 ECB

Prefault voltage = 0.208 kV

= 100.00 % of nominal bus kV (0.208 kV)

= 100.00 % of base kV (0.208 kV)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus ID	To Bus ID	% V From Bus	kA Symm. rms	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
				Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
1310 T-ESB #B2 ECB	Total	0.00	2.909	0.00	85.00	93.76	3.584	3.584	3.19E+003	8.99E+003	3.26E+003	4.64E+003
EX ESSENTIAL SB #B2	1310 T-ESB #B2 ECB	0.00	0.000	0.00	85.00	93.76	0.000	0.000				
Bus32	1310 T-ESB #B2 ECB	2.51	2.909	4.91	85.00	92.41	3.584	3.584	3.19E+003	8.99E+003	3.26E+003	4.64E+003

Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta- Y transformer

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC GEN

Page: 16

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG GEN

V22.5PSE_20231231.lib

Fault at bus: 1500 EMCC #B3

Prefault voltage = 0.600 kV

= 100.00 % of nominal bus kV (0.600 kV)

= 100.00 % of base kV (0.600 kV)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus ID	To Bus ID	% V From Bus	kA Symm. rms	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
				Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
1500 EMCC #B3	Total	0.00	2.104	0.00	72.89	77.40	3.235	3.235	1.39E+002	4.57E+003	3.46E+002	1.34E+003
Bus9	1500 EMCC #B3	2.36	2.104	5.65	73.51	75.77	3.235	3.235	1.39E+002	4.57E+003	3.46E+002	1.34E+003
Bus37	1500 EMCC #B3	0.00	0.000	0.00	72.89	77.40	0.000	0.000				
Bus38	1500 EMCC #B3	0.00	0.000	0.00	72.89	77.40	0.000	0.000				
Bus39	1500 EMCC #B3	0.00	0.000	0.00	72.89	77.40	0.000	0.000				
Bus40	1500 EMCC #B3	0.00	0.000	0.00	72.89	77.40	0.000	0.000				
Bus41	1500 EMCC #B3	0.00	0.000	0.00	72.89	77.40	0.000	0.000				
Bus42	1500 EMCC #B3	0.00	0.000	0.00	72.89	77.40	0.000	0.000				
Bus43	1500 EMCC #B3	0.00	0.000	0.00	72.89	77.40	0.000	0.000				
Bus45	1500 EMCC #B3	0.00	0.000	0.00	72.89	77.40	0.000	0.000				
Bus46	1500 EMCC #B3	0.00	0.000	0.00	72.89	77.40	0.000	0.000				
EX T-CBW2 #B3	1500 EMCC #B3	0.00	0.000	0.00	72.89	77.40	0.000	0.000				

Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta- Y transformer

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC GEN

Page: 17

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG GEN

V22.5PSE_20231231.lib

Fault at bus: 1510 T-ESB #B3 ECB

Prefault voltage = 0.208 kV
= 100.00 % of nominal bus kV (0.208 kV)
= 100.00 % of base kV (0.208 kV)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus ID	To Bus ID	% V From Bus	kA Symm. rms	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
				Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
1510 T-ESB #B3 ECB	Total	0.00	2.911	0.00	84.95	93.81	3.587	3.587	3.18E+003	8.99E+003	3.26E+003	4.64E+003
EX ESSENTIAL SB #B3	1510 T-ESB #B3 ECB	0.00	0.000	0.00	84.95	93.81	0.000	0.000				
Bus44	1510 T-ESB #B3 ECB	2.51	2.911	4.91	84.95	92.46	3.587	3.587	3.18E+003	8.99E+003	3.26E+003	4.64E+003

- # Indicates fault current contribution is from three-winding transformers
- * Indicates a zero sequence fault current contribution (3I0) from a grounded Delta- Y transformer

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC GEN

Page: 18

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG GEN

V22.5PSE_20231231.lib

Fault at bus: 1700 EMCC #B4

Prefault voltage = 0.600 kV

= 100.00 % of nominal bus kV (0.600 kV)

= 100.00 % of base kV (0.600 kV)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus ID	To Bus ID	% V From Bus	kA Symm. rms	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
				Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
1700 EMCC #B4	Total	0.00	2.109	0.00	72.87	77.01	3.253	3.253	1.32E+002	4.56E+003	3.25E+002	1.32E+003
Bus6	1700 EMCC #B4	2.09	2.109	5.03	73.43	75.56	3.253	3.253	1.32E+002	4.56E+003	3.25E+002	1.32E+003
Bus51	1700 EMCC #B4	0.00	0.000	0.00	72.87	77.01	0.000	0.000				
Bus52	1700 EMCC #B4	0.00	0.000	0.00	72.87	77.01	0.000	0.000				
Bus53	1700 EMCC #B4	0.00	0.000	0.00	72.87	77.01	0.000	0.000				
Bus54	1700 EMCC #B4	0.00	0.000	0.00	72.87	77.01	0.000	0.000				
Bus55	1700 EMCC #B4	0.00	0.000	0.00	72.87	77.01	0.000	0.000				
Bus56	1700 EMCC #B4	0.00	0.000	0.00	72.87	77.01	0.000	0.000				
Bus57	1700 EMCC #B4	0.00	0.000	0.00	72.87	77.01	0.000	0.000				
Bus59	1700 EMCC #B4	0.00	0.000	0.00	72.87	77.01	0.000	0.000				
Bus60	1700 EMCC #B4	0.00	0.000	0.00	72.87	77.01	0.000	0.000				
EX T-CBW2 #B4	1700 EMCC #B4	0.00	0.000	0.00	72.87	77.01	0.000	0.000				

Indicates fault current contribution is from three-winding transformers

* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta- Y transformer

Project: CBBT-Support Bldg Emg

Location: CAPE CHARLES, VA

Contract: 50204245

Engineer:

Filename: 50204245- CBBT Support Bldg

ETAP

22.5.0C

Study Case: SC GEN

Page: 19

Date: 09-18-2024

SN: SCHNDR-CA2

Revision: Base

Config.: CFG GEN

V22.5PSE_20231231.lib

Fault at bus: 1710 T-ESB #B4 ECB

Prefault voltage = 0.208 kV
= 100.00 % of nominal bus kV (0.208 kV)
= 100.00 % of base kV (0.208 kV)

Contribution		3-Phase Fault		Line-To-Ground Fault					Positive & Zero Sequence Impedances Looking into "From Bus"			
From Bus ID	To Bus ID	% V From Bus	kA Symm. rms	% Voltage at From Bus			kA Symm. rms		% Impedance on 100 MVA base			
				Va	Vb	Vc	Ia	3I0	R1	X1	R0	X0
1710 T-ESB #B4 ECB	Total	0.00	2.893	0.00	85.18	94.44	3.536	3.536	3.22E+003	9.04E+003	3.42E+003	4.79E+003
EX ESSENTIAL SB #B4	1710 T-ESB #B4 ECB	0.00	0.000	0.00	85.18	94.44	0.000	0.000				
Bus58	1710 T-ESB #B4 ECB	3.32	2.893	6.46	85.14	92.67	3.536	3.536	3.22E+003	9.04E+003	3.42E+003	4.79E+003

- # Indicates fault current contribution is from three-winding transformers
- * Indicates a zero sequence fault current contribution (3I0) from a grounded Delta- Y transformer

Project: CBBT-Support Bldg Emg

ETAP

Page: 20

Location: CAPE CHARLES, VA

22.5.0C

Date: 09-18-2024

Contract: 50204245

SN: SCHNDR-CA2

Engineer:

Study Case: SC GEN

Revision: Base

Filename: 50204245- CBBT Support Bldg

Config.: CFG GEN

V22.5PSE_20231231.lib

Short-Circuit Summary Report

30 Cycle - 3-Phase, LG, LL, & LLG Fault Currents

Prefault Voltage = 100 % of the Bus Nominal Voltage

Bus		3-Phase Fault			Line-to-Ground Fault			Line-to-Line Fault			*Line-to-Line-to-Ground		
ID	kV	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.
1100 EMCC #B1	0.600	0.060	-2.110	2.111	0.301	-3.245	3.259	2.209	0.147	2.214	-2.163	1.732	2.771
1110 T-ESB #B1 ECB	0.208	0.970	-2.750	2.916	1.523	-3.253	3.592	2.531	1.017	2.728	-3.336	0.784	3.427
1300 EMCC #B2	0.600	0.062	-2.107	2.108	0.307	-3.232	3.247	2.204	0.149	2.209	-2.167	1.718	2.765
1310 T-ESB #B2 ECB	0.208	0.974	-2.741	2.909	1.525	-3.244	3.584	2.522	1.020	2.721	-3.328	0.779	3.418
1500 EMCC #B3	0.600	0.064	-2.104	2.104	0.313	-3.219	3.235	2.200	0.151	2.205	-2.171	1.703	2.759
1510 T-ESB #B3 ECB	0.208	0.970	-2.745	2.911	1.522	-3.248	3.587	2.526	1.016	2.723	-3.331	0.784	3.422
1700 EMCC #B4	0.600	0.061	-2.108	2.109	0.304	-3.238	3.253	2.206	0.148	2.211	-2.165	1.725	2.768
1710 T-ESB #B4 ECB	0.208	0.971	-2.725	2.893	1.517	-3.194	3.536	2.506	1.016	2.704	-3.306	0.736	3.387

All fault currents are symmetrical (30 Cycle network) values in rms kA.

* LLG fault current is the larger of the two faulted line currents.

Sequence Impedance Summary Report

Bus		Positive Seq. Imp. (ohm)			Negative Seq. Imp. (ohm)			Zero Seq. Imp. (ohm)			Fault Zf (ohm)		
ID	kV	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance	Resistance	Reactance	Impedance
1100 EMCC #B1	0.600	0.00468	0.16403	0.16410	0.01332	0.10643	0.10726	0.01143	0.04709	0.04845	0.00000	0.00000	0.00000
1110 T-ESB #B1 ECB	0.208	0.01370	0.03883	0.04118	0.01474	0.03191	0.03515	0.01409	0.02009	0.02454	0.00000	0.00000	0.00000
1300 EMCC #B2	0.600	0.00484	0.16428	0.16435	0.01348	0.10668	0.10753	0.01194	0.04770	0.04917	0.00000	0.00000	0.00000
1310 T-ESB #B2 ECB	0.208	0.01382	0.03890	0.04128	0.01486	0.03197	0.03526	0.01409	0.02009	0.02454	0.00000	0.00000	0.00000
1500 EMCC #B3	0.600	0.00501	0.16453	0.16461	0.01365	0.10693	0.10780	0.01246	0.04832	0.04989	0.00000	0.00000	0.00000
1510 T-ESB #B3 ECB	0.208	0.01374	0.03889	0.04125	0.01478	0.03197	0.03522	0.01409	0.02009	0.02454	0.00000	0.00000	0.00000
1700 EMCC #B4	0.600	0.00476	0.16416	0.16422	0.01340	0.10656	0.10739	0.01168	0.04739	0.04881	0.00000	0.00000	0.00000
1710 T-ESB #B4 ECB	0.208	0.01393	0.03911	0.04152	0.01497	0.03218	0.03550	0.01481	0.02073	0.02547	0.00000	0.00000	0.00000

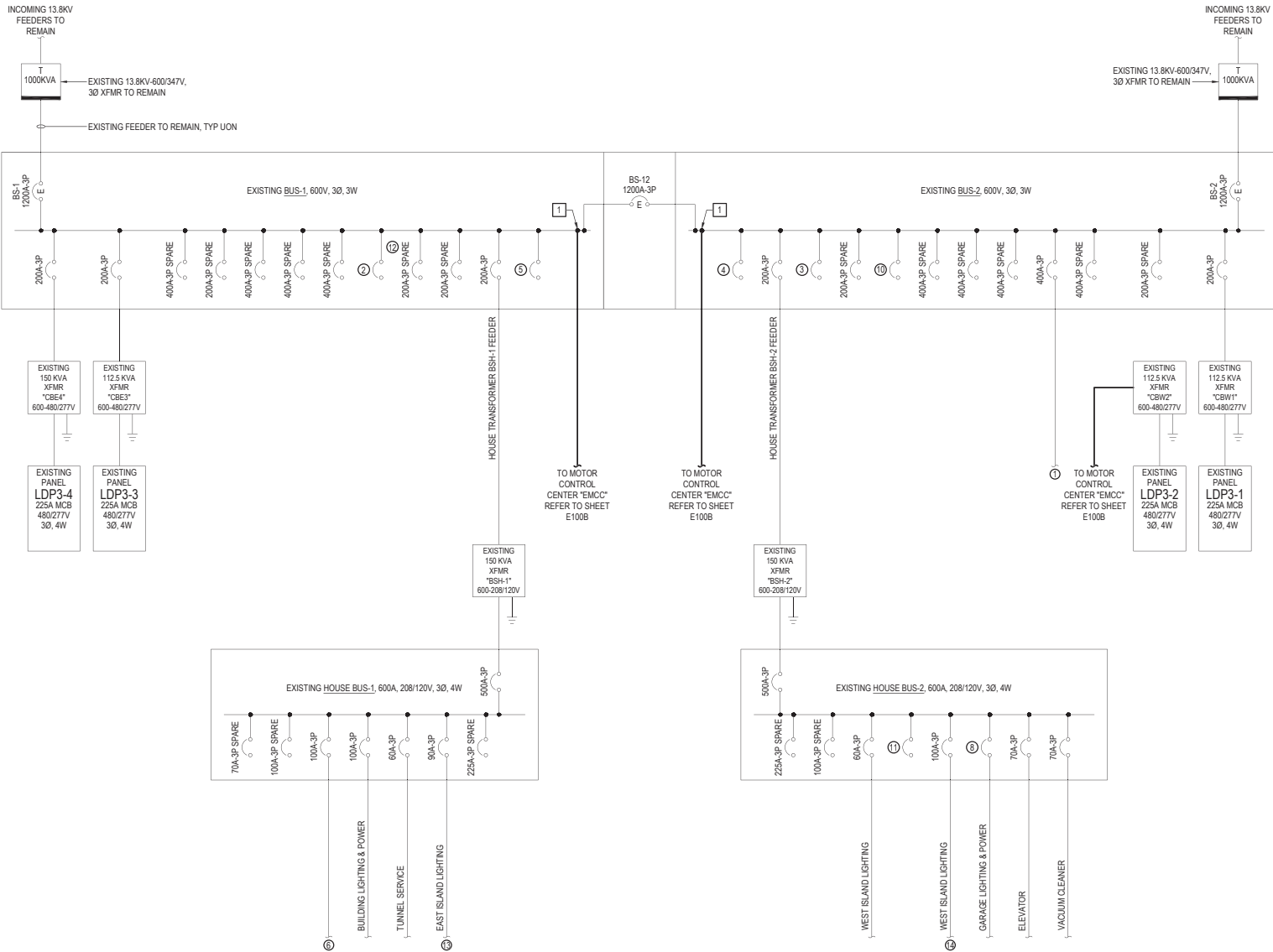
APPENDIX C: REFERENCES

I. SUPPLIED DATA

- 1 Customer One Line
- 2 MCC submittal
- 3 LV Transformer
- 4 Mail reference from customer for all building MCC identical.
- 5 Cable data
- 6 Utility transformer and generator information
- 7 Email references.

II. 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 Molded Case Breakers
- 5 Std AF Study Options - ETAP
- 6 Approach Boundaries Table - 70E
- 7 Project Recommendation & Action Table



NOTES THIS SHEET

- 1 DRILL AND TAP EXISTING BUSSING DOWNSTREAM OF MAIN 1200A-3P CIRCUIT BREAKER. PROVIDE LUGS AS REQUIRED TO ACCOMMODATE QUANTITY AND SIZE OF CONDUCTORS INDICATED. ENGAGE A UL FIELD ENGINEERING SERVICES STAFF MEMBER TO EVALUATE BUSSING MODIFICATIONS AND OBTAIN APPROVAL FROM THE AHJ PRIOR TO COMMENCING WORK. MAKE ALL NECESSARY MODIFICATIONS AS DIRECTED BY THE UL FILED ENGINEERING STAFF AND THE AHJ.

BUILDING SPECIFIC NOTES

- 1 BUILDING #1: TO FISHING PIER, SNACK BAR
BUILDING #2: SPACE ONLY
BUILDING #3: TO VERIZON EQUIPMENT
BUILDING #4: SPARE
- 2 BUILDING #1: 400A-3P SPARE
BUILDING #2: 200A-3P SPARE
BUILDING #3: 200A-3P SPARE
BUILDING #4: 200A-3P SPARE
- 3 BUILDING #1: 200A-3P SPARE
BUILDING #2: 200A-3P (125HP MID-CHANNEL PUMP)
BUILDING #3: 400A-3P SPARE
BUILDING #4: 400A-3P SPARE
- 4 BUILDING #1: 200A-3P SPARE
BUILDING #2: SPACE ONLY
BUILDING #3: 200A-3P (125HP MID-CHANNEL PUMP)
- 5 BUILDING #1: SPACE ONLY
BUILDING #2 ONLY: SPARE (UNKNOWN RATING) LABELED "DO NOT OPERATE"
- 6 BUILDING #1: SPARE
BUILDING #2: SPARE
BUILDING #3: SUNCOM
BUILDING #4: SPARE
- 7 NOTE NOT USED.
- 8 BUILDING #1: 90A-3P
BUILDING #2: 100A-3P
BUILDING #3: 100A-3P
BUILDING #4: 100A-3P
- 9 NOTE NOT USED.
- 10 BUILDING #1: 200A-3P SPARE
BUILDING #2: 400A-3P SPARE
BUILDING #3: 400A-3P SPARE
BUILDING #4: 400A-3P SPARE
- 11 BUILDING #1: 100A-3P
BUILDING #2: 90A-3P
BUILDING #3: 100A-3P
BUILDING #4: 90A-3P
- 12 BUILDING #4 ONLY: 400A-3P.
- 13 BUILDING #4 ONLY: SPARE.
- 14 BUILDING #4 ONLY: EAST/WEST LIGHTING.

GENERAL NOTE:

WORK SHOWN IN THIS SET OF CONTRACT DOCUMENTS IS BASED ON PORTAL ISLAND BUILDING #3. THIS WORK IS TYPICAL FOR PORTAL ISLAND BUILDINGS #1, #2, AND #4.



1277 PERIMETER PARKWAY
VIRGINIA BEACH, VIRGINIA 23464
(757) 499-7223

7814 CAROUSEL LANE, SUITE 200
RECHMICKS, VIRGINIA 22304
(864) 270-7222

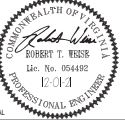
Designed By: RTW

Drawn By: MLC

Checked By: JSB

Scale: AS NOTED

Date: 12-01-2021



No.	DATE	REVISIONS	DESCRIPTION

CHESAPEAKE BAY BRIDGE TUNNEL
SUPPORT BUILDINGS EMERGENCY POWER SYSTEM UPGRADES
CAPE CHARLES
VIRGINIA
PARTIAL ONE-LINE DIAGRAM - BUILDING #3 - NEW WORK

PROJECT No: 21161

E100A

SHEET 9 OF 13

PARTIAL ONE-LINE DIAGRAM - BUILDING #3 - NEW WORK

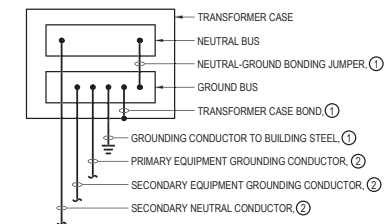
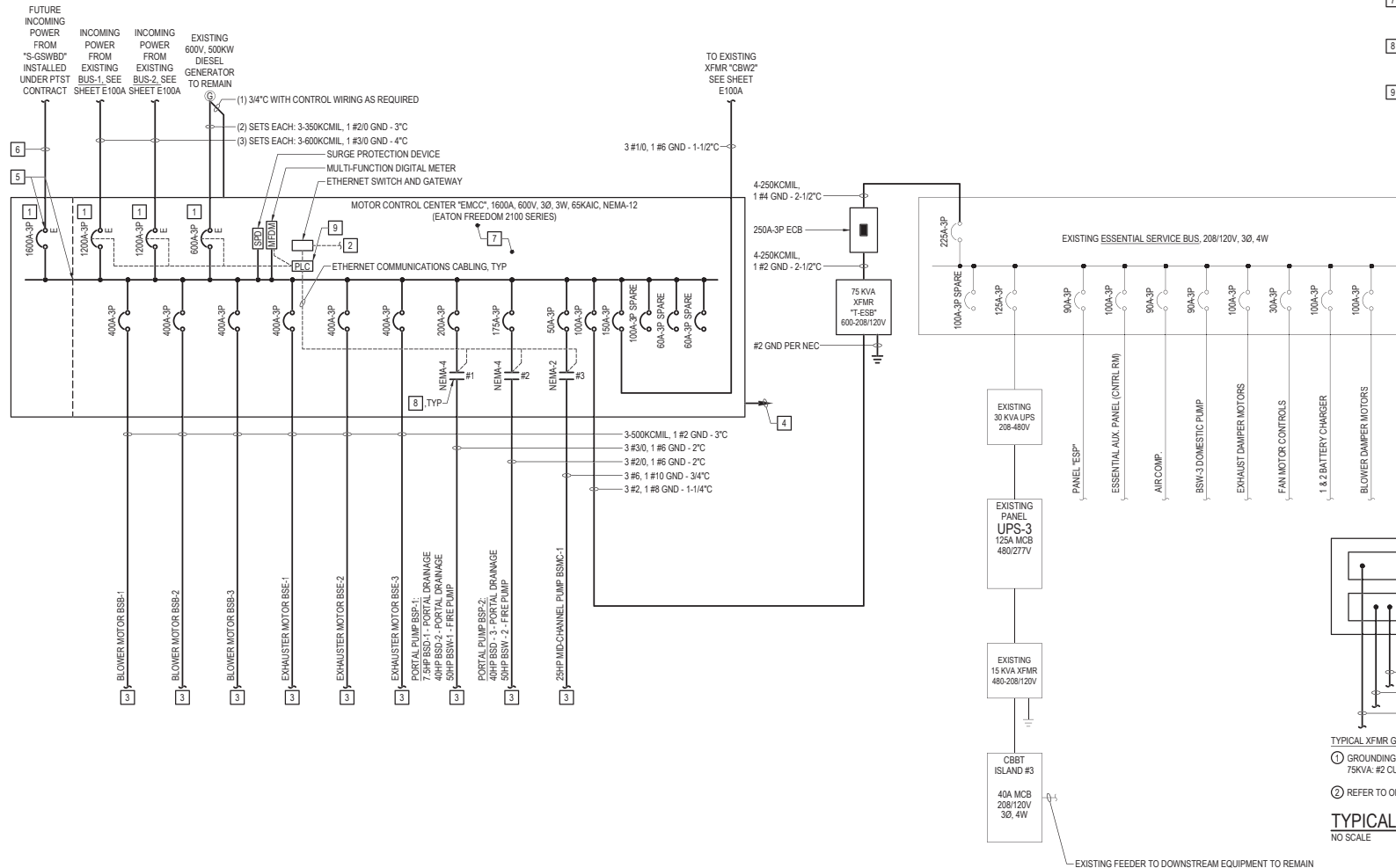
NO SCALE

GENERAL PROGRAMMING NOTES:

- BUS-1 IS THE PREFERRED SOURCE OF UTILITY POWER TO "EMCC".
- UPON LOSS OF UTILITY POWER FROM BUS-1 AS SENSED BY THE PLC, THE PLC SHALL AUTOMATICALLY TRANSFER TO THE BUS-2 UTILITY SOURCE BY OPENING THE BUS-1 INPUT BREAKER AND CLOSING THE BUS-2 INPUT BREAKER.
- UPON LOSS OF BOTH UTILITY POWER SOURCES FROM BUS-1 AND BUS-2 AS SENSED BY THE PLC, THE PLC SHALL AUTOMATICALLY START THE EXISTING GENERATOR AND TRANSFER TO EMERGENCY POWER BY OPENING THE BUS-1 AND BUS-2 INPUT BREAKERS AND CLOSING THE GENERATOR INPUT BREAKER WITHIN 10-SECONDS.
- UPON RESTORATION OF POWER FROM BUS-1 OR BUS-2 UTILITY SOURCES AS SENSED BY THE PLC, THE PLC SHALL AUTOMATICALLY RETRANSFER BACK TO UTILITY POWER BY OPENING THE GENERATOR INPUT BREAKER AND CLOSING THE AVAILABLE UTILITY SOURCE INPUT BREAKER. PLC SHALL HAVE AN ADJUSTABLE TIME DELAY FOR RETRANSFER TO UTILITY POWER (0-30 MINUTES MINIMUM).
- PLC SHALL INCLUDE AN ADJUSTABLE GENERATOR COOL DOWN TIMER. COOL DOWN TIME SHALL BE PROGRAMMED AS DIRECTED BY THE DISTRICT.
- PLC SHALL BE PROGRAMMED TO EXERCISE THE GENERATOR AS DIRECTED BY THE DISTRICT. PROGRAMMING SHALL INCLUDE OPTIONS FOR EXERCISING WITH OR WITHOUT LOAD AND ADJUSTABLE INTERVALS FOR EXERCISING FREQUENCY AND TIME DURATION.
- WHEN "EMCC" IS POWERED BY THE EMERGENCY GENERATOR, THE SCADA SYSTEM SHALL BE PROGRAMMED TO INHIBIT ANY OF THE BLOWER MOTORS OR EXHAUSTER MOTORS FROM OPERATING AT ANY SPEED OTHER THAN SPEED-1. ONLY (1) BLOWER MOTOR AND (1) EXHAUSTER MOTOR MAY OPERATE SIMULTANEOUSLY WHEN "EMCC" IS POWERED BY THE GENERATOR. AN ADJUSTABLE TIME DELAY SHALL BE PROGRAMMED BETWEEN STARTING THESE LOADS (30 SECONDS MINIMUM).
- UPON LOSS OF POWER AS SENSED BY "EMCC" AUTO TRANSFER PLC, NETWORKED CONTACTORS SHALL OPEN. ADJUSTABLE TIME DELAYS SHALL BE PROGRAMMED BETWEEN CLOSING THESE CONTACTORS. CONTACTORS SHALL CLOSE SEQUENTIALLY AS NUMBERED ON ONE-LINE DIAGRAM WITH 30 SECOND MINIMUM TIME DELAYS BETWEEN EACH.
- UPON LOSS OF COMMUNICATIONS SIGNAL BETWEEN "EMCC" PLC AND SCADA SYSTEM AND IN ORDER TO PREVENT OVERLOADING THE STANDBY GENERATOR, THE SCADA SYSTEM SHALL BE PROGRAMMED TO DEFAULT TO OPERATING (1) BLOWER MOTOR AND (1) EXHAUSTER MOTOR AT SPEED-1 ONLY UNTIL COMMUNICATIONS IS RESTORED.

NOTES THIS SHEET

- INSULATED CASE, ELECTRICALLY OPERATED BREAKER.
- CAT-5E CABLE IN 3/4" TO EXISTING SCADA SYSTEM (AT EXISTING CNC CABINET LOCATED IN TUNNEL LIGHTING CONTROL ROOM).
- CONNECT TO EXISTING FEEDERS SAVED DURING DEMOLITION.
- 2 #12 - 3/4" TO EXISTING DC LIGHTING PANEL LOCATED IN CONTROL ROOM. SEE E201. CONNECT TO SPARE CIRCUIT BREAKER IN EXISTING PANEL.
- PROVIDE 1600A INPUT BREAKER AS INDICATED IN MCCs LOCATED IN PORTAL ISLAND BUILDINGS #1 AND #2 ONLY. FOR MCCs LOCATED IN PORTAL ISLAND BUILDINGS #3 AND #4 ONLY, PROVIDE PROVISIONS FOR FUTURE 1600A BUS EXTENSION AND FUTURE 1600A BREAKER.
- FUTURE (4) SETS EACH 3-600KCMIL, 1 #4/0 GND - 4" TO BE INSTALLED UNDER A SEPARATE CONTRACT.
- PROVIDE ELECTRONIC TRIP UNITS WITH ADJUSTABLE LONG TIME, SHORT TIME, AND INSTANTANEOUS TRIP SETTINGS FOR ALL CIRCUIT BREAKERS.
- CONTACTOR WITH COMMUNICATIONS CARD/DEVICE TO ALLOW CONTACTOR COIL TO ENERGIZE/DE-ENERGIZE VIA NETWORK COMMUNICATIONS.
- AUTO-TRANSFER AND INHIBIT PLC.



TYPICAL XFMR GROUNDING DETAIL NOTES:

① GROUNDING ELECTRODE CONDUCTOR SIZES:
75KVA: #2 CU GND - 1/2"

② REFER TO ONE-LINE DIAGRAMS FOR CONDUCTOR SIZES.

TYPICAL XFMR GROUNDING DETAIL

NO SCALE

GENERAL NOTE:

WORK SHOWN IN THIS SET OF CONTRACT DOCUMENTS IS BASED ON PORTAL ISLAND BUILDING #3. THIS WORK IS TYPICAL FOR PORTAL ISLAND BUILDINGS #1, #2, AND #4.

PARTIAL ONE-LINE DIAGRAM - BUILDING #3 - NEW WORK

NO SCALE



1277 PERIMETER PARKWAY
VIRGINIA BEACH, VIRGINIA 23454
(757) 498-7223

7814 CAROLAN LANE, SUITE 200
FARMERSBURG, VIRGINIA 22044
(804) 275-7222

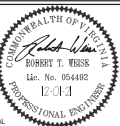
Designed By: RTW

Drawn By: MLC

Checked By: JSB

Scale: AS NOTED

Date: 12-01-2021



No.	DATE	REVISIONS	DESCRIPTION

CHESAPEAKE BAY BRIDGE TUNNEL
SUPPORT BUILDINGS EMERGENCY POWER SYSTEM UPGRADES
CAPE CHARLES
VIRGINIA
PARTIAL ONE-LINE DIAGRAM - BUILDING #3 - NEW WORK

PROJECT No: 21161

E100B

SHEET 10 OF 13

[illegible]

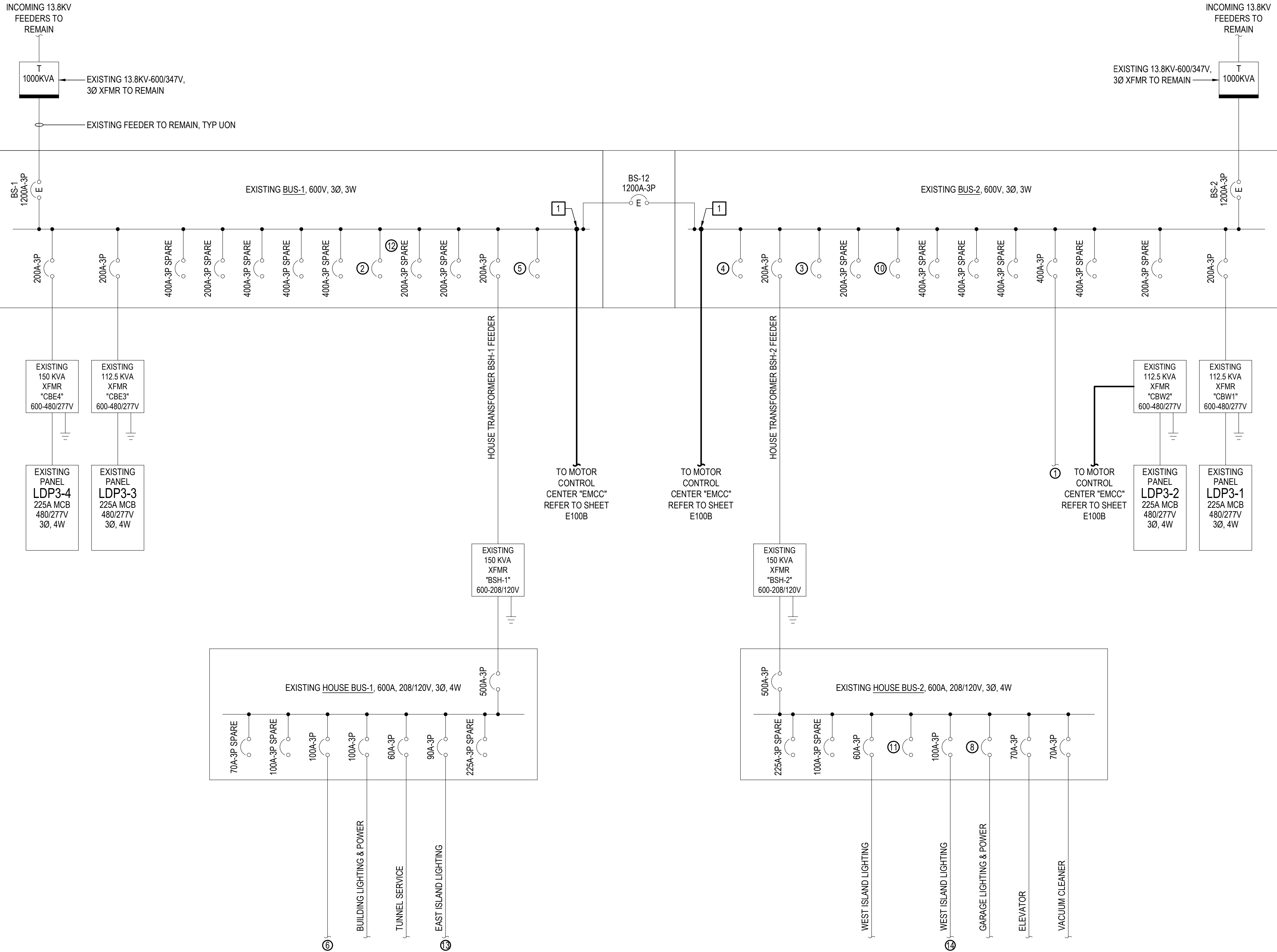
REV	DESCRIPTION	BY	DATE																		
-	----	--	--/--/--	-----										-- --/--/--				-- --/--/--			
UNIT LOC	UNIT NAMEPLATES	UNIT TYPE	SIZE	HP	FRAME AMPS	TRIP AMPS	CONTROL SOURCE	VA	FUSE SIZE		INTERLOCKS		PILOT DEVICES: LED		30 mm **		SS / PB		OTHER UNIT FEATURES	ELEMENTARY #	
									PRI	SEC	NO	NC	ON LIGHT	OFF LIGHT	ADDL P/L						
5A	PM5563	POWER METER																	ETHERNET COMM, PM5563 W/DISPLAY	E50204245-001-05	
5C	SURGE PROTECTION DEVICE	SPD	240kA																SOLIDLY GROUNDED, SURGE COUNTER	E50204245-001-06	
5E	Provide Blank Nameplate	6" BRANCH BKR			HR 150	100													(1) 14-3/0AWG WIRE/PH, 80% RATED, AL MECH LUG AL/CU CABLE, ELECTRONIC ENERGY TRIP UNIT, LSI TRIP FUNCTION	E50204245-001-07	
5G	Provide Blank Nameplate	6" BRANCH BKR			HR 150	100													(1) 14-3/0AWG WIRE/PH, 80% RATED, AL MECH LUG AL/CU CABLE, ELECTRONIC ENERGY TRIP UNIT, LSI TRIP FUNCTION	E50204245-001-08	
5I	Provide Blank Nameplate	6" BRANCH BKR			HR 150	150													80% RATED, AL MECH LUG AL/CU CABLE, ELECTRONIC ENERGY TRIP UNIT, LSI TRIP FUNCTION	E50204245-001-09	
5K	Provide Blank Nameplate	6" BRANCH BKR			HR 150	60													(1) 14-3/0AWG WIRE/PH, 80% RATED, AL MECH LUG AL/CU CABLE, ELECTRONIC ENERGY TRIP UNIT, LSI TRIP FUNCTION	E50204245-001-10	
5M	Provide Blank Nameplate	6" BRANCH BKR			HR 150	60													(1) 14-3/0AWG WIRE/PH, 80% RATED, AL MECH LUG AL/CU CABLE, ELECTRONIC ENERGY TRIP UNIT, LSI TRIP FUNCTION	E50204245-001-11	
5O		SPACE																			
5Q		BRANCH BKR			LR 400	400													(2) 2/0-500KCMIL WIRES/PH, 80% RATED, AL MECH LUG AL/CU CABLE, ELECTRONIC ENERGY TRIP UNIT, LSI TRIP FUNCTION	E50204245-001-12	
6A		BRANCH BKR			LR 400	400													(2) 2/0-500KCMIL WIRES/PH, 80% RATED, AL MECH LUG AL/CU CABLE, ELECTRONIC ENERGY TRIP UNIT, LSI TRIP FUNCTION	E50204245-001-13	
6I	Provide Blank Nameplate	FVNR	NEMA 2	25	HR 150	60					2	2	RED PTT	GREEN PTT			HOA SS		#16 AWG MTW CONTROL WIRE, ETHERNET IP, OMIT RESET, Tesys T OL, TRANSIENT SUPPRESSION CONTROL TRANS. COIL STARTER	E50204245-001-14	
6M	Special Unit	SPECIAL UNIT																	#16 AWG MTW CONTROL WIRE 26TX, MANAGED ETHERNET SWITCH UNIT	E50204245-001-15 E50204245-001-16	
7A		TRANSITION SECT																			
UNIT LOC	UNIT NAMEPLATES	UNIT TYPE	SIZE	HP	FRAME AMPS	TRIP AMPS	CONTROL SOURCE	VA	FUSE SIZE		INTERLOCKS		PILOT DEVICES: LED		30 mm **		SS / PB		OTHER UNIT FEATURES	ELEMENTARY #	
									PRI	SEC	NO	NC	ON LIGHT	OFF LIGHT	ADDL P/L						
									FUSE SIZE		INTERLOCKS		PILOT DEVICES: LED		30 mm **						
										JOB NAME: CBBT SUPPORT BLDGS.						EQUIPMENT DESIGNATION: EMCC					
										JOB LOCATION: HAMPTON, VA						EQUIPMENT TYPE: MODEL 6 MOTOR CONTROL CENTER					
										DRAWN BY: JORGE LUIS PALACIOS						DRAWING TYPE: UNIT INFORMATION					
										ENGR: JLP											
										DATE: MARZO 07, 2024											
										DRAWING STATUS: RECORD						DWG# I50204245-001-01					
																PG 2 OF 4 REV					

REV	DESCRIPTION										BY	DATE																							
-	----										-	--/--/--																							
UNIT LOC	UNIT NAMEPLATES			UNIT TYPE	SIZE	HP	FRAME AMPS	TRIP AMPS	CONTROL SOURCE	VA	FUSE PRI	SIZE SEC	INTERLOCKS NO	NC	PILOT DEVICES: ON LIGHT	LED OFF LIGHT	30 mm ** ADDL P/L	SS / PB	OTHER UNIT FEATURES			ELEMENTARY #													
8A				BRANCH BKR			LR 400	400												(2) 2/0-500KCMIL WIRES/PH, 80% RATED, AL MECH LUG AL/CU CABLE, ELECTRONIC ENERGY TRIP UNIT, LSI TRIP FUNCTION			E50204245-001-17												
8I	Provide Blank Nameplate			FVNR	NEMA 4	100	JR 250	225					2	1	RED PTT	GREEN PTT		HOA SS		#16 AWG MTW CONTROL WIRE, ETHERNET IP, OMIT RESET, Tesys T OL,TRANSIENT SUPPRESSION CONTROL TRANS. COIL STARTER			E50204245-001-18												
8Q				BRANCH BKR			LR 400	400												(2) 2/0-500KCMIL WIRES/PH, 80% RATED, AL MECH LUG AL/CU CABLE, ELECTRONIC ENERGY TRIP UNIT, LSI TRIP FUNCTION			E50204245-001-29												
9A				BRANCH BKR			LR 400	400												(2) 2/0-500KCMIL WIRES/PH, 80% RATED, AL MECH LUG AL/CU CABLE, ELECTRONIC ENERGY TRIP UNIT, LSI TRIP FUNCTION			E50204245-001-20												
9I	Provide Blank Nameplate			FVNR	NEMA 4	100	JR 250	225				3.20	2	1	RED PTT	GREEN PTT		HOA SS		#16 AWG MTW CONTROL WIRE, ETHERNET IP, OMIT RESET, Tesys T OL,TRANSIENT SUPPRESSION CONTROL TRANS. COIL STARTER			E50204245-001-21												
9Q				BRANCH BKR			LR 400	400												(2) 2/0-500KCMIL WIRES/PH, 80% RATED, AL MECH LUG AL/CU CABLE, ELECTRONIC ENERGY TRIP UNIT, LSI TRIP FUNCTION			E50204245-001-22												
10A	pull section			MT UNIT																SPL															
11A	pull section			MT UNIT																SPL															
UNIT LOC	UNIT NAMEPLATES			UNIT TYPE	SIZE	HP	FRAME AMPS	TRIP AMPS	CONTROL SOURCE	VA	FUSE PRI	SIZE SEC	INTERLOCKS NO	NC	PILOT DEVICES: ON LIGHT	LED OFF LIGHT	30 mm ** ADDL P/L	SS / PB	OTHER UNIT FEATURES			ELEMENTARY #													
											FUSE SIZE INTERLOCKS PILOT DEVICES: LED 30 mm **																								
											JOB NAME: CBBT SUPPORT BLDGS.										EQUIPMENT DESIGNATION: EMCC														
											JOB LOCATION: HAMPTON, VA										EQUIPMENT TYPE: MODEL 6 MOTOR CONTROL CENTER														
											DRAWN BY: JORGE LUIS PALACIOS										DRAWING TYPE: UNIT INFORMATION														
											ENGR: JLP										By  SQUARE D														
											DATE: MARZO 07, 2024										By  SQUARE D														
											DRAWING STATUS: RECORD										DWG# I50204245-001-01 PG 3 OF 4 REV -														

Please see below requested data:

Impedance Data for Catalog Number(s) below	%IZ	%IX	X/R	RMS Inrush (x Rated Pri Current)
EX75T65HFCU	3.77	3.15	1.52	9.20

- I gave drawings for only line 001. Lines 011, 021, and 031 are identical MCC lineups. I didn't attach the drawings for lines 011, 021, and 031 because engineering made some mistakes on these drawings and they should not be used. Engineering is working on revising the drawings but they are not ready yet. We can use line 001's drawings as a basis for all MCC lines.
- We have an open change order for all lines that will take the feeder breakers in sections 5-9 off the iMCC network. I'm not sure this will affect the study but wanted to mention it just in case.



NOTES THIS SHEET

- 1 DRILL AND TAP EXISTING BUSSING DOWNSTREAM OF MAIN 1200A-3P CIRCUIT BREAKER. PROVIDE LUGS AS REQUIRED TO ACCOMMODATE QUANTITY AND SIZE OF CONDUCTORS INDICATED. ENGAGE A UL FIELD ENGINEERING SERVICES STAFF MEMBER TO EVALUATE BUSSING MODIFICATIONS AND OBTAIN APPROVAL FROM THE AHJ PRIOR TO COMMENCING WORK. MAKE ALL NECESSARY MODIFICATIONS AS DIRECTED BY THE UL FILED ENGINEERING STAFF AND THE AHJ.

BUILDING SPECIFIC NOTES

- 1 BUILDING #1: TO FISHING PIER, SNACK BAR
BUILDING #2: SPACE ONLY
BUILDING #3: TO VERIZON EQUIPMENT
BUILDING #4: SPARE
- 2 BUILDING #1: 400A-3P SPARE
BUILDING #2: 200A-3P SPARE
BUILDING #3: 200A-3P SPARE
BUILDING #4: 200A-3P SPARE
- 3 BUILDING #1: 200A-3P SPARE
BUILDING #2: 200A-3P (*25HP MID-CHANNEL PUMP)
BUILDING #3: 400A-3P SPARE
BUILDING #4: 400A-3P SPARE
- 4 BUILDING #1: 200A-3P SPARE
BUILDING #2: SPACE ONLY
BUILDING #3: SPACE ONLY
BUILDING #4: 200A-3P (*25HP MID-CHANNEL PUMP)
- 5 BUILDING #1: SPACE ONLY
BUILDING #2 ONLY: SPARE (UNKNOWN RATING) LABELED "DO NOT OPERATE"
- 6 BUILDING #1: SPARE
BUILDING #2: SPARE
BUILDING #3: SUNCOM
BUILDING #4: SPARE
- 7 NOTE NOT USED.
- 8 BUILDING #1: 90A-3P
BUILDING #2: 100A-3P
BUILDING #3: 100A-3P
BUILDING #4: 100A-3P
- 9 NOTE NOT USED.
- 10 BUILDING #1: 200A-3P SPARE
BUILDING #2: 400A-3P SPARE
BUILDING #3: 400A-3P SPARE
BUILDING #4: 400A-3P SPARE
- 11 BUILDING #1: 100A-3P
BUILDING #2: 90A-3P
BUILDING #3: 100A-3P
BUILDING #4: 90A-3P
- 12 BUILDING #4 ONLY: 400A-3P.
- 13 BUILDING #4 ONLY: SPARE.
- 14 BUILDING #4 ONLY: EAST/WEST LIGHTING.

PARTIAL ONE-LINE DIAGRAM - BUILDING #3 - NEW WORK

NO SCALE

GENERAL NOTE:

WORK SHOWN IN THIS SET OF CONTRACT DOCUMENTS IS BASED ON PORTAL ISLAND BUILDING #3. THIS WORK IS TYPICAL FOR PORTAL ISLAND BUILDINGS #1, #2, AND #4.



1277 PERIMETER PARKWAY
VIRGINIA BEACH, VIRGINIA 23454
(757) 499-7223

7814 CAROUSEL LANE, SUITE 200
RICHMOND, VIRGINIA 23294
(804) 270-7222

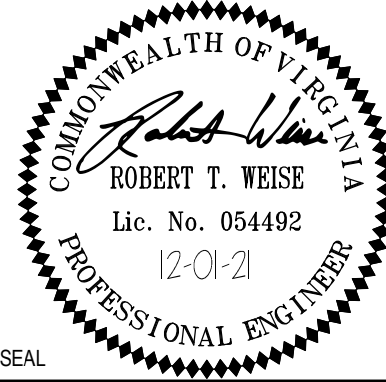
Designed By: RTW

Drawn By: MLC

Checked By: JSB

Scale: AS NOTED

Date: 12-01-2021



No.	DATE	DESCRIPTION

CHESAPEAKE BAY BRIDGE TUNNEL
SUPPORT BUILDINGS EMERGENCY POWER SYSTEM UPGRADES
CAPE CHARLES
VIRGINIA
PARTIAL ONE-LINE DIAGRAM - BUILDING #3 - NEW WORK

PROJECT No: 21161

E100A

SHEET 9 OF 13



CABLE SCHEDULE

BBT- SUPPORT BLDG EMG POWER SYSTEM UPGRADES

CAPE CHARLES, VA

POWER SYSTEM ENGINEERING

50204245

Cable ID	From	To	Cable Sets (per phase)	Size (AWG)	Type (Cu/Al)	Length (ft)
----------	------	----	---------------------------	------------	-----------------	----------------

BUILDING #1

Cable 24	1000 BUS-1 (EX)	1100 EMCC	3	600MCM	CU	45
Cable 25	1005 BUS-2 (EX)	1100 EMCC	3	600MCM	CU	45
Cable 27	BLDG#1 BUS2 XFMR	1005 BUS-2 (EX)	1	1/4X4 COATED BUSS	CU	15
Cable 28	3000 GENERATOR (EX)	1100 EMCC	2	350 MCM	CU	110
Cable 29	1100 EMCC	BSB-1 MOTOR #B1	1	500MCM	CU	110
Cable 30	1100 EMCC	BSB-2 MOTOR #B1	1	500MCM	CU	65
Cable 31	1100 EMCC	BSB-3 MOTOR #B1	1	500MCM	CU	75
Cable 32	1100 EMCC	BSE-1 MOTOR #B1	1	500MCM	CU	100
Cable 33	1100 EMCC	BSE-2 MOTOR #B1	1	500MCM	CU	65
Cable 34	1100 EMCC	BSE-3 MOTOR #B1	1	500MCM	CU	55
Cable 35	1100 EMCC	BSP-1 MOTOR #B1	1	3/0	CU	120
Cable 36	1100 EMCC	T-ESB #B1	1	#2	CU	25
Cable 37	T-ESB #B1	1110 ECB	1	250MCM	CU	15
Cable 38	1110 ECB	EX ESSENTIAL SB #B1	1	250MCM	CU	25
Cable 39	1100 EMCC	BSP-2 MOTOR #B1	1	3/0	CU	125
Cable 40	1100 EMCC	EX T-CBW2 #B1	1	1/0	CU	45
Cable 5	BLDG#1 BUS1 XFMR	1000 BUS-1 (EX)	1	1/4X4 COATED BUSS	CU	15

BUILDING #2

Cable 42	BUS2 BLDG#2 XFMR	1205 BUS-2 (EX)	1	1/4X4 COATED BUSS	CU	15
Cable 43	1205 BUS-2 (EX)	1300 EMCC	3	600MCM	CU	45
Cable 44	3005 GENERATOR (EX)	1300 EMCC	2	350MCM	CU	120
Cable 45	1300 EMCC	BSB-1 MOTOR #B2	1	500MCM	CU	120
Cable 46	1300 EMCC	BSB-2 MOTOR #B2	1	500MCM	CU	100
Cable 47	1300 EMCC	BSB-3 MOTOR #B2	1	500MCM	CU	80
Cable 48	1300 EMCC	BSE-1 MOTOR #B2	1	500MCM	CU	100
Cable 49	1300 EMCC	BSE-2 MOTOR #B2	1	500MCM	CU	65
Cable 50	1300 EMCC	BSE-3 MOTOR #B2	1	500MCM	CU	80
Cable 51	1300 EMCC	BSP-1 MOTOR #B2	1	3/0	CU	140
Cable 52	1310 ECB	EX ESSENTIAL SB #B2	1	250MCM	CU	40
Cable 53	T-ESB #B2	1310 ECB	1	250MCM	CU	15
Cable 54	1300 EMCC	T-ESB #B2	1	#2	CU	30
Cable 55	1300 EMCC	BSP-2 MOTOR #B2	1	2/0	CU	140
Cable 56	1300 EMCC	EX T-CBW2 BLDG#2	1	1/0	CU	50
Cable 57	1200 BUS-1 (EX)	1300 EMCC	3	600MCM	CU	15

BUILDING #3

Cable 58	BLDG#3 BUS2 XFMR	1405 BUS-2 (EX)	1	1/4X4 COATED BUSS	CU	15
Cable 59	1405 BUS-2 (EX)	1500 EMCC	3	600MCM	CU	55
Cable 60	3010 GENERATOR (EX)	1500 EMCC	2	350MCM	CU	130
Cable 61	1500 EMCC	BSB-1 MOTOR #B3	1	500MCM	CU	110
Cable 62	1500 EMCC	BSB-2 MOTOR #B3	1	500MCM	CU	100
Cable 63	1500 EMCC	BSB-3 MOTOR #B3	1	500MCM	CU	70
Cable 64	1500 EMCC	BSE-1 MOTOR #B3	1	500MCM	CU	100
Cable 65	1500 EMCC	BSE-2 MOTOR #B3	1	500MCM	CU	60
Cable 66	1500 EMCC	BSE-3 MOTOR #B3	1	500MCM	CU	50
Cable 67	1500 EMCC	BSP-1 MOTOR #B3	1	3/0	CU	120
Cable 68	1510 ECB	EX ESSENTIAL SB #B3	1	250MCM	CU	35
Cable 69	T-ESB #B3	1510 ECB	1	250MCM	CU	15
Cable 70	1500 EMCC	T-ESB #B3	1	#2	CU	25

Cable 71	1500 EMCC	BSP-2 MOTOR #B3	1	2/0	CU	130
Cable ID	From	To	Cable Sets (per phase)	Size (AWG)	Type (Cu/Al)	Length (ft)
Cable 72	1500 EMCC	EX T-CBW2 #B3	1	1/0	CU	55
Cable 73	1400 BUS-1 (EX)	1500 EMCC	3	600MCM	CU	60
Cable 74	BLDG#3 BUS1 XFMR	1400 BUS-1 (EX)	1	1/4X4 COATED BUSS	CU	15

BUILDING #4

Cable 75	BLDG #4 BUS2 XFMR2	1605 BUS-2 (EX)	1	1/4X4 COATED BUSS	CU	15
Cable 76	1605 BUS-2 (EX)	1700 EMCC	3	600 MCM	CU	55
Cable 77	3015 GENERATOR (EX)	1700 EMCC	2	350MCM	CU	115
Cable 78	1700 EMCC	BSB-1 MOTOR #B4	1	500MCM	CU	120
Cable 79	1700 EMCC	BSB-2 MOTOR #B4	1	500MCM	CU	100
Cable 80	1700 EMCC	BSB-3 MOTOR #B4	1	500MCM	CU	80
Cable 81	1700 EMCC	BSE-1 MOTOR #B4	1	500MCM	CU	100
Cable 82	1700 EMCC	BSE-2 MOTOR #B4	1	500MCM	CU	65
Cable 83	1700 EMCC	BSE-3 MOTOR #B4	1	500MCM	CU	100
Cable 84	1700 EMCC	BSP-1 MOTOR #B4	1	3/0	CU	145
Cable 85	1710 ECB	EX ESSENTIAL SB #B4	1	250MCM	CU	40
Cable 86	T-ESB #B4	1710 ECB	1	250MCM	CU	20
Cable 87	1700 EMCC	T-ESB #B4	1	#2	CU	25
Cable 88	1700 EMCC	BSP-2 MOTOR #B4	1	2/0	CU	140
Cable 89	1700 EMCC	EX T-CBW2 #B4	1	1/0	CU	55
Cable 90	1600 BUS-1 (EX)	1700 EMCC	3	600MCM	CU	55
Cable 91	BLDG #4 BUS1 XFMR	1600 BUS-1 (EX)	1	1/4X4COATED BUSS	CU	15

NO 1 MAIN

Atlantic Power Systems, Inc. Fayetteville
North Carolina

S/N **CF0831021** KVA **1000** 55°C RISE **GALS. OIL 400**

THREE PHASE 60 HZ CLASS OA % IMP. AT 85°C **5.7** INS. FLUID **R-TEMP**

HV **13800 DELTA** LV **600Y/347**

POS. % **VOLTAGE**

1 100

2 97.5

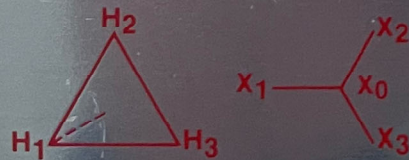
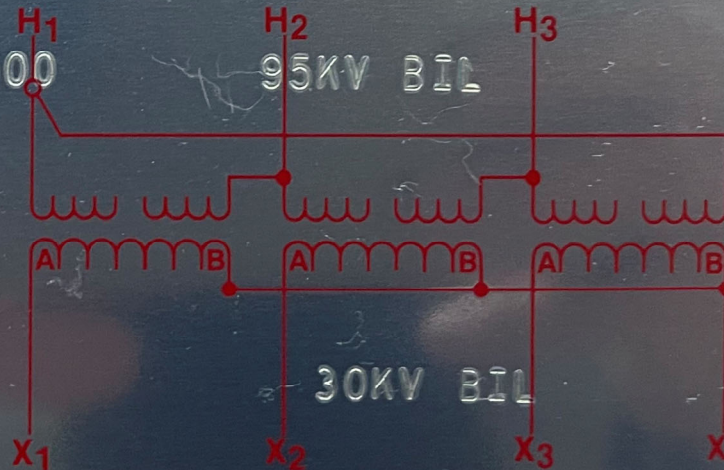
3 95

4 92.5

5 90

WT. **10500**

This Unit Contains **NON-PCB FLUID** At Time Of Manufacture



MADE IN U.S.A.

Caution: Before Operating Read Instruction Book 8701

NO 2 MAIN

Atlantic Power Systems, Inc. Fayetteville
North Carolina

S/N	CF0831020	KVA	1000	55	65°C RISE	GALS. OIL	400
THREE PHASE 60 HZ	CLASS OA	% IMP. AT 85°C	5.7	INS. FLUID	R-TEMP		

HV 13800 DELTA LV 600Y/347

POS.	% VOLTAGE
1	100
2	97.5
3	95
4	92.5
5	90

WT. 8320

This Unit Contains NON-PCB FLUID At Time Of Manufacture

95KV BIL

30KV BIL

MADE IN U.S.A.

Caution: Before Operating Read Instruction Book 8701

CATERPILLAR®

GENERATOR SET

ENGINE MODEL 3412

625 kVA
PRIME

500 kW
X STANDBY

0.8 COS Ø 60 HERTZ
CONTINUOUS

GENERATOR DATA

3 PHASE ~

6 WIRE

X WYE

DELTA

X SERIES

PARALLEL

GENERATOR 600 VOLTS 752 AMPS

EXCITATION 61 VOLTS 9.3 AMPS

591 FRAME 1800 REV/MIN

MAXIMUM TEMPERATURE RISE 130 ° C BY RESISTANCE

40 ° C AMBIENT 1000 METERS ALTITUDE

CLASS H INSULATION

ENCLOSURE TYPE

2000 YEAR

INCLUDE SERIAL NUMBER AND GENERATOR PART
NUMBER FROM GENERATOR SERIAL NUMBER PLATE
WHEN ORDERING PARTS AND IN CORRESPONDENCE.
ESO JLM19

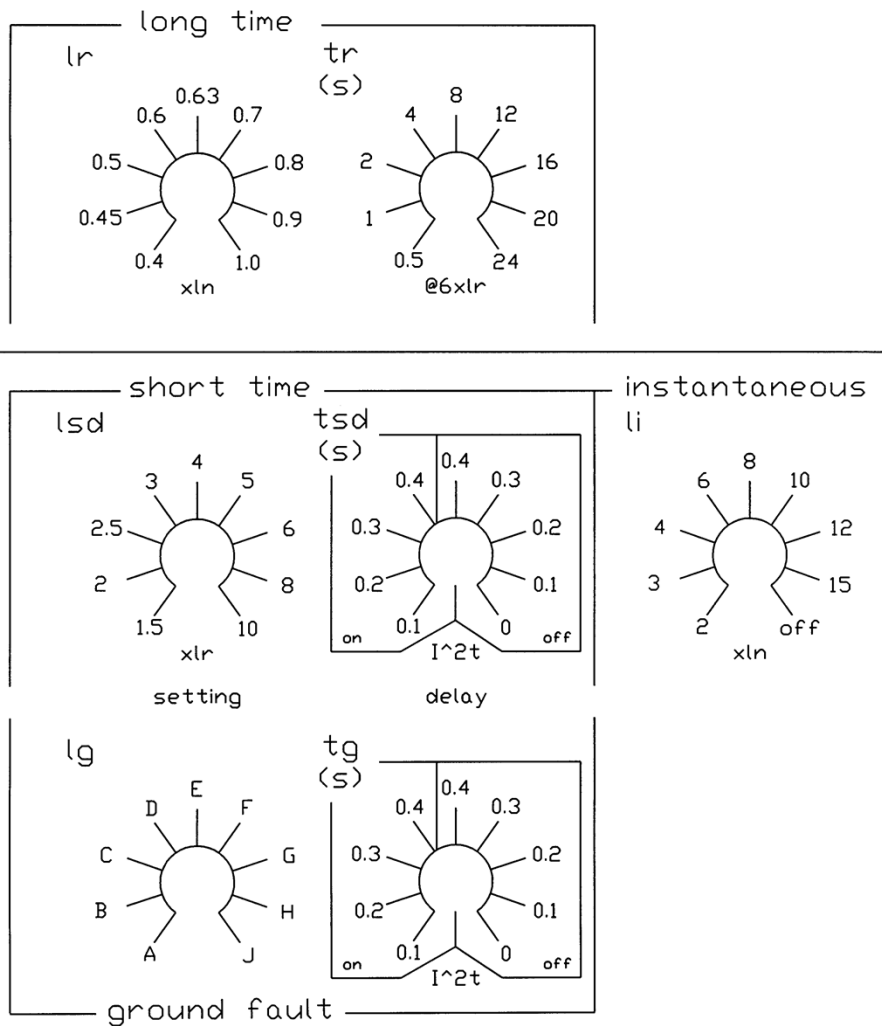
Attached are the cable data sheets, along with pictures of the main breakers information and a pic of the generator spec. The mains in the existing 600V gear will not be in the loop when the new MCC is installed. They will be fed direct from the 600V buss on the secondary side of the transformer. The 600V mains are old and fragile and do not always reset when they are tripped out. Please let me know if they need more information on the MV mains as they will be the source of disconnect ahead of the new MCC. The generator does not have a breaker in it. It is only protected at the generator breaker it ties to in the new MCC.

It looks like there is a mis-communication of the MCC connections. The MCCs are being fed directly from the transformers. There is no breaker between the transformers and the MCCs. Attached is revised drawing showing how it should look.

Per the contractor in reference to the Generator information:

What we sent last time is all the information they have on the gensets. I would say they will have to proceed with assumption.

TRIP ADJUSTMENT DIALS FOR MICROLOGIC 6.0, 6.0A, 6.0P, & 6.0H TRIP UNITS



Notes

l_n = sensor
 l_r = long time pickup setting
 t_r = long time delay setting
 l_{sd} = short time pickup setting
 t_{sd} = short time delay setting
 l_i = instantaneous setting
 l_g = ground fault pickup setting
 t_g = 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.

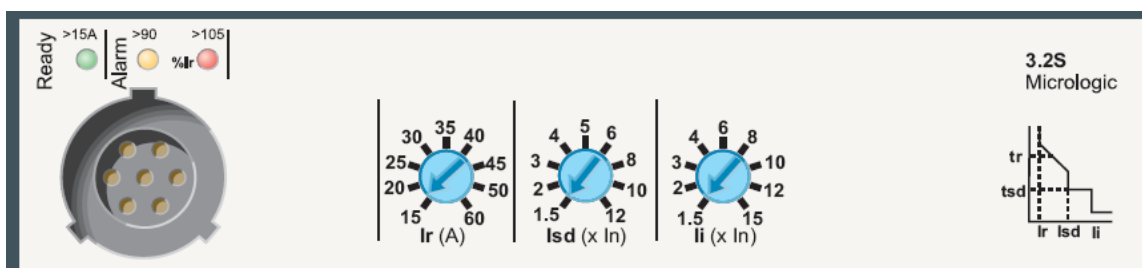
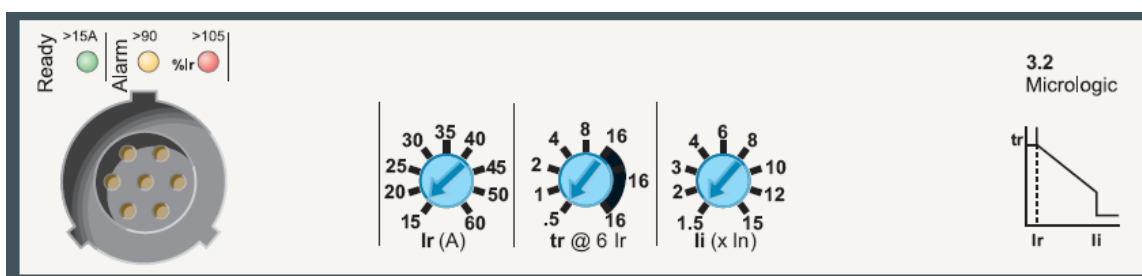
Sensor rating is **In**

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.

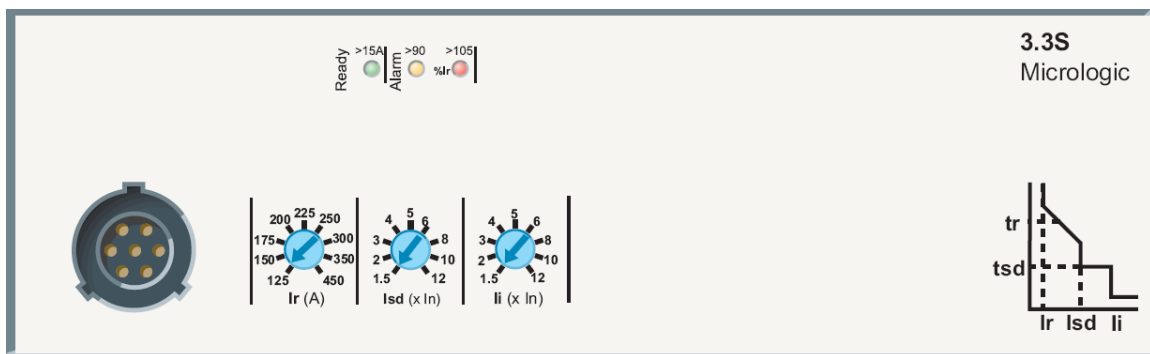
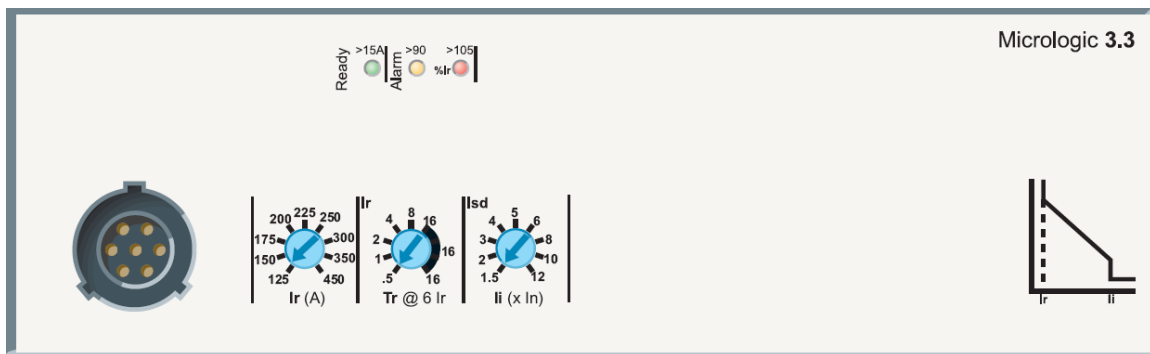
Sensor rating is **In**

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**



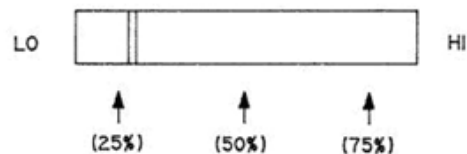
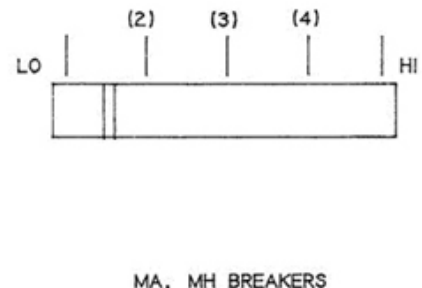
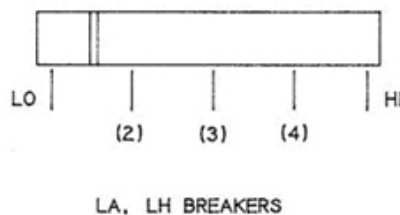
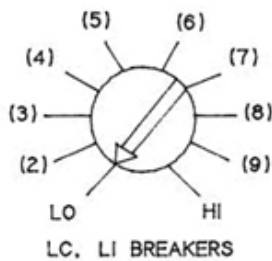
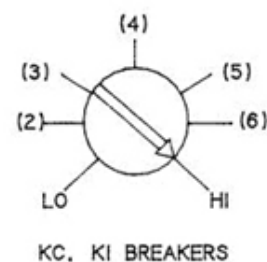
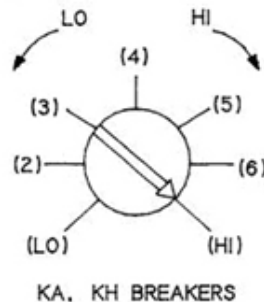
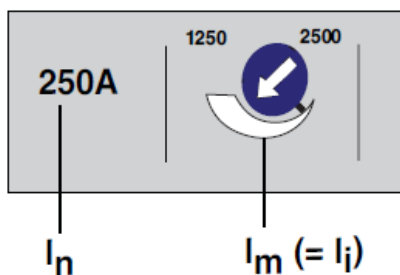
For more information on how to set these trip units, please refer to the User Guide 48940-313-01.

MOLDED CASE CIRCUIT BREAKERS
MAGNETIC (INSTANTANEOUS) TRIP ADJUSTMENT DIALS
(ON FRONT OF CIRCUIT BREAKER)

J-Frame Thermal-Magnetic Trip Unit

I_n : 150A – 250A

I_m : Low – High ($5x - 10x I_n$)



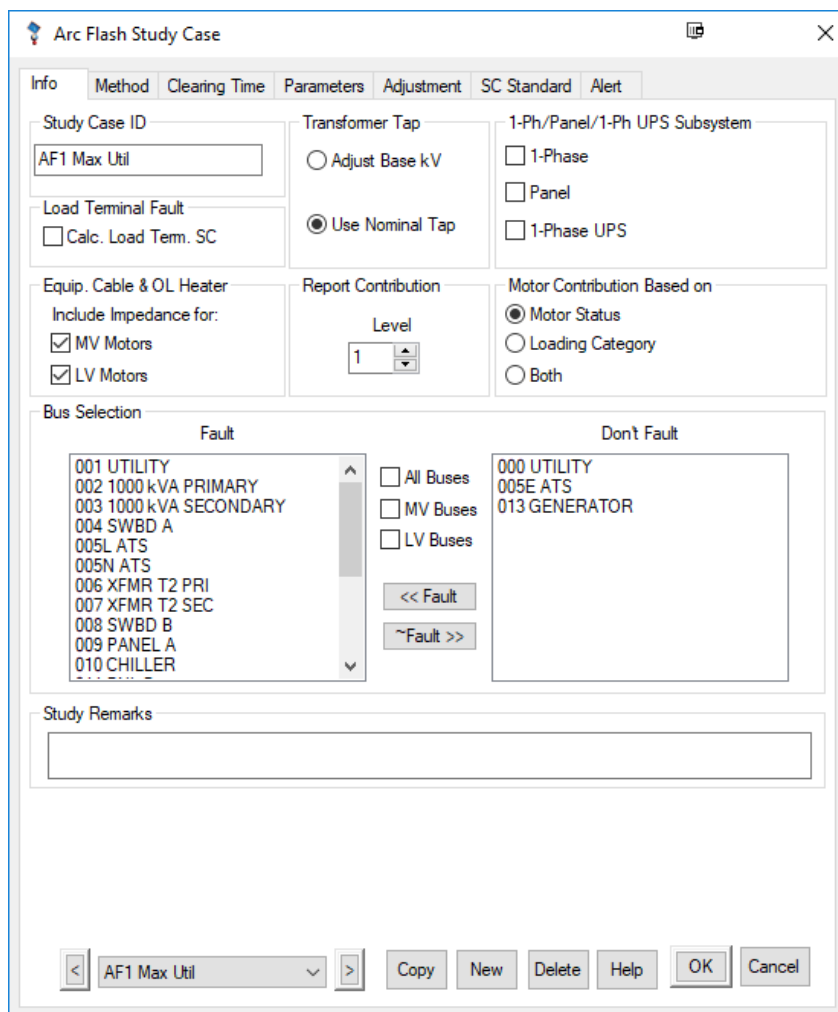
PERCENTAGE OF DISTANCE
FROM LO TO HI SETTINGS
NA, NH, PA, PH, PC BREAKERS

NOTE: THE "LO" AND "HI" MARKINGS APPEAR ON THE DIAL FACES.
(THE MARKINGS IN PARENTHESIS DO NOT)

SETTINGS ARE SHOWN FOR ILLUSTRATION ONLY

"LO" typically corresponds to a 5.0x Magnetic Trip level.
"HI" typically corresponds to a 10.0x Magnetic Trip level.

STANDARD ARC FLASH IEEE 1584-2018 STUDY OPTIONS – ETAP



Arc Flash Study Case

Info Method Clearing Time Parameters Adjustment SC Standard Alert

Study Case ID: AF1 Max Util

Load Terminal Fault: ☐ Calc. Load Term. SC

Equip. Cable & OL Heater: Include Impedance for: ☒ MV Motors ☒ LV Motors

Transformer Tap: ☐ Adjust Base kV ☒ Use Nominal Tap

1-Ph/Panel/1-Ph UPS Subsystem: ☐ 1-Phase ☐ Panel ☐ 1-Phase UPS

Report Contribution: Level: 1

Motor Contribution Based on: ☒ Motor Status ☐ Loading Category ☐ Both

Bus Selection:

Fault	Don't Fault
001 UTILITY	000 UTILITY
002 1000 kVA PRIMARY	005E ATS
003 1000 kVA SECONDARY	013 GENERATOR
004 SWBD A	
005L ATS	
005N ATS	
006 XFMR T2 PRI	
007 XFMR T2 SEC	
008 SWBD B	
009 PANEL A	
010 CHILLER	

Study Remarks:

< AF1 Max Util >

Copy New Delete Help OK Cancel

Options for 1-Ph systems, 3-Ph and 1-Ph Panels, and 1-Ph UPS are used when applicable.


Arc Flash Study Case

Info

Method

Clearing Time

Parameters

Adjustment

SC Standard

Alert

Arc Flash Method

☒ IEEE 1584-2018
☒ Apply Iarc variation <= 0.6 kV

☐ IEEE 1584-2002
☒ Apply Iarc variation > 0.6 kV

☐ ArcFault

Capacitor Energy

☐ Include

Bus Fault Current

☒ Calculate
☐ Symm. 1/2 Cycle

☒ 3-Phase System
☐ Symm. 1.5 to 4 Cycle

☐ Panel/1-Ph UPS/1-Ph System
☒ Fault Current Decay

Steady-State Ibf at

10

Cycles

Syn. Gen Steady-State Ibf

☒ Update Ibf to Bus
☒ Max / Min
☒ Limit Gen Ibf to

300

%FLA

☐ Max
☐ Determine from Decrement Curve

☐ Min

Motor Contributions

☒ Remove after

5

Cycles

☒ Exclude if Motor <=

49

HP/kW

☒ Incident Energy for LV Equipment

Voltage <=

240

☒

1.2

cal/cm^2

Ibf <=

2

kA

☐

4

cal/cm^2

Update AF Results to Buses

☒ Update
☐ No Update
☐ Update if Result is More Conservative

<

AF1 Max Util

>

Copy

New

Delete

Help

OK

Cancel

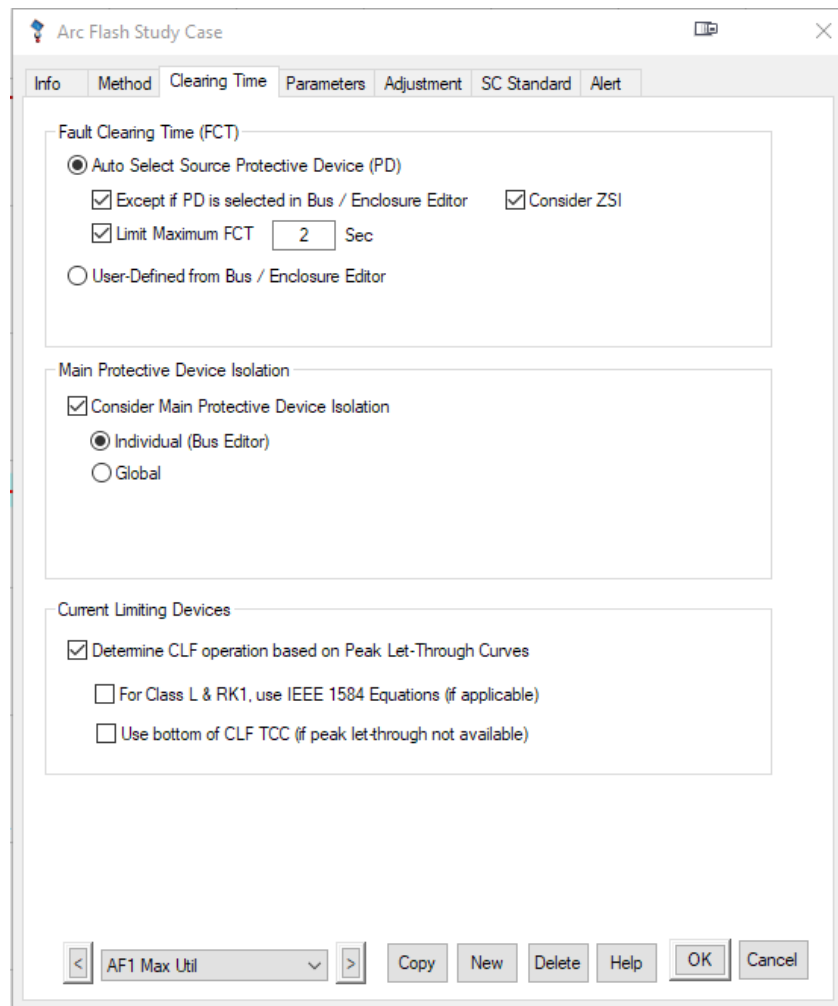
The Exclude if Motor $\leq$ is set to 49 HP/kW for Motors ON.
 The Exclude if Motor $\leq$ is set to 9999 HP/kW for Motors OFF.
 For motors exceeding 9999 HP/kW:

- ETAP Configuration can be used to turn motors ON/OFF. Changing the Demand Factor to Spare results in motors OFF.

Determine from Decrement Curve is used when complete generator data is available.

For LV buses that use the 1.2 cal/cm² result because they meet the criteria of the Incident Energy for LV Eqpt checkbox, the AF results will not have Final FCT, Source PD ID, and Trip Time shown.

Note: Update Ibf to Bus (Max/Min) does not affect the Arc Flash Calculation results. It is an option ETAP uses for the Bus Element on the Protection tab.



Arc Flash Study Case

Info Method **Clearing Time** Parameters Adjustment SC Standard Alert

Fault Clearing Time (FCT)

☒ Auto Select Source Protective Device (PD)

☒ Except if PD is selected in Bus / Enclosure Editor ☒ Consider ZSI

☒ Limit Maximum FCT Sec

☐ User-Defined from Bus / Enclosure Editor

Main Protective Device Isolation

☒ Consider Main Protective Device Isolation

☒ Individual (Bus Editor)

☐ Global

Current Limiting Devices

☒ Determine CLF operation based on Peak Let-Through Curves

☐ For Class L & RK1, use IEEE 1584 Equations (if applicable)

☐ Use bottom of CLF TCC (if peak let-through not available)

< AF1 Max Util > Copy New Delete Help OK Cancel

Arc Flash Study Case

Info

Method

Clearing Time

Parameters

Adjustment

SC Standard

Alert

Bus Gap & Working Distance

☒ Individual (Bus Editor)

☐ Global (Arc Flash Analysis Data)

Edit

Incident Energy Levels

☒ NFPA 70E 2012 to 2021 / User-Defined

Edit/Approve PPE

System Grounding

Arc Flash Boundary

☒ 1.2 cal/cm²

☐ User-Defined

Shock Risk Assessment

Shock Protection Boundaries

☐ Individual (Bus Editor)

☒ Global

☒ NFPA 70E 2018 to 2021

☐ User-Defined

Global Voltage-Rated Glove Class

☒ ASTM D 120-14a

☐ User-Defined

Edit

<

AF1 Max Util

>

Copy

New

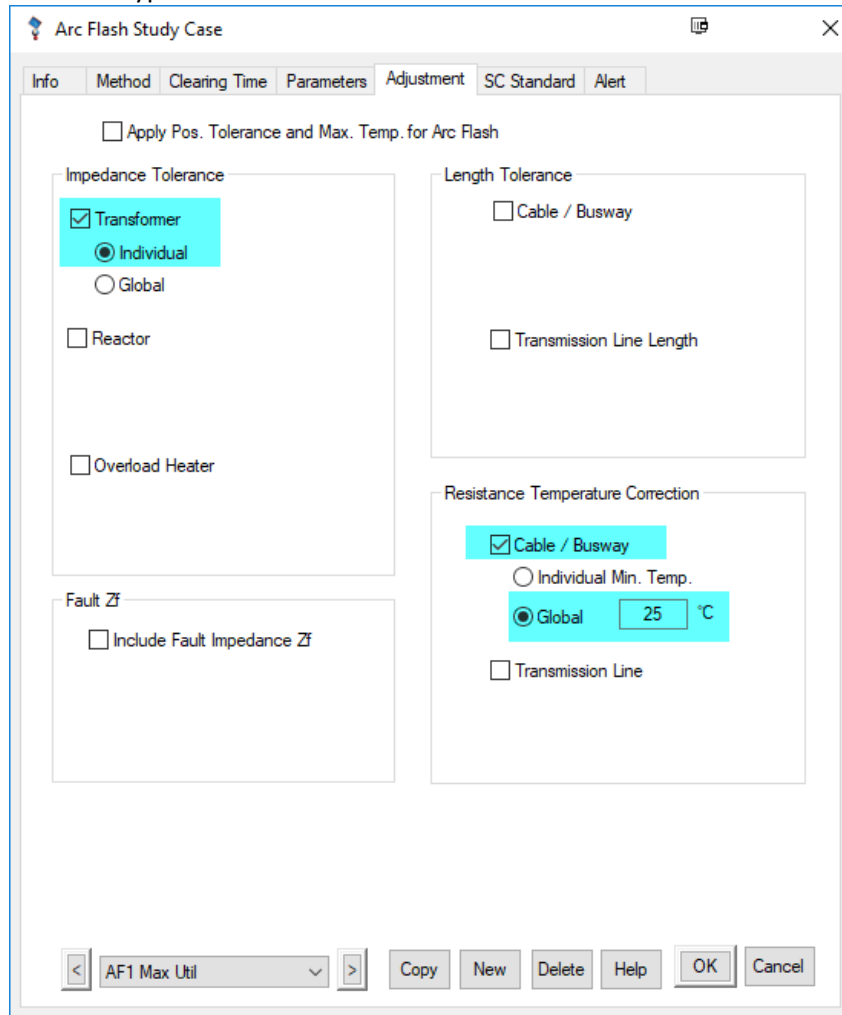
Delete

Help

OK

Cancel

For **maximum** type AF cases:



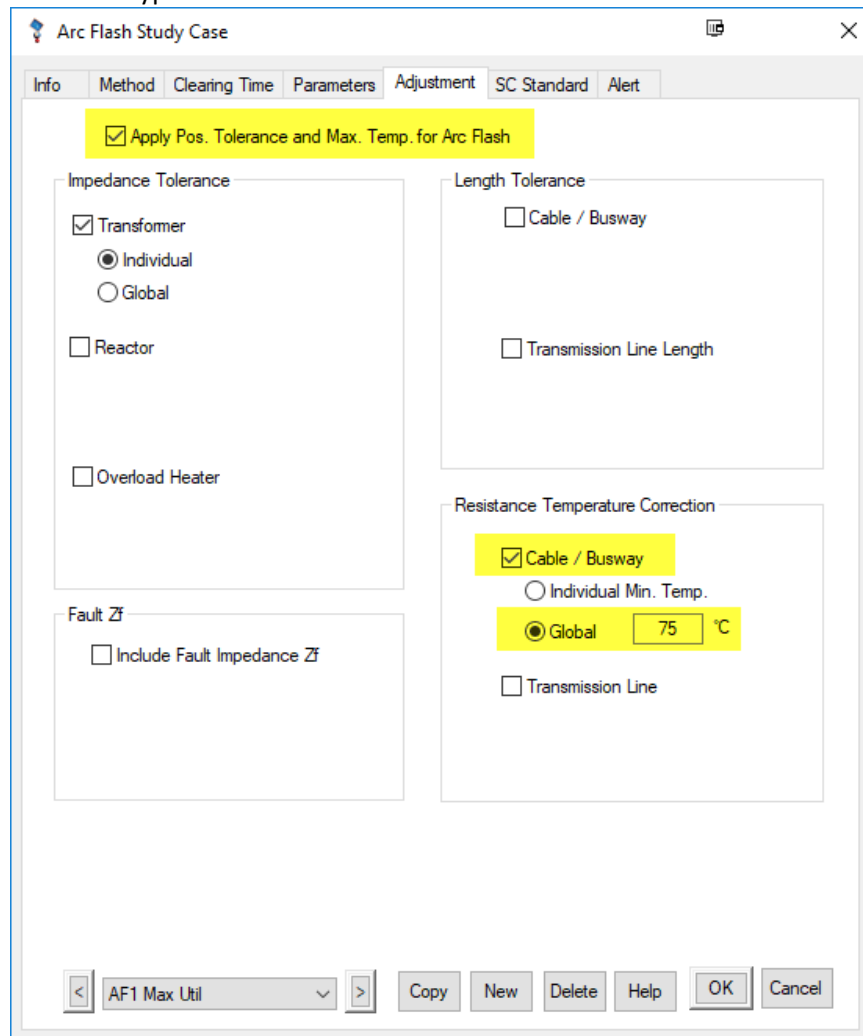
The image shows the 'Arc Flash Study Case' dialog box with the 'Adjustment' tab selected. The dialog box contains several sections for configuring study parameters:

- Apply Pos. Tolerance and Max. Temp. for Arc Flash:** An unchecked checkbox.
- Impedance Tolerance:**
 - ☒ Transformer
 - ☒ Individual
 - ☐ Global
 - ☐ Reactor
 - ☐ Overload Heater
- Length Tolerance:**
 - ☐ Cable / Busway
 - ☐ Transmission Line Length
- Resistance Temperature Correction:**
 - ☒ Cable / Busway
 - ☐ Individual Min. Temp.
 - ☒ Global °C
 - ☐ Transmission Line
- Fault Z_f:**
 - ☐ Include Fault Impedance Z_f

At the bottom, there is a dropdown menu showing 'AF1 Max Util', and buttons for '<', '>', 'Copy', 'New', 'Delete', 'Help', 'OK', and 'Cancel'.

If 7.5% transformer tolerance is specified, ETAP will use +7.5% tolerance (6.18%Z) for load flow, motor starting, dynamic stability, and harmonic calculations, while using -7.5% tolerance (5.32%Z) for short-circuit and AF calculations.

For **minimum** type AF cases:



The image shows the 'Arc Flash Study Case' dialog box with the 'Adjustment' tab selected. The 'Apply Pos. Tolerance and Max. Temp. for Arc Flash' checkbox is checked. Under 'Impedance Tolerance', 'Transformer' is checked with 'Individual' selected. Under 'Length Tolerance', 'Cable / Busway' and 'Transmission Line Length' are unchecked. Under 'Resistance Temperature Correction', 'Cable / Busway' is checked, 'Global' is selected with a temperature of 75 °C. The 'AF1 Max Util' dropdown is at the bottom left, and 'Copy', 'New', 'Delete', 'Help', 'OK', and 'Cancel' buttons are at the bottom right.

Using the Apply Positive Tolerance and Max. Temperature for ANSI Minimum Short-Circuit Calculation & Arc Flash feature will set the impedance tolerance, length tolerance (not used by PSE as standard) and resistance temperature impedance corrections as positive adjustments instead of negative. For transformers, higher impedance is used if the Impedance Tolerance has been entered for a transformer. Likewise, for cables, the Max Temp. will be used — the cable Max Temp. should be 75 deg C for all the cables. This means smaller fault and arcing currents will result. It's possible the worst-case incident energy may occur when the system provides minimum short-circuit currents because of the inverse characteristic of some protective devices. A small reduction in the arcing current may increase the fault clearing time, making for more arc flash incident energy

Arc Flash Study Case
✕

Info
Method
Clearing Time
Parameters
Adjustment
SC Standard
Alert

Standard

☐ IEC

☒ ANSI

Prefault Voltage

☒ Fixed 100

☐ Vmag X Nominal kV (from Bus Editor)

HV CB Interrupting Capability

Adjust Based on Bus

☒ Nominal kV

☐ Nominal kV & Vf

Zero Sequence Z

☐ Include Branch Y

Machine X/R

☒ Fixed

☐ Variable

LV CB Interrupting Capability

Evaluate Based on Rated Max. kV Limit

☒ C37.13 / UL 489

☐ User-Defined

Prefault Generation Conditions

Design

☐ Operating P.Q.V

☐ WTG/Inverter Control Adjustment Angle

Protective Device Duty

☒ Total Bus Fault Current

☐ Max Through Fault Current

MF for HV CB & Bus Momentary Duty

☒ Based on Calculated X/R

☐ Use 1.6 & 2.6 (RMS & Peak) as Minimum

☐ Set to 1.6 & 2.6 (RMS & Peak)

☒ C37.010 - 1999

☐ C37.010 - 1979 and Older

MF for LV CB (Molded & Insulated) Duty

☐ Based on Peak Current

☒ Based on Asymmetrical Current

☐ Higher MF (Peak or Asymmetrical)

< AF1 Max Util >
Copy New Delete Help OK Cancel

FROM NFPA 70E

Table 130.4(D)(a) Shock Protection Approach Boundaries to Exposed Energized Electrical Conductors or Circuit Parts for Alternating-Current Systems

(1)	(2)	(3)	(4)
Limited Approach Boundary ^b		Restricted Approach Boundary ^b ; Includes Inadvertent Movement Adder	
Nominal System Voltage Range, Phase to Phase ^a	Exposed Movable Conductor ^c	Exposed Fixed Circuit Part	
< 50 V	Not specified	Not specified	Not specified
50 V to 150 ^d V	3.0 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	Avoid contact
151 V to 750 V	3.0 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	0.3 m (1 ft 0 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.)
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.)
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.)
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.)
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.)
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.)
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.)
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.)
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.)
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.)
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.)

Note (1): For arc flash boundary, see 130.5(A).

Note (2): All dimensions are distance from exposed energized electrical conductors or circuit part to employee.

^a For single-phase systems above 250 V, 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 Informative Annex C for elaboration.

^c *Exposed movable conductors* 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.

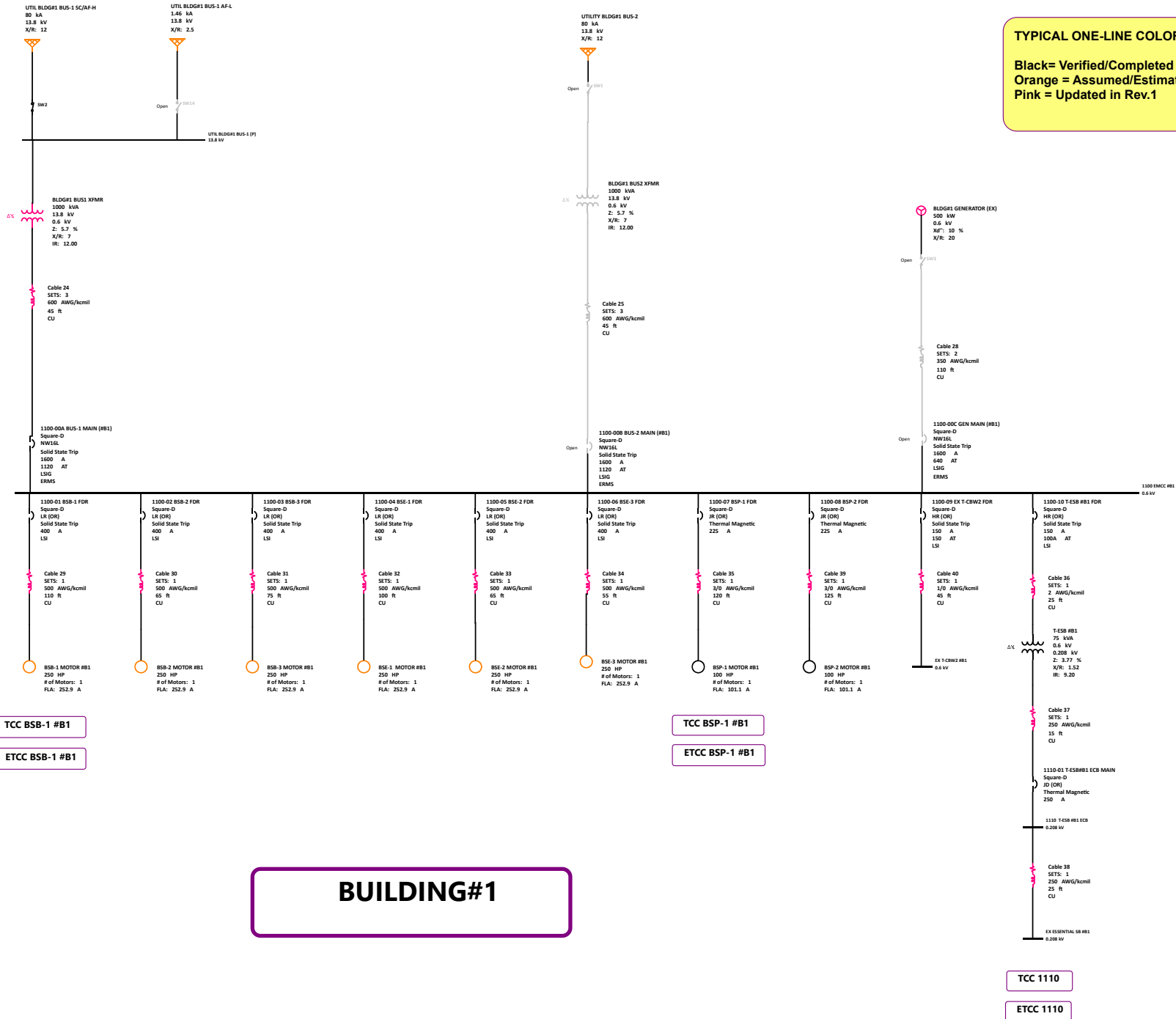
^d This includes circuits where the exposure does not exceed 120V nominal.

IMPLEMENTING AND MAINTAINING AN ELECTRICAL SAFE WORK PRACTICES (ESWP) PROGRAM

Action No.	Recommendation	Action	Person Assigned	Due Date
1	Establish Safety-Related Work Practices	Implement and document a comprehensive Electrical Safety Program to address items such as safe work practices, training, PPE, Risk Assessment, and maintenance of equipment. See NFPA 70E for guidance.		
2	Establish Electrical Safety Training Program	1) Develop training curriculum for employees potentially exposed to electrical hazards. 2) Train workers to become Qualified Employees as appropriate for their job duties. 3) Document training results and re-train (or update) as necessary.		
3	Project Management	Keep accurate records on system changes and re-evaluate arc flash results when major changes are made, or at most 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 regarding proper selection, use, and maintenance of PPE for use when working on or around energized equipment.		
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, or on industry standards such as NFPA 70B.		
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 D: SYSTEM STUDY ONE-LINE DIAGRAM



POWER SYSTEM
ENGINEERING

1601 MERCER ROAD
LEXINGTON, KY 40511

NOTES:

ALL LOW-VOLTAGE CABLES WERE CONSIDERED TO BE TYPE RHH, SINGLE CONDUCTOR COPPER, RUN IN STEEL CONDUIT, UNLESS OTHERWISE NOTED.

ALL DEVICES WERE CONSIDERED TO BE THREE-POLE UNLESS NOTED OTHERWISE.

ORANGE - COLOR DENOTES THE VALUE WAS ASSUMED

KVam - CONNECTED MOTOR KVA USED FOR FAULT CALCULATIONS.

AF - AMPERE FRAME RATING

AS - AMPERE SENSOR RATING

AP - AMPERE PLUG RATING

AT - AMPERE TRIP RATING

L - LONG TIME FUNCTION

S - SHORT TIME FUNCTION

I - INSTANTANEOUS FUNCTION

G - GROUND FUNCTION

REVISIONS			
8			
7			
6			
5			
4			
3			
2			
1	09/18/24	Rev.1	NIT
REV	DATE	DESCRIPTION	DRAWN BY

CBBT- SUPPORT BLDG EMG
POWER SYSTEM UPGRADES

POWER SYSTEM STUDY

CAPE CHARLES

DRAWN BY:	NIT
DATE:	05/06/2024
SCALE:	NTS

PROJECT NO.
50204245

ONE-LINE DIAGRAM

SHEET NO.
1 OF 4

Schneider Electric

POWER SYSTEM ENGINEERING

1601 MERCER ROAD
LEXINGTON, KY 40511

NOTES:

ALL LOW-VOLTAGE CABLES WERE CONSIDERED TO BE TYPE RHH, SINGLE CONDUCTOR COPPER, RUN IN STEEL CONDUIT, UNLESS OTHERWISE NOTED.

ALL DEVICES WERE CONSIDERED TO BE THREE-POLE UNLESS NOTED OTHERWISE.

ORANGE - COLOR DENOTES THE VALUE WAS ASSUMED

KVAm - CONNECTED MOTOR KVA USED FOR FAULT CALCULATIONS.

AF - AMPERE FRAME RATING
AS - AMPERE SENSOR RATING
AP - AMPERE PLUG RATING
AT - AMPERE TRIP RATING

L - LONG TIME FUNCTION
S - SHORT TIME FUNCTION
I - INSTANTANEOUS FUNCTION
G - GROUND FUNCTION

REVISIONS			
8			
7			
6			
5			
4			
3			
2			
1	09/18/24	Rev.1	NIT
REV	DATE	DESCRIPTION	DRAWN BY

CBBT- SUPPORT BLDG EMG POWER SYSTEM UPGRADES

POWER SYSTEM STUDY

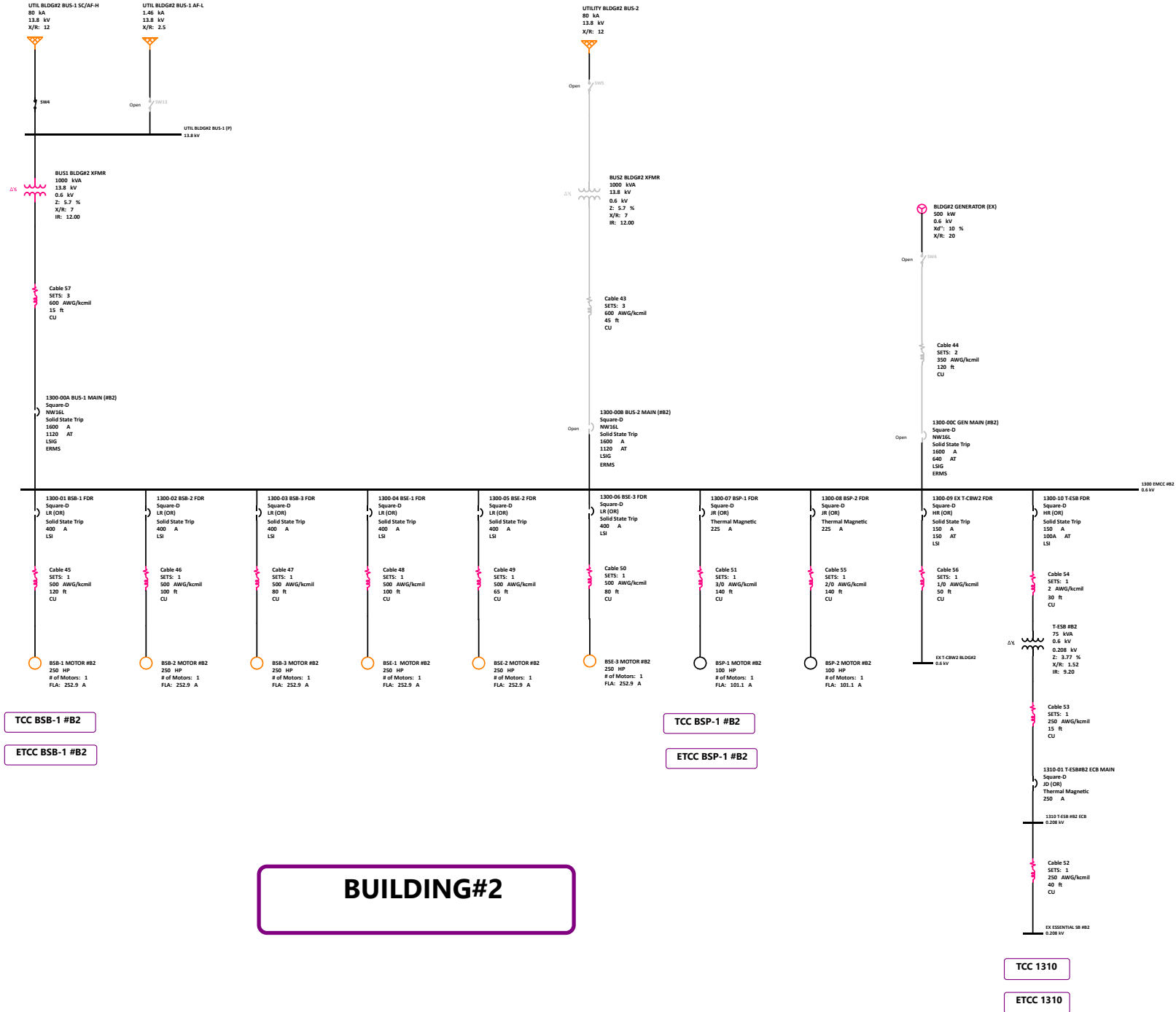
CAPE CHARLES

DRAWN BY:	NIT
DATE:	05/06/2024
SCALE:	NTS

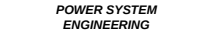
PROJECT NO.
50204245

ONE-LINE DIAGRAM

SHEET NO.
2 OF 4



BUILDING#2



NOTES:

ALL LOW-VOLTAGE CABLES WERE
CONSIDERED TO BE TYPE RHH, SINGLE
CONDUCTOR COPPER, RUN IN STEEL
CONDUIT, UNLESS OTHERWISE NOTED

ORANGE - COLOR DENOTES THE VALUE
WAS ASSUMED

AF - AMPERE FRAME RATING

AT - AMPERE TRIP RATING

L - LONG TIME FUNCTION

S - SHORT TIME FUNCTION

I - INSTANTANEOUS FUNCTION

G - GROUND FUNCTION

6			
7			
8			
5			
4			
3			
2			
1	09/18/24	Rev.1	NIT
REV	DATE	DESCRIPTION	DRAWN

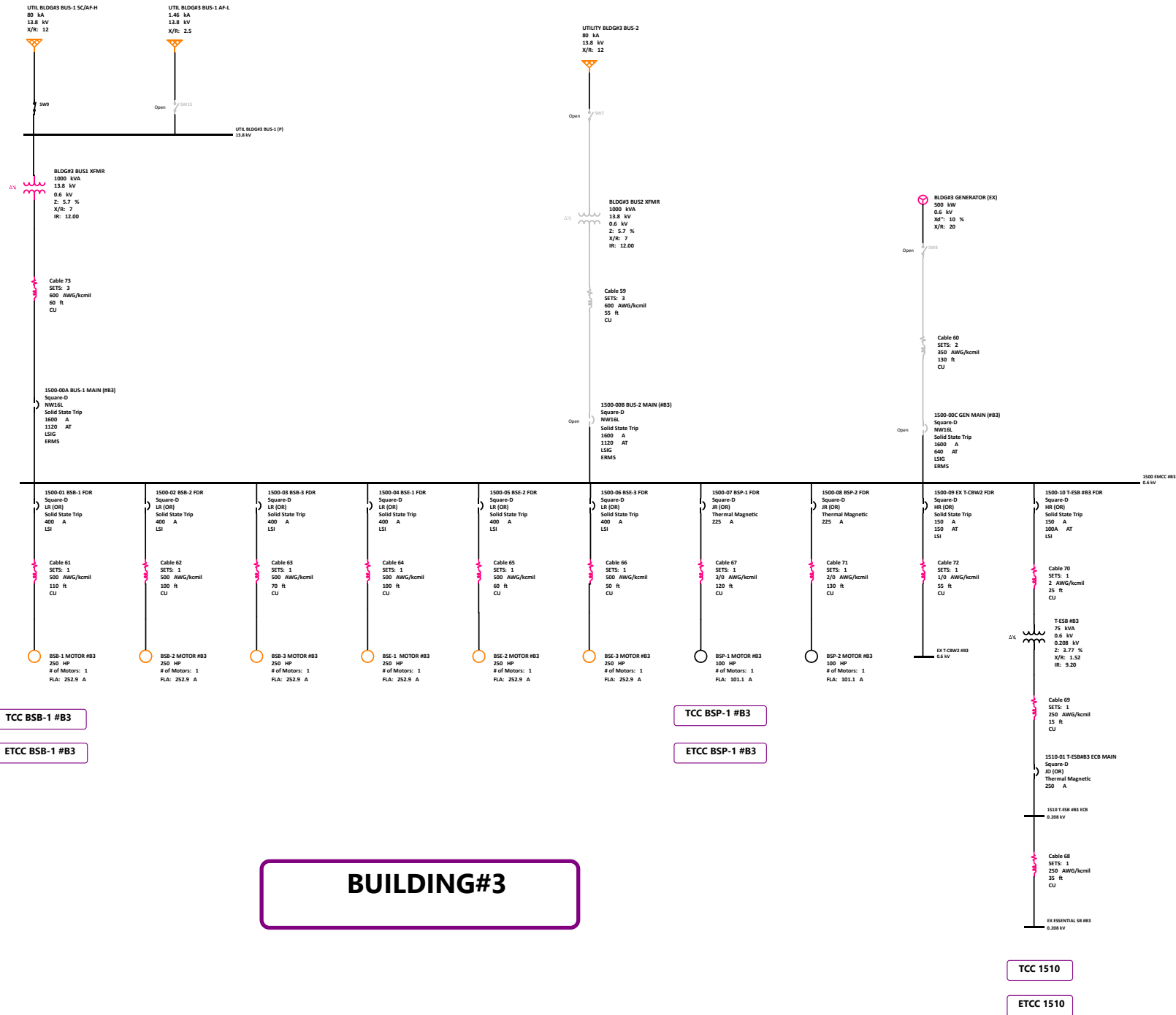
POWER SYSTEM STUDY

DRAWN BY:	NIT
DATE:	05/06/2024
SCALE:	NTS

PROJECT NO.
50204245

ONE-LINE DIAGRAM

SHEET NO.
3 OF 4



Schneider Electric

POWER SYSTEM ENGINEERING

1601 MERCER ROAD
LEXINGTON, KY 40511

NOTES:

ALL LOW-VOLTAGE CABLES WERE CONSIDERED TO BE TYPE RHH, SINGLE CONDUCTOR COPPER, RUN IN STEEL CONDUIT, UNLESS OTHERWISE NOTED.

ALL DEVICES WERE CONSIDERED TO BE THREE-POLE UNLESS NOTED OTHERWISE.

ORANGE - COLOR DENOTES THE VALUE WAS ASSUMED

KVAm - CONNECTED MOTOR KVA USED FOR FAULT CALCULATIONS.

AF - AMPERE FRAME RATING
AS - AMPERE SENSOR RATING
AP - AMPERE PLUG RATING
AT - AMPERE TRIP RATING

L - LONG TIME FUNCTION
S - SHORT TIME FUNCTION
I - INSTANTANEOUS FUNCTION
G - GROUND FUNCTION

REVISIONS			
8			
7			
6			
5			
4			
3			
2			
1	09/18/24	Rev.1	NIT
REV	DATE	DESCRIPTION	DRAWN BY

CBBT- SUPPORT BLDG EMG POWER SYSTEM UPGRADES

POWER SYSTEM STUDY

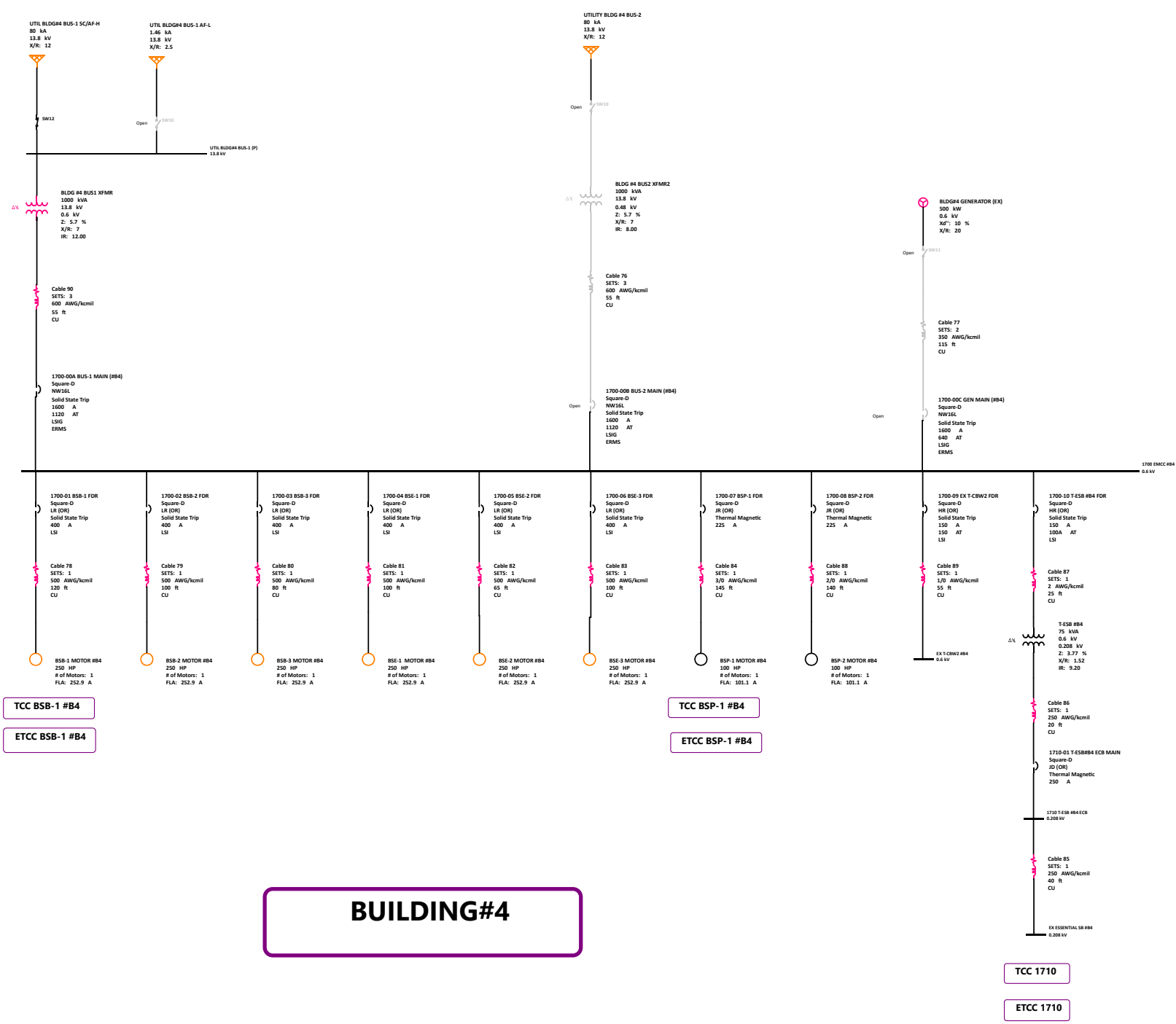
CAPE CHARLES

DRAWN BY:	NIT
DATE:	05/06/2024
SCALE:	NTS

PROJECT NO.
50204245

ONE-LINE DIAGRAM

SHEET NO.
4 OF 4



TCC BSB-1 #B4

ETCC BSB-1 #B4

TCC BSP-1 #B4

ETCC BSP-1 #B4

TCC 1710

ETCC 1710