Submittal #26 05 00-001.E 26 05 00 - Basic Electrical Requirements

Hazen and Sawyer
5775 Peachtree Dunwoody Road, Suite D-520
Atlanta, Georgia 30342
Phone: (404) 459-6363

Project: 32457-011 - CCWA - WJ Hooper WPP Generator
70 Oakdale Drive
Stockbridge, Georgia 30281

Distribution Summary

Distributed on 03/16/2022 by Tyler Chow **()**

To: Eddie McCallum **(Hazen and Sawyer - Atlanta)**, Jeff Winston **(Clayton County Water Authority)** , Jordan Tinnell **(Crowder Construction Company)**, Tyler Chow **(Hazen and Sawyer - Atlanta)** , Griffin Ghesquiere **(Hazen and Sawyer - Atlanta)**

Message: None

Additional Attachments:

NAME	RESPONSE	ATTACHMENTS	COMMENT
Nick Meyer **(Hazen and Sawyer - Atlanta)**	Furnish as Corrected		No Comments

Power System Study Report

SPEC SECTION:	26 05 00 - Basic Electrical Requirements	**CREATED BY:**	
		DATE CREATED:	03/11/2022
ISSUE DATE:	03/11/2022	**REVISION:**	E
RESPONSIBLE CONTRACTOR:	Crowder Construction Company	**RECEIVED FROM:**	Jordan Tinnell
RECEIVED DATE:	03/11/2022	**SUBMIT BY:**	03/07/2022
FINAL DUE DATE:	03/21/2022	**LOCATION:**	
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Jeff Winston **(Clayton County Water Authority)** , Jordan Tinnell **(Crowder Construction Company)** , Eddie McCallum **(Hazen and Sawyer - Atlanta)** , Griffin Ghesquiere **(Hazen and Sawyer - Atlanta)** , Tyler Chow **(Hazen and Sawyer - Atlanta)**

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Submittal to address comment from Version D

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26 05 00-001-E Power System Study Report - Address Comm From Ver. D.pdf

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1080 Holcomb Bridge Road
Building 200, Suite 180
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LETTER OF TRANSMITTAL

To: Hazen & Sawyer
5775 Peachtree Dunwoody Road
Suite 2-520
Atlanta, GA 300342

Attn: Tyler Chow, P.E.

Ph: 404-459-6363
Cell: 626-780-7164

Date:	Job No.:
03/11/2022	Hazen: 32457-010 Crowder: 40781

Project:
W.J. Hooper WPP Standby Power Generator

Location:
Stockbridge, GA

Submittal No:
26 05 00-001-E

Specification Section:
26 05 00

WE ARE SENDING YOU ☑ Attached ☐ Under separate cover via ______________________ the following items:

☑ Shop drawings ☐ Prints ☐ Plans ☐ Samples ☐ Specifications

☐ Copy of Letter ☐ Change order ☑ Other

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TRANSMITTED BY: Jordan Tinnell DATE: 03/11/2022

W.J. Hooper WPP Standby Generator

70 Oakdale Drive, Stockbridge, GA 30281

Owner: Clayton County Water Authority
Engineer: Hazen & Sawyer
Submittal Prepared by: Crowder Construction Company

Contractor:	Subcontractor:	Supplier:
Crowder Construction Company 1080 Holcomb Bridge Rd Bldg. 200, Suite 180 Roswell, GA 30076	N/A	Electrical Reliability Services Inc 2275 Northwest Parkway SE Suite 180 Marietta, GA 30067

Submittal No:	26 05 00-001-E
Submittal Name:	Power System Study Report – Resubmittal to Address Comments from Version D
Product Manufacturer:	Electrical Reliability Services (ERS)
Ref. Specification No:	26 05 00
Ref. Specification Title:	Basic Electrical Requirements
Drawing Reference:	N/A
Submittal Date:	03/11/2022

Crowder Construction Submittal Review:

For approval………………... ☐
Approved…………………… ☑
Approved as Noted…..…… ☐
Revise and Resubmit…….. ☐
For Information Only……… ☐

Crowder Construction has reviewed, checked, and approved this submittal for compliance with Contract Documents.

Approval by Crowder Construction Company does not relieve suppliers or subcontractors of responsibility to comply with requirements of plans and specification and/or other contract document under and for which this information is submitted. Nor does our approval establish compliance with the design concept of the project.

By: Jordan Tinnell

Date: 03/11/2022

Crowder Comments:

Attached is the resubmittal from Power System Study performed by ERS to address the required changes below.

Summary of changes to the SEL 700G relay:

1. The settings are approved. Please make all haste to implement the change to the GEN breaker relay. In the mean time make the following corrections to the study report:

2. Update TCC-001-GENERATOR G1 to show the RY-35-52-G1 trip curve. Page 48 of the PDF does not include the trip curve.

3. Update Row 4 (35MSG (LineSide) RY-35-52-F1)
   with the correct incident energy value on the bus of 35MVATS. 51.68 cal/cm2 is not a value that would be seen downstream of RY-35-52-UM.

Submittal #26 05 00-001.D 26 05 00 - Basic Electrical Requirements

Hazen and Sawyer
5775 Peachtree Dunwoody Road, Suite D-520
Atlanta, Georgia 30342
Phone: (404) 459-6363

Project: 32457-011 - CCWA - WJ Hooper WPP Generator
70 Oakdale Drive
Stockbridge, Georgia 30281

Distribution Summary

Distributed on 02/22/2022 by Griffin Ghesquiere **()**

To: Eddie McCallum **(Hazen and Sawyer - Atlanta)**, Jeff Winston **(Clayton County Water Authority)**, Jordan Tinnell **(Crowder Construction Company)**, Tyler Chow **(Hazen and Sawyer - Atlanta)**, Griffin Ghesquiere **(Hazen and Sawyer - Atlanta)**

Message: Engineer's review of the Contractor's submittals shall in no way relieve the Contractor of any of his responsibilities under the Contract. An acceptance of a submittal shall be interpreted to mean that the Engineer has no specific objections to the submitted material, subject to conformance with the Contract Drawings and Specifications. Engineer's review is confined to general arrangement and compliance with the Contract Drawings and Specifications only, and will not be for the purpose of checking dimensions, weights, clearances, fittings, tolerances, interferences, coordination of trades, etc.

Additional Attachments: 26 05 00-001-D Power System Study Report - SEL 700G Relay Settings Adj.pdf

NAME	RESPONSE	ATTACHMENTS	COMMENT
Nick Meyer **(Hazen and Sawyer - Atlanta)**	Furnish as Corrected-Confirm		1) The settings are approved. Please make all haste to implement the change to the GEN breaker relay. In the mean time make the following corrections to the study report: 2) Update TCC-001-GENERATOR G1 to show the RY-35-52-G1 trip curve. Page 48 of the PDF does not include the trip curve. 3) Update Row 4 (35MSG (LineSide) RY-35-52-F1) with the correct incident energy value on the bus of 35MVATS. 51.68 cal/cm2 is not a value that would be seen downstream of RY-35-52-UM.

Power System Study Report

SPEC SECTION:	26 05 00 - Basic Electrical Requirements	**CREATED BY:**	
		DATE CREATED:	02/22/2022
ISSUE DATE:	02/22/2022	**REVISION:**	D
RESPONSIBLE CONTRACTOR:	Crowder Construction Company	**RECEIVED FROM:**	Jordan Tinnell
RECEIVED DATE:	02/21/2022	**SUBMIT BY:**	03/07/2022
FINAL DUE DATE:	03/07/2022	**LOCATION:**	
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DESCRIPTION:

ATTACHMENTS:
26 05 00-001-D Power System Study Report - SEL 700G Relay Settings Adj.pdf

BY	DATE	COPIES TO

VERTIV - ***Electrical Reliability Services, Inc.***

2275 Northwest Parkway SE, Suite 180
Marietta, GA 30067
USA
T (770) 541-6600
F (770) 541-6501
www.Vertiv.com

March 10, 2022

Crowder Construction Company
1229 Royal Dr SW
Conyers, GA, 30094

Attention: Mr. Jordan Tinnel

Subject: Power System Study – WJ Hooper
ERS Reference No. 1075681

Mr. Jordan Tinnel:

Enclosed is the subject Power System Study. Please review and contact us if you find any errors or omissions that need to be addressed.

Please let me know upon your acceptance/approval of the study so that we can move forward and order the arc flash hazard labels.

It was our pleasure to be of service to you on this project. If you have any questions, or if we can be of further assistance, please do not hesitate to call.

Thank you,

Electrical Reliability Services, Inc.

Enclosures

Power System Study

Electrical Reliability Services, Inc.

2275 Northwest Parkway SE, Suite 180
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Submitted: March 10, 2022

ERS Reference No. 1075681

Project: **WJ Hooper**
700 Millers Mill Rd
Stockbridge, GA, 30281

Client **Crowder Construction Company**
1229 Royal Dr SW
Conyers, GA, 30094

Attention: **Mr. Jordan Tinnel**

Submitted by: Stephen Tyler
Power Systems Engineer

Reviewed by: Jeff Sullivan
Supervising Power Systems Engineer

TABLE OF CONTENTS

REVISION NOTES

REV	DATE	CHANGES
0	6/16/2021	• N/A - Original Issue
1	7/8/2021	• Settings for “RY-35-52-UM” adjusted • Load for “HSP-3”, “HSP- 4”, and “HSP-5” changed to 800 HP
2	12/20/21	• Motor Starting curve for 800 HP HSP adjusted based on end user input • Settings for SEL 700G relay for generator breaker G1 adjusted • Coordination adjusted for change in settings of generator breaker
3	2/16/22	• 51P setting determined to be unable to be applied to installed SEL 700G breaker. Settings for 50P adjusted per direction by Hazen.
4	3/9/2022	• TCC display settings adjusted to show RY-35-52-G1 curve. Was not previously shown as other TCC’s were limited to only show effective settings within maximum available fault currents. • Arc Flash Tables adjusted

1.0 INTRODUCTION

Power system studies were performed to analyze the quality of protection for the electrical power distribution system at the WJ Hooper facility. The studies performed included short circuit, protective device coordination and arc flash evaluation for the equipment as indicated on the attached analysis model one-line diagram in the Appendix.

1.1 Major objectives of the studies

- Compare calculated fault duties with the withstand and interrupting ratings for distribution panels and protective devices.
- Recommend protective device settings which selectively isolate faults in a manner which is consistent with the basic system design and applicable codes and standards. These recommendations will be given to achieve an optimum balance between protection and selective fault isolation.
- Determine arc flash incident energy levels and PPE requirements.
- Note areas of deficiency and make general recommendations.

1.2 Report Content

- Section 2.0 contains an executive summary of the study findings.
- Section 3.0 contains detailed information on the analysis and methods.
- Section 4.0 contains detailed findings and recommendations.
- The appendices contain short circuit fault analysis information, recommended settings, time current curves, arc flash analysis data and a one-line diagram of the system studied.

1.3 Basic System Data and Assumptions

System data for the power system study was based on the electrical submittals and drawings as supplied by Crowder Construction Company. Any system changes will render the findings in this report to be inaccurate and a study revision will be required.

Utility source short circuit fault duties were as given by the electrical utility and are attached in Appendix 3.

All analysis was performed with the power system in the normal condition only (utility power source, ATS's in normal position, Tie breakers open). The only exception to this is that all UPS's were assumed to have bypass capability in order to propagate the maximum fault duty through the system to facilitate the most stringent short circuit evaluation. Alternative scenarios (if any) modify this default configuration assumption as noted in Section 1.4 below (if applicable).

1.4 System Analysis Scenarios

Multiple system configuration scenarios were analyzed as detailed in the table below. The arc flash results as indicated in the Appendix are independently based on the worst-case scenario (S0 & S1) for each location. The short circuit analysis and associated equipment short circuit evaluation were based on the scenario with the greatest fault duty (S0).

SCENARIO NAME	DESCRIPTION
Normal	Utility in Service, Breakers in 35MVATS set to power downstream equipment from utility power.
Emergency	Utility out of Service, Breakers in 35MVATS set to power downstream equipment from generator power.

2.0 EXECUTIVE SUMMARY

2.1 Short Circuit Analysis

All known devices within the scope of the project were found to have acceptable short circuit interrupting ratings when compared to system fault duties. Please refer to Sections 3.1 and 4.1 for more detailed information.

2.2 Protective Device Coordination

The recommended device settings provided in this report should provide adequate system protection and coordination. Please refer to Sections 3.2 and 4.2 for more detailed information.

2.3 Arc Flash Evaluation

The arc flash hazard calculations within this study are based on the *recommended* settings. As such, all recommended settings must be successfully implemented prior to the application of the corresponding arc flash hazard labels. These recommended settings were typically chosen to provide optimum protective device selectivity while minimizing the resulting arc flash incident energy at each location where possible. No work should be done on or around any energized equipment without the use of a proper level of PPE and adequate training. Please refer to Sections 3.3 and 4.3 for more detailed information.

3.0 ANALYSIS AND METHODS

3.1 Short Circuit Analysis

The SKM System Analysis, Inc. PowerTools for Windows A_FAULT program used for the analysis complies with the ANSI/IEEE C37 standards for calculation of short circuit fault currents. It offers separate solutions for low, medium and high voltage systems and for symmetrical, momentary and interrupting calculations as defined in the standards.

A computer model of the electrical system was created based on the data obtained for the analysis. The model was input into the software program and analyzed to determine the maximum short circuit fault current levels throughout the system. These calculated short circuit currents were then compared to the equipment short circuit ratings to determine the adequacy of the equipment ratings. If the calculated short circuit fault current[1] exceeded the rating of the equipment, then the equipment failed the short circuit device evaluation and was flagged as “Fail” within the device evaluation tables in the appendix.

When evaluating the ability of low voltage protective devices to interrupt available fault duties, two types of systems are common; fully rated or series rated.

A fully rated system is one in which each and every overcurrent protective device has a short circuit rating that meets or exceeds the actual short circuit fault current available at the device.

A series rated system utilizes special elevated (series) ratings for some of the equipment. Series ratings are special short circuit interrupting ratings assigned to tested & approved combinations of two or more overcurrent protective devices which are connected in series and in which the rating of the downstream device(s) in the combination is less than the series rating. The elevated series rating is essentially based on the two devices operating simultaneously and *sharing* the interrupting energies; thereby facilitating an elevated short circuit rating.

To conform with the National Electrical Code, Section 110-22, where circuit breakers or fuses are applied in compliance with the series combination ratings marked on the equipment by the manufacturer, equipment enclosures must be legibly marked in the field to indicate the equipment has been applied with a series combination rating.

Complete short circuit analysis input & output reports as well as device evaluation tables are contained in the Appendices.

[1] Including any applicable X/R multiplication factors

3.2 Protective Device Coordination

The intent of the protective device coordination analysis is to evaluate, and if necessary, recommend overcurrent protective device setting adjustments to yield optimum power system performance, reliability and safety. In many cases the above goals conflict with one another and compromises must be made based on system criticality and facility operating philosophy. Where necessary, the recommended settings were chosen to maximize system reliability while minimizing conditions of jeopardized system selectivity.

As stated in ANSI/IEEE Standard 242-2001, "Whether minimizing the risk of equipment damage or preserving service continuity is the more important objective depends upon the operating philosophy of the particular industrial plant or commercial business." Regardless, the equipment applications within the facility have been compared with acceptable practices and industry standards.

System selectivity is most often illustrated by the use of Time-Current Curves (TCC's) which graphically illustrate the overcurrent responses of protective devices to overcurrent events. The specific manufacturer specified time-current characteristics of the overcurrent devices are plotted on logarithmic graphs. Other electrical equipment characteristics such as, but not limited to, transformer damage, transformer inrush, motor starting and generator decrement can also be plotted on the same graphs to help with the analysis. Protective device setting tables and TCC's for the system studied are included in the Appendices.

3.3 Arc Flash Evaluation

Arc flash evaluations are used in conjunction with the client's/facility operator's safety policy to determine the required personal protective equipment (PPE) when working on or near energized equipment. Many electrical injuries are burns that are the result from exposure to the energies liberated during an arcing fault. The burns are typically second and third degree in nature and are often fatal.

NFPA 70-2017, _National Electrical Code_, requires equipment to be field marked to indicate where a flash hazard exists:

> **110.16 Arc-Flash Hazard Warning.** Electrical equipment, such as switchboards, switchgear, panelboards, industrial control panels, meter socket enclosures, and motor control centers, that is in other than dwelling units, and is likely to require examination, adjustment, servicing, or maintenance while energized, shall be field or factory marked to warn qualified persons of potential electric arc flash hazards. The marking shall meet the requirements in 110.21(B) and shall be located so as to be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

NFPA 70E-2021, _Standard for Electrical Safety in the Workplace,_ states the following:

130.5 Arc Flash Risk Assessment.
(A) General. An arc flash risk assessment shall be performed:
(1) To identify arc flash hazards
(2) To estimate the likelihood of occurrence of injury or damage to health and the potential severity of injury or damage to health
(3) To determine if additional protective measures are required, including the use of PPE

(G) Incident Energy Analysis Method. The incident energy exposure level shall be based on the working distance of the employee's face and chest areas from a prospective arc source for the specific task to be performed. Arc-rated clothing and other PPE shall be used by the employee based on the incident energy exposure associated with the specific task. Recognizing that incident energy increases as the distance from the arc flash decreases, additional PPE shall be used for any parts of the body that are closer than the working distance at which the incident energy was determined.

The incident energy analysis shall take into consideration the characteristics of the overcurrent protective device and its fault clearing time, including its condition of maintenance.

The incident energy analysis shall be updated when changes occur in the electrical distribution system that could affect the results of the analysis. The incident energy analysis shall also be reviewed for accuracy at intervals not to exceed 5 years.

OSHA regulations represent the other major source of standards that apply to arc flash hazards. The primary regulations are in 29CFR 1910 Subparts I, and S. These can be broken down into three general areas, hazard identification and PPE selection, training, and proficiency.

1910.132(d) Hazard assessment and equipment selection

The employer shall assess the workplace to determine if hazards are present, or are likely to be present, which necessitate the use of personal protective equipment (PPE). If such hazards are present, or likely to be present, the employer shall: Select, and have each affected employee use, the types of PPE that will protect the affected employee from the hazards identified in the hazard assessment; Communicate selection decisions to each affected employee; and, Select PPE that properly fits each affected employee.

The employer shall verify that the required workplace hazard assessment has been performed through a written certification that identifies the workplace evaluated; the person certifying that the evaluation has been performed; the date(s) of the hazard assessment; and, which identifies the document as a certification of hazard assessment.

1910.335(a)(1)(i) Personal Protective Equipment

Employees working in areas where there are potential electrical hazards shall be provided with, and shall use, electrical protective equipment that is appropriate for the specific parts of the body to be protected and for the work to be performed.

1910.132(f) Training

The employer shall provide training to each employee who is required by this section to use PPE. Each such employee shall be trained to know at least the following: When PPE is necessary; What PPE is necessary; How to properly don, doff, adjust, and wear PPE;

The limitations of the PPE; and, The proper care, maintenance, useful life and disposal of the PPE.

Each affected employee shall demonstrate an understanding of the training specified in paragraph (f)(1) of this section, and the ability to use PPE properly, before being allowed to perform work requiring the use of PPE.

1910.132(f)(3) Proficiency & Retraining

When the employer has reason to believe that any affected employee who has already been trained does not have the understanding and skill required by paragraph (f)(2) of this section, the employer shall retrain each such employee. Circumstances where retraining is required include, but are not limited to, situations where: Changes in the workplace render previous training obsolete; or Changes in the types of PPE to be used render previous training obsolete; or Inadequacies in an affected employee's knowledge or use of assigned PPE indicate that the employee has not retained the requisite understanding or skill.

The employer shall verify that each affected employee has received and understood the required training through a written certification that contains the name of each employee trained, the date(s) of training, and that identifies the subject of the certification.

The calculations used in this study comply with NFPA 70E requirements in that the incident energy levels and arc flash boundaries are calculated and the corresponding level of PPE required is identified. The results of the arc-flash calculations are based on the values of fault current magnitudes calculated in the short-circuit analysis and the associated clearing times of the over current protective devices as determined by the coordination study. A table summarizing the results for all locations evaluated is included in the Appendix.

3.3.1 Basis for Arc Flash Evaluation

The **IEEE Std 1584-2018** *IEEE Guide for Performing Arc-Flash Hazard Calculations* was used as the calculation basis for the equipment within the scope of this project. This standard contains calculation methods developed through testing by several sources to determine boundary distances for unprotected personnel and the incident energy at the working distance for qualified personnel working on energized equipment. The incident energy level can be used to determine the proper PPE required for personnel.

The equations developed in the IEEE standard assess the arc flash hazard based on the available short circuit fault current, system voltage, clearing time, working distance, equipment type, enclosure dimensions, bus gaps and electrode configuration.

Enclosure dimensions, bus bar gaps and electrode configurations were selected based on equipment type, as recommended in Annex C & G of IEEE Std 1584-2018, and are summarized in the table below.

Voltage	***Equipment Type***	***H x W (in)***	***Depth (in)***	***Gap (mm)***	***Electrode Configuration***
15kV	Switchgear (Any)	45 x 30	30	152	HCB
15kV	MCC (Any)	36 x 36	36	152	HCB
5kV	Switchgear (Any)	45 x 30	30	104	HCB
5kV	MCC (Any)	26 x 26	26	104	HCB
≤600V	Switchgear (Any)	20 x 20	20	32	HCB
≤600V	MCC (Any)	20 x 20	>8	25	VCBB
≤600V	Panel (Any)	20 x 20	>8	25	VCBB
≤600V	J-Box/Disc (Any)	20 x 20	>8	25	HCB

IEEE Std 1584-2018 describes five different electrode/conductor configurations as follows:

- VCB: vertical conductors inside a metal enclosure
- VCBB: vertical conductors terminated in an insulating barrier inside a metal enclosure
- HCB: horizontal conductors inside a metal enclosure
- VOA: vertical conductors in open air
- HOA: horizontal conductors in open air

Results from the short circuit and coordination study yield the fault duties and clearing times at locations where arc flash evaluations are to be performed. Per IEEE Std 1584, a maximum arc time of two seconds is utilized to limit incident energy values. The two-second value is intended to simulate the likely egress time of a worker exposed to an electrical arc.

The SKM PowerTools for Windows software uses these techniques to determine the required PPE for energized work, the flash boundary and the incident energy at various distances from the location. Typical ATPV values for protective equipment is used if site-specific manufacturer's data is not available.

For locations where there is an elevated incident energy level, either energized work should be prohibited or extension tools (i.e. hot stick, remote controls…) should be used to distance personnel from the potential arc point. The incident energy at the working distance dictates the required PPE.

3.3.2 Protective Equipment Description

Depending upon the arc thermal levels present at a location, different levels of PPE are required to help facilitate safe work. The following information is based on PPE descriptions per the NFPA 70E standard. Where site specific PPE descriptions and ATPV information is not available, the data in this table is used for the evaluation.

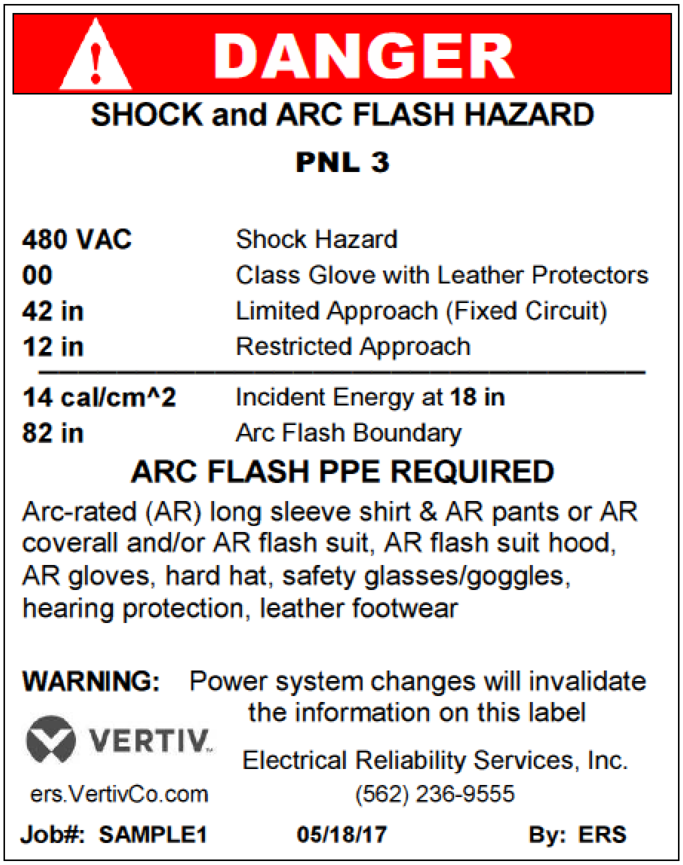
TABLE 3.3.2 ARC FLASH HAZARD RISK/PPE LEVELS

INCIDENT ENERGY (cal/cm^2)	PPE DESCRIPTION
0-1.2	Long sleeve shirt & pants or coverall (nonmelting or untreated natural fiber), safety glasses/goggles, leather gloves, hearing protection
1.2-12	Arc-rated (AR) long sleeve shirt & AR pants or AR coverall or AR flash suit, AR face shield & AR balaclava or AR flash suit hood, hard hat, safety glasses/goggles, hearing protection, leather gloves, leather footwear
>12	Arc-rated (AR) long sleeve shirt & AR pants or AR coverall and/or AR flash suit, AR flash suit hood, AR gloves, hard hat, safety glasses/goggles, hearing protection, leather footwear

3.3.3 Arc Flash Hazard Labels

Based on the PPE descriptions detailed above, all resulting arc flash hazard labels will be similar to that as shown in Figure 3.3.3 below.

FIGURE 3.3.3 TYPICAL ARC FLASH HAZARD LABEL



4.0 FINDINGS AND RECOMMENDATIONS

4.1 Short Circuit Analysis

Based on the model created, a fault case was run and the available short circuit fault duties were compared to the short circuit ratings of the devices studied. All known devices within the scope of the project were found to have acceptable short circuit ratings when compared to system fault duties. Complete short circuit analysis input & output reports as well as device evaluation tables are contained in the Appendices.

4.2 Protective Device Coordination

The recommended device settings provided in this report should provide adequate system protection and coordination. The recommended settings were chosen to maximize system reliability while minimizing conditions of jeopardized system selectivity. It is recommended to implement the settings as indicated in the Appendix and thoroughly test the devices to assure proper operation within the manufacturer's tolerances.

WARNING! Since the arc flash incident energy calculations are based on the recommended settings as given in this study, <u>all</u> recommended settings must be successfully implemented <u>prior to</u> affixing of the arc flash hazard labels!

4.3 Arc Flash Evaluation

The arc flash hazard calculations within this study are based on the *<u>recommended</u>* settings. As such, all recommended settings must be successfully implemented prior to the application of the corresponding arc flash hazard labels. These recommended settings were typically chosen to provide optimum protective device selectivity while minimizing the resulting arc flash incident energy at each location where possible. No work should be done on or around any energized equipment without the use of a proper level of PPE and adequate training. An arc flash hazard summary/data table is included in the Appendix which provides full details of the analysis and the results.

IMPORTANT NOTE: The Arc flash hazard analysis methods and calculations used within this study are based on the protective devices operating as designed and being applied, maintained and tested as per the manufacturer's specifications and accepted industry standards. Periodic maintenance and testing of the electrical equipment is highly recommended as endorsed by the NFPA-70B Standard, *Recommended Standard for Electrical Equipment Maintenance*, to confirm the safe and acceptable operation of the power system equipment and protective devices.

4.4 System-Wide Study

It is recommended that a complete Short Circuit, Coordination and Arc Flash Study be performed for the entire facility in order to ensure optimum power system reliability, performance and safety throughout the system.

5.0 CLOSING REMARKS

The combination of the successful implementation/verification of the recommended/as-found protective device settings and the thorough testing of the protective devices will provide optimum power system reliability and performance.

Power System Studies have consistently proven to be an effective component for improving power system reliability and performance. Also, Arc Flash Studies are a vital component to the safe operation and maintenance of any electrical power system. Hopefully the results and recommendations of this study will substantially increase the quality, reliability and safety of your electrical power system.

This study is intended for use by qualified individuals to help facilitate the installation, operation, maintenance and safety of the electrical power system as depicted. Modification of equipment, changes to system configuration, adjustment of trip-unit settings, and/or failure to properly maintain equipment may invalidate these results.

Any personnel who perform inspections, maintenance or testing while equipment is energized must receive training to understand the hazards identified in this report. This training should be based on relevant, NFPA and OSHA standards and recommendations.

For information regarding training (safety, arc flash, technical…), engineering, corrective and preventive maintenance services offered by *Electrical Reliability Services*, please call your local ERS Service Center Office.

APPENDIX 1

GLOSSARY OF TERMS

GLOSSARY OF TERMS

1.0 SHORT CIRCUIT STUDIES

1.1 **Series Rating**: A tested combination of protective devices that allow the use of protective devices in locations that exceed the nameplate rating by operation of a main or upstream protecting devices. Operation of the series rated combination allows the devices to *share* the interrupting energies.

2.0 COORDINATION STUDIES

2.1 **Selectivity** (also referred to as Coordination): Refers to the capacity or lack of capacity of a system to isolate a fault to the smallest portion of a system possible.

2.2 **Time-Current Curve (TCC)**: A graphical representation of the operating characteristics of an over current protective device. Typically shown on a log-log chart, this information details the operating time of the breaker over a range of currents.

2.3 **Time-Current Curve Set**: A group of TCC's arranged to show the operating characteristics of a portion of an electrical system.

3.0 ARC FLASH EVALUATIONS

3.1 **Arc-rated (AR) Clothing**: Aramid (i.e. Dupont Nomex) or treated natural fiber (Indura or Proban) clothing of various types and weights that are resistant to ignition when exposed to an arc.

3.2 **ATPV (Arc Thermal Performance exposure Value)**: A rating (in cal/cm^2) given to PPE in terms of its ability to protect against the thermal energy resulting from an arcing fault. The incident energy from an arcing fault can be compared with the ATPV values to determine what amount (or number of layers) of PPE is required for safe energized work.

3.3 **Electrical Hazard**: A dangerous condition in which inadvertent or unintentional contact or equipment failure can result in shock, arc-flash burn, thermal burn, or blast.

3.4 **Electrical Shock**: Physical stimulation that occurs when electrical current passes through the body.

3.5 **Energized**: Electrically connected to or having a source of voltage.

3.6 **Exposed (live parts)**: Capable of being inadvertently touched or approached nearer than a safe distance by a person. It is applied to parts that are not suitably guarded, isolated, or insulated.

3.7 **Flash Boundary**: An approach limit at a distance from a prospective arc source with a person could receive a second degree burn (1.2cal/cm^2) if an electrical arc flash were to occur.

3.8 **Flash Suit**: A complete arc-rated clothing and equipment system that covers the entire body, except for the hands and feet.

3.9 **Incident Energy**: The thermal energy measured in calories per square centimeter (cal/cm^2) seen by a person or object as a result of exposure to an electric arc.

3.10 **Incident Energy Analysis**: A component of an arc flash risk assessment used to predict the incident energy of an arc flash for a specified set of conditions.

3.11 **Natural Fiber Clothing**: Long sleeve shirts and pants made of cotton or wool. This clothing is not flame-resistant (NON AR), but will char instead of melting like synthetic fibers.

3.12 **PPE (Personal Protective Equipment)**: Clothing or tools used to protect personnel from potentially hazardous conditions while working.

3.13 **Shock Hazard**: A dangerous condition associated with the possible release of energy caused by contact or approach to live parts.

3.14 **Working Distance**: The dimension between the possible arc point and the head and body of the worker positioned in place to perform the assigned task.

APPENDIX 2

ENGINEERING BIBLIOGRAPHY & REFERENCE MATERIALS

ENGINEERING BIBLIOGRAPHY & REFERENCE MATERIALS

1. **IEEE 1584-2002**, IEEE Guide for Performing Arc-Flash Hazard Calculations.
2. **IEEE 1584-2018**, IEEE Guide for Performing Arc-Flash Hazard Calculations.
3. **NFPA 70-2017,** National Electrical Code.
4. **ANSI/NFPA 70E-2021,** Standard For Electrical Safety In The Workplace.
5. **ANSI/IEEE Std 141-1993 (R 1999)**, IEEE Recommended Practice for Electrical Power Distribution for Industrial Plants (IEEE Red Book).
6. **ANSI/IEEE Std 142-2007**, IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems (IEEE Green Book).
7. **IEEE STD 242-2001**, IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (IEEE Buff Book).
8. **IEEE STD C37.010-2016**, IEEE Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
9. **IEEE STD C37.20.7-2007**, IEEE Guide for Testing Medium-Voltage Metal-Enclosed Switchgear for Internal Arcing Faults.
10. **ANSI/IEEE Std 399-1997**, IEEE Recommended Practice for Industrial and Commercial Power Systems Analysis (IEEE Brown Book).
11. **Beeman, D.L.**, INDUSTRIAL POWER SYSTEMS HANDBOOK, McGraw-Hill, 1955.
12. **Bussmann/Eaton**, Selecting Protective Devices Electrical Protection Handbook, Bussmann/Eaton, 2014.
13. **SKM Systems Analysis, Inc.**, POWER TOOLS ELECTRICAL ENGINEERING SOFTWARE FOR WINDOWS, SKM Systems Analysis, 2018.

APPENDIX 3

PROJECT DRAWINGS & UTILITY FAULT DUTY DATA

Antwoine C Freeman
1704 Noah's Ark Rd
Jonesboro, GA 30236
(404) 210-4611

GEORGIA POWER
A SOUTHERN COMPANY

Mar 18, 2021

Andrew Powell
50 Oakdale Dr
McDonough, GA 30253

Dear Mr. Powell:

The following information concerning available fault current is furnished at your request:

Location: Andrew Powell
50 Oakdale Dr.
McDonough, GA 30253

Available fault current at Customer's Service entrance is 7,888 amperes, which does not include any contribution from motor load.

Note: This fault current is based on the following assumptions:

Transformer size: One 5000.0 kVA Underground Transformer
Transformer type: Three-Phase 2400/4160 Volts

A change in transformer size, transformer impedance, service size, or service length will result in a change to the fault current listed above.

If additional information or assistance is required, please contact Antwoine C. Freeman at 404-210-4611.

Sincerely,

Antwoine C Freeman
Engineer
JDA

Job Number: Clayton Water

APPENDIX 4

SHORT CIRCUIT FAULT ANALYSIS INPUT REPORT

Project: WJ HOOPER GENERATOR
Crowder Construction Company
WJ Hooper
1075681

DAPPER Fault Analysis Input Report (English)

Utilities

Contribution From Name	Bus Name	In/Out Service	Nominal Voltage		-------- Contribution Data -------- Duty	Units	X/R	PU (100 MVA Base)	R PU	X PU
UTIL-GEORGIA-POWER	BUS-0042	In	24,940	3P:	7,888	Amps	8.00	Pos:	0.036	0.291
				SLG:	7,888	Amps	8.00	Zero:	0.036	0.291

Generators

Contribution From Name	Bus Name	In/Out Service	Nominal Voltage	-------- Contribution Data -------- Base kVA	X"	X/R	PU (100 MVA Base) R PU	X PU
GEN-G1	GENERATOR G-1	In	4,160	3,125.00	0.15	20.00	0.24	4.80
					0.15	20.00	0.24	4.80
					0.15	20.00	0.24	4.80

Motors

Contribution From Name	# of Motors	Bus Name	In/Out Service	Nominal Voltage	--------- Contribution Data -------- Base kVA	Xd"	X/R	PU (100 MVA Base) R PU	X PU
MTR-HSP-1	1	35MVC1	In	4,160	601.61	0.1507	4.90	5.114	25.056
MTR-HSP-2	1	35MVC2	In	4,160	601.61	0.1507	4.90	5.114	25.056
MTR-HSP-3	1	35MVC1	In	4,160	802.15	0.1507	4.90	3.836	18.792
MTR-HSP-4	1	35MVC2	In	4,160	802.15	0.1507	4.90	3.836	18.792
MTR-HSP-5	1	35MVC1	In	4,160	713.02	0.1507	4.90	4.315	21.141

Cables

Cable Name	From Bus To Bus	In/Out Service	Qty /Ph	Length Feet	------ Cable Description ------ Size	Cond. Type	Duct Type	Insul	Per Unit (100 MVA Base) R pu	jX pu

Cable Name	From Bus To Bus	In/Out Service	Qty /Ph	Length Feet	Size	Cond. Type	Duct Type	Insul		R pu	jX pu
					------ Cable Description ------				Per Unit (100 MVA Base)		
CBL-0004	35MVATS 35MVATS.	In	25	0	4000	Copper	Busway	Epoxy	Pos: Zero:	0.0000 0.0000	0.0000 0.0000
CBL-10F-1	10LS-1 BUS-0025	In	1	100	2	Copper	Non-Magnetic	EPR	Pos: Zero:	0.1167 0.1855	0.0270 0.0686
CBL-10F-2	50LS-1 BUS-0029	In	1	145	2	Copper	Non-Magnetic	EPR	Pos: Zero:	0.1693 0.2690	0.0391 0.0995
CBL-10SWBD-LEFT	BUS-0043 10SWBD-LEFT	In	4	65	500	Copper	Magnetic	PVC	Pos: Zero:	0.2074 0.6531	0.3287 0.8090
CBL-10SWBD-RIGHT	BUS-0045 10SWBD-RIGHT	In	4	110	500	Copper	Magnetic	PVC	Pos: Zero:	0.3509 1.1053	0.5562 1.3690
CBL-2F-1	2LS-1 BUS-0037	In	1	36	2	Copper	Non-Magnetic	EPR	Pos: Zero:	0.0420 0.0668	0.0097 0.0247
CBL-2F-2	2LS-2 BUS-0050	In	1	50	2	Copper	Non-Magnetic	EPR	Pos: Zero:	0.0584 0.0928	0.0135 0.0343
CBL-2F-3	2LS-2 BUS-0040	In	1	55	6	Copper	Non-Magnetic	EPR	Pos: Zero:	0.1621 0.2582	0.0174 0.0443
CBL-2MCC-RIGHT	BUS-0054 2MCC-RIGHT	In	4	105	350	Copper	Magnetic	PVC	Pos: Zero:	0.4307 1.3569	0.5594 1.3774
CBL-35PP1	BUS-0023 35PP1	In	2	33	3/0	Copper	Magnetic	PVC	Pos: Zero:	0.5765 1.8169	0.3717 0.9152
CBL-35TX1	35MVC2 BUS-0022	In	1	35	1/0	Copper	Non-Magnetic	EPR	Pos: Zero:	0.0257 0.0408	0.0087 0.0222
CBL-50F-1	10LS-1 BUS-0026	In	1	40	2	Copper	Non-Magnetic	EPR	Pos: Zero:	0.0467 0.0742	0.0108 0.0275
CBL-50F-2	50LS-1 BUS-0030	In	1	35	2	Copper	Non-Magnetic	EPR	Pos: Zero:	0.0409 0.0649	0.0094 0.0240
CBL-50SWBD-LEFT	BUS-0046 50SWBD-LEFT	In	4	150	500	Copper	Magnetic	PVC	Pos: Zero:	0.4785 1.5072	0.7585 1.8669
CBL-50SWBD-RIGHT	BUS-0048 50SWBD-RIGHT	In	4	90	500	Copper	Magnetic	PVC	Pos: Zero:	0.2871 0.9043	0.4551 1.1201
CBL-7F-1	2LS-1 BUS-0031	In	1	241	2	Copper	Non-Magnetic	EPR	Pos: Zero:	0.2812 0.4470	0.0650 0.1654
CBL-F1 35MVC1	35MSG 35MVC1	In	1	20	350	Copper	Non-Magnetic	EPR	Pos: Zero:	0.0043 0.0068	0.0045 0.0115
CBL-F2 35MVC2	35MSG 35MVC2	In	1	20	350	Copper	Non-Magnetic	EPR	Pos: Zero:	0.0043 0.0068	0.0045 0.0115
CBL-F3-1	35MSG 10LS-1	In	2	103	4/0	Copper	Non-Magnetic	EPR	Pos: Zero:	0.0188 0.0299	0.0118 0.0301
CBL-F3-2	10LS-1 50LS-1	In	2	145	4/0	Copper	Non-Magnetic	EPR	Pos: Zero:	0.0265 0.0421	0.0167 0.0424
CBL-F3-3	50LS-1 2LS-1	In	2	65	4/0	Copper	Non-Magnetic	EPR	Pos: Zero:	0.0119 0.0189	0.0075 0.0190

Cable Name	From Bus To Bus	In/Out Service	Qty /Ph	Length Feet	Size	Cond. Type	Duct Type	Insul		R pu	jX pu
					------ Cable Description ------				Per Unit (100 MVA Base)		
CBL-F3-4	2LS-1 2LS-2	In	2	241	4/0	Copper	Non-Magnetic	EPR	Pos: Zero:	0.0441 0.0700	0.0277 0.0704
CBL-F4-1	35MSG 2LS-2	In	2	241	4/0	Copper	Non-Magnetic	EPR	Pos: Zero:	0.0441 0.0700	0.0277 0.0704
C-P-3500	35PP1 PP-EC1	In	1	175	4	Copper	Magnetic	PVC	Pos: Zero:	24.3815 76.8359	4.8003 11.8186
C-P-3501	PP-EC1 BUS-0009	In	1	15	8	Copper	Magnetic	PVC	Pos: Zero:	5.2799 16.6400	0.4909 1.2083
C-P-3502	BUS-0010 LP-EC1	In	1	15	2	Copper	Magnetic	PVC	Pos: Zero:	7.0035 22.0715	2.0282 4.9926
C-P-3503	35PP1 DSW-TX-LP-G1	In	1	355	2	Copper	Magnetic	PVC	Pos: Zero:	31.1241 98.0872	9.0137 22.1875
C-P-3504	DSW-TX-LP-G1 BUS-0013	In	1	15	2	Copper	Magnetic	PVC	Pos: Zero:	1.3151 4.1445	0.3809 0.9375
C-P-3505	BUS-0014 LP-G1	In	1	15	1/0	Copper	Magnetic	PVC	Pos: Zero:	4.4379 13.9862	1.8722 4.6078
C-P3507-3510	BUS-0041 35MVATS	In	4	55	500	Copper	Non-Magnetic	EPR	Pos: Zero:	0.0022 0.0035	0.0030 0.0079
C-P3512-3515	35MVATS MH-MV1	In	4	50	500	Copper	Non-Magnetic	EPR	Pos: Zero:	0.0020 0.0032	0.0027 0.0072
C-P3512-3515.	MH-MV1 35MSG	In	4	50	500	Copper	Non-Magnetic	EPR	Pos: Zero:	0.0020 0.0032	0.0027 0.0072
C-P3517	GENERATOR G-1 35MVATS.	In	1	220	500	Copper	Non-Magnetic	EPR	Pos: Zero:	0.0351 0.0557	0.0474 0.1270

2-Winding Transformers

Xformer Name	In/Out Service	Bus	Conn.	Volts	FLA	Nominal kVA		R pu	jX pu
		------------------Primary & Secondary---------------					Z PU (100 MVA Base)		
10TX-1	In	BUS-0025 BUS-0043	D WG	4,160 480	139 1,203	1,000.0	Pos: Zero:	0.9917 0.9917	5.6638 5.6638
10TX-2	In	BUS-0029 BUS-0045	D WG	4,160 480	139 1,203	1,000.0	Pos: Zero:	0.9917 0.9917	5.6638 5.6638
2TX-1	In	BUS-0050 2FS-3(LEFT)	D WG	4,160 480	104 902	750.0	Pos: Zero:	1.2496 1.2496	6.5485 6.5485
2TX-2	In	BUS-0037 BUS-0054	D WG	4,160 480	104 902	750.0	Pos: Zero:	1.2496 1.2496	6.5485 6.5485
2TX-3	In	BUS-0040 2FS-3(RIGHT)	D WG	4,160 2,400	42 72	300.0	Pos: Zero:	2.3427 2.3427	9.7217 9.7217
35TX-1	In	BUS-0022 BUS-0023	D WG	4,160 480	42 361	300.0	Pos: Zero:	4.5293 4.5293	18.7953 18.7953

Xformer Name	In/Out Service	------------------Primary & Secondary--------------- Bus	Conn.	Volts	FLA	Nominal kVA	Z PU (100 MVA Base)	R pu	jX pu
50TX-1	In	BUS-0026	D	4,160	139	1,000.0	Pos:	0.9917	5.6638
		BUS-0046	WG	480	1,203		Zero:	0.9917	5.6638
50TX-2	In	BUS-0030	D	4,160	139	1,000.0	Pos:	0.9917	5.6638
		BUS-0048	WG	480	1,203		Zero:	0.9917	5.6638
7TX-1	In	BUS-0031	D	4,160	69	500.0	Pos:	1.2500	5.8684
		MCC-1	WG	480	601		Zero:	1.2500	5.8684
TX-LP-EC1	In	BUS-0009	D	480	36	30.0	Pos:	25.3800	69.1567
		BUS-0010	WG	208	83		Zero:	25.3800	69.1567
TX-LP-G1	In	BUS-0013	D	480	54	45.0	Pos:	30.4222	88.2356
		BUS-0014	WG	208	125		Zero:	30.4222	88.2356
XF-UTIL-GEORGIA-POV	In	BUS-0042	D	24,940	116	5,000.0	Pos:	0.0697	0.8772
		BUS-0041	WG	4,160	694		Zero:	0.0697	0.8772

APPENDIX 5

SHORT CIRCUIT FAULT ANALYSIS OUTPUT REPORT

Project: WJ HOOPER GENERATOR
Crowder Construction Company
WJ Hooper
1075681

ANSI Complete Fault Report

A_FAULT Settings

Fault Type	3 Phase+Unbalanced	**LV Duty**	Yes	**Int Duty**	Yes
Faulted Bus	All Buses	**LV Report**	Complete	**Int Report**	Complete
Include Tap	No	**Mom Duty**	Yes	**Solution Method**	E/Z
Pre-fault Voltage	1.0000	**Mom Report**	Complete	**NACD Option**	Interpolated

Low Voltage 3 Phase and Unbalanced

Fault Location Bus Name	Bus Voltage		Fault Duty kA	Fault Duty MVA	X/R	-----Asym kA----- Max RMS	Avg RMS	Sequence Impedance pu		Equivalent R	+jX
10LS-1	4,160	3 Phase:	14.71	106.0	8.05	20.36	17.66	Z1:	0.94	0.02	0.16
		SLG:	14.77	61.4	8.27	20.55	---	Z2:	0.94	---	---
		LL:	17.63	73.3	---	---	---	Z0:	0.93	---	---
LLG Gnd Return kA:	20.586	LLG:	20.57	85.6	---	---	---				
2LS-1	4,160	3 Phase:	14.49	104.4	7.04	19.54	17.12	Z1:	0.96	0.02	0.16
		SLG:	14.46	60.1	7.06	19.51	---	Z2:	0.96	---	---
		LL:	16.93	70.4	---	---	---	Z0:	0.96	---	---
LLG Gnd Return kA:	19.458	LLG:	19.59	81.5	---	---	---				
2LS-2	4,160	3 Phase:	14.54	104.7	7.24	19.72	17.23	Z1:	0.95	0.02	0.16
		SLG:	14.52	60.4	7.29	19.73	---	Z2:	0.95	---	---
		LL:	17.07	71.0	---	---	---	Z0:	0.96	---	---
LLG Gnd Return kA:	19.693	LLG:	19.79	82.3	---	---	---				
35MSG	4,160	3 Phase:	14.90	107.4	9.27	21.15	18.17	Z1:	0.93	0.02	0.16
		SLG:	15.05	62.6	9.85	21.59	---	Z2:	0.93	---	---
		LL:	18.32	76.2	---	---	---	Z0:	0.90	---	---
LLG Gnd Return kA:	21.717	LLG:	21.57	89.7	---	---	---				
35MVATS	4,160	3 Phase:	14.95	107.7	9.54	21.33	18.29	Z1:	0.93	0.02	0.16
		SLG:	15.17	63.1	10.24	21.90	---	Z2:	0.93	---	---
		LL:	18.47	76.8	---	---	---	Z0:	0.89	---	---
LLG Gnd Return kA:	22.110	LLG:	21.84	90.8	---	---	---				
35MVATS.	4,160	3 Phase:	2.86	20.6	17.62	4.43	3.69	Z1:	4.86	0.05	0.84
		SLG:	2.84	11.8	17.29	4.40	---	Z2:	4.86	---	---
		LL:	3.84	16.0	---	---	---	Z0:	4.94	---	---
LLG Gnd Return kA:	4.376	LLG:	4.42	18.4	---	---	---				

Low Voltage 3 Phase and Unbalanced

Fault Location Bus Name	Bus Voltage		Fault Duty kA	Fault Duty MVA	X/R	-----Asym kA----- Max RMS	-----Asym kA----- Avg RMS	Sequence Impedance pu		Equivalent R	Equivalent +jX
35MVC1	4,160	3 Phase:	14.84	106.9	8.98	20.95	18.04	Z1:	0.94	0.02	0.16
		SLG:	14.95	62.2	9.44	21.29	---	Z2:	0.94	---	---
		LL:	18.15	75.5	---	---	---	Z0:	0.92	---	---
LLG Gnd Return kA:	21.357	LLG:	21.29	88.6	---	---	---				
35MVC2	4,160	3 Phase:	14.83	106.9	8.96	20.94	18.03	Z1:	0.94	0.02	0.16
		SLG:	14.94	62.2	9.43	21.28	---	Z2:	0.94	---	---
		LL:	18.13	75.4	---	---	---	Z0:	0.92	---	---
LLG Gnd Return kA:	21.349	LLG:	21.28	88.5	---	---	---				
35PP1	480	3 Phase:	5.79	4.8	3.84	6.82	6.32	Z1:	20.78	0.01	0.05
		SLG:	5.80	2.8	3.56	6.72	---	Z2:	20.78	---	---
		LL:	5.91	2.8	---	---	---	Z0:	20.71	---	---
LLG Gnd Return kA:	6.788	LLG:	6.88	3.3	---	---	---				
50LS-1	4,160	3 Phase:	14.53	104.7	7.21	19.69	17.22	Z1:	0.96	0.02	0.16
		SLG:	14.52	60.4	7.26	19.70	---	Z2:	0.96	---	---
		LL:	17.06	71.0	---	---	---	Z0:	0.96	---	---
LLG Gnd Return kA:	19.664	LLG:	19.77	82.2	---	---	---				
DSW-TX-LP-G1	480	3 Phase:	2.58	2.1	0.80	2.58	2.58	Z1:	46.59	0.08	0.07
		SLG:	1.77	0.9	0.57	1.77	---	Z2:	46.59	---	---
		LL:	2.24	1.1	---	---	---	Z0:	112.52	---	---
LLG Gnd Return kA:	1.337	LLG:	2.48	1.2	---	---	---				
GENERATOR G-1	4,160	3 Phase:	2.89	20.8	20.00	4.53	3.76	Z1:	4.81	0.04	0.83
		SLG:	2.89	12.0	20.00	4.53	---	Z2:	4.81	---	---
		LL:	3.92	16.3	---	---	---	Z0:	4.81	---	---
LLG Gnd Return kA:	4.530	LLG:	4.53	18.8	---	---	---				
LP-EC1	208	3 Phase:	2.36	0.8	1.44	2.39	2.37	Z1:	117.71	0.03	0.04
		SLG:	2.57	0.5	1.47	2.61	---	Z2:	117.71	---	---
		LL:	2.07	0.4	---	---	---	Z0:	88.03	---	---
LLG Gnd Return kA:	2.873	LLG:	2.55	0.5	---	---	---				
LP-G1	208	3 Phase:	1.98	0.7	1.65	2.03	2.01	Z1:	139.89	0.03	0.05
		SLG:	2.18	0.5	1.75	2.24	---	Z2:	139.89	---	---
		LL:	1.76	0.4	---	---	---	Z0:	102.92	---	---
LLG Gnd Return kA:	2.473	LLG:	2.21	0.5	---	---	---				
PP-EC1	480	3 Phase:	3.11	2.6	0.84	3.11	3.11	Z1:	38.70	0.07	0.06
		SLG:	2.20	1.1	0.57	2.20	---	Z2:	38.70	---	---
		LL:	2.69	1.3	---	---	---	Z0:	88.96	---	---
LLG Gnd Return kA:	1.680	LLG:	3.03	1.5	---	---	---				

Momentary 3 Phase

Fault Location Bus Name	Bus Voltage	-----Sym Fault Duty----- kA	MVA	X/R	---------Mom kA--------- Sym*1.6	Based on X/R	--------Crest kA-------- Sym*2.7	Based on X/R	Equivalent R	+jX
10LS-1	4,160	14.193	102.27	8.21	22.709	19.720	38.322	33.760	0.02	0.17
2LS-1	4,160	13.994	100.83	7.19	22.390	18.960	37.784	32.580	0.03	0.17
2LS-2	4,160	14.037	101.14	7.39	22.460	19.120	37.901	32.830	0.02	0.17
35MSG	4,160	14.373	103.56	9.44	22.997	20.470	38.807	34.900	0.02	0.17
35MVATS	4,160	14.426	103.95	9.71	23.082	20.640	38.952	35.170	0.02	0.17
35MVATS.	4,160	2.858	20.60	17.62	4.574	4.430	7.718	7.420	0.05	0.84
35MVC1	4,160	14.316	103.15	9.13	22.906	20.270	38.654	34.600	0.02	0.17
35MVC2	4,160	14.310	103.11	9.12	22.897	20.260	38.638	34.580	0.02	0.17
50LS-1	4,160	14.032	101.10	7.37	22.451	19.100	37.886	32.800	0.02	0.17
GENERATOR G-1	4,160	2.888	20.81	20.00	4.620	4.530	7.797	7.570	0.04	0.83

Momentary Unbalanced

Fault Location Bus Name	Bus Voltage		---Sym Fault Duty--- kA	MVA	X/R	--Mom. Fault Duty-- kA*1.6	Based on X/R	Sequence Impedance pu	
10LS-1	4,160	3 Phase:	14.193	102.27	8.21	22.709	19.720	Z1:	0.98
		SLG:	14.420	59.99	8.38	23.072	20.110	Z2:	0.98
		LL:	17.078	71.05	---	---	---	Z0:	0.93
LLG Gnd Return kA:	20.40	LLG:	20.018	83.27	---	---	---		
2LS-1	4,160	3 Phase:	13.994	100.83	7.19	22.390	18.960	Z1:	0.99
		SLG:	14.123	58.75	7.16	22.597	19.110	Z2:	0.99
		LL:	16.416	68.29	---	---	---	Z0:	0.96
LLG Gnd Return kA:	19.30	LLG:	19.073	79.35	---	---	---		
2LS-2	4,160	3 Phase:	14.037	101.14	7.39	22.460	19.120	Z1:	0.99
		SLG:	14.187	59.02	7.39	22.700	19.320	Z2:	0.99
		LL:	16.556	68.87	---	---	---	Z0:	0.96
LLG Gnd Return kA:	19.53	LLG:	19.270	80.16	---	---	---		
35MSG	4,160	3 Phase:	14.373	103.56	9.44	22.997	20.470	Z1:	0.97
		SLG:	14.691	61.11	9.96	23.506	21.110	Z2:	0.97
		LL:	17.725	73.74	---	---	---	Z0:	0.90
LLG Gnd Return kA:	21.50	LLG:	20.967	87.22	---	---	---		
35MVATS	4,160	3 Phase:	14.426	103.95	9.71	23.082	20.640	Z1:	0.96
		SLG:	14.807	61.60	10.36	23.691	21.410	Z2:	0.96
		LL:	17.876	74.37	---	---	---	Z0:	0.89
LLG Gnd Return kA:	21.89	LLG:	21.234	88.33	---	---	---		
35MVATS.	4,160	3 Phase:	2.858	20.60	17.62	4.574	4.430	Z1:	4.86
		SLG:	2.843	11.83	17.29	4.548	4.400	Z2:	4.86
		LL:	3.835	15.95	---	---	---	Z0:	4.94
LLG Gnd Return kA:	4.38	LLG:	4.416	18.37	---	---	---		
35MVC1	4,160	3 Phase:	14.316	103.15	9.13	22.906	20.270	Z1:	0.97
		SLG:	14.589	60.69	9.55	23.342	20.820	Z2:	0.97
		LL:	17.557	73.04	---	---	---	Z0:	0.92
LLG Gnd Return kA:	21.15	LLG:	20.696	86.10	---	---	---		
35MVC2	4,160	3 Phase:	14.310	103.11	9.12	22.897	20.260	Z1:	0.97
		SLG:	14.585	60.67	9.54	23.336	20.810	Z2:	0.97
		LL:	17.546	72.99	---	---	---	Z0:	0.92
LLG Gnd Return kA:	21.14	LLG:	20.687	86.06	---	---	---		
50LS-1	4,160	3 Phase:	14.032	101.10	7.37	22.451	19.100	Z1:	0.99
		SLG:	14.179	58.99	7.36	22.687	19.300	Z2:	0.99
		LL:	16.538	68.80	---	---	---	Z0:	0.96
LLG Gnd Return kA:	19.50	LLG:	19.245	80.06	---	---	---		
GENERATOR G-1	4,160	3 Phase:	2.888	20.81	20.00	4.620	4.530	Z1:	4.81
		SLG:	2.888	12.01	20.00	4.620	4.530	Z2:	4.81
		LL:	3.923	16.32	---	---	---	Z0:	4.81
LLG Gnd Return kA:	4.53	LLG:	4.530	18.84	---	---	---		

Interrupting 3 Phase and Unbalanced

Fault Location Bus Name	Bus Voltage		-----Init Sym Fault----- kA	X/R	Equivalent R	+jX	Seq. Imp. pu		-------Interrupting Fault kA----- 2 cyc.	3 cyc.	5 cyc.	8 cyc.
10LS-1	4,160	3 Phase:	12.65	8.77	0.02	0.19	Z1: 1.10	3Ph.Sym:	12.65	12.65	12.65	12.68
		SLG:	13.32	8.77	---	---	Z2: 1.10	Tot:	14.83	13.10	12.67	12.65
NACD:	0.92	LL:	15.41	---	---	---	Z0: 0.93	SLG Sym:	13.32	13.32	13.32	13.32
LLG Gnd Return kA:	19.774	LLG:	18.33	---	---	---		Tot:	15.62	13.79	13.34	13.32
2LS-1	4,160	3 Phase:	12.50	7.72	0.03	0.19	Z1: 1.11	3Ph.Sym:	12.50	12.50	12.50	12.50
		SLG:	13.07	7.52	---	---	Z2: 1.11	Tot:	14.22	12.74	12.50	12.50
NACD:	0.92	LL:	14.86	---	---	---	Z0: 0.96	SLG Sym:	13.07	13.07	13.07	13.07
LLG Gnd Return kA:	18.762	LLG:	17.58	---	---	---		Tot:	14.79	13.28	13.07	13.07
2LS-2	4,160	3 Phase:	12.53	7.93	0.02	0.19	Z1: 1.11	3Ph.Sym:	12.53	12.53	12.53	12.54
		SLG:	13.12	7.76	---	---	Z2: 1.11	Tot:	14.34	12.81	12.53	12.53
NACD:	0.92	LL:	14.98	---	---	---	Z0: 0.96	SLG Sym:	13.12	13.12	13.12	13.12
LLG Gnd Return kA:	18.974	LLG:	17.73	---	---	---		Tot:	14.95	13.39	13.13	13.12
35MSG	4,160	3 Phase:	12.79	10.01	0.02	0.19	Z1: 1.08	3Ph.Sym:	12.79	12.79	12.79	12.84
		SLG:	13.55	10.36	---	---	Z2: 1.08	Tot:	15.51	13.49	12.88	12.79
NACD:	0.92	LL:	15.93	---	---	---	Z0: 0.90	SLG Sym:	13.55	13.55	13.55	13.55
LLG Gnd Return kA:	20.778	LLG:	19.15	---	---	---		Tot:	16.56	14.39	13.70	13.55
35MVATS	4,160	3 Phase:	12.85	10.32	0.02	0.19	Z1: 1.08	3Ph.Sym:	12.85	12.85	12.85	12.93
		SLG:	13.66	10.78	---	---	Z2: 1.08	Tot:	15.67	13.63	12.98	12.85
NACD:	0.92	LL:	16.08	---	---	---	Z0: 0.89	SLG Sym:	13.66	13.66	13.66	13.66
LLG Gnd Return kA:	21.152	LLG:	19.41	---	---	---		Tot:	16.84	14.62	13.88	13.66
35MVATS.	4,160	3 Phase:	2.86	17.62	0.05	0.84	Z1: 4.86	3Ph.Sym:	2.86	2.86	2.86	2.86
		SLG:	2.84	17.29	---	---	Z2: 4.86	Tot:	3.89	3.30	2.95	2.86
NACD:	0.00	LL:	3.84	---	---	---	Z0: 4.94	SLG Sym:	2.84	2.84	2.84	2.84
LLG Gnd Return kA:	4.376	LLG:	4.42	---	---	---		Tot:	3.96	3.37	3.09	2.91
35MVC1	4,160	3 Phase:	12.74	9.68	0.02	0.19	Z1: 1.09	3Ph.Sym:	12.74	12.74	12.74	12.78
		SLG:	13.46	9.93	---	---	Z2: 1.09	Tot:	15.31	13.37	12.81	12.74
NACD:	0.92	LL:	15.78	---	---	---	Z0: 0.92	SLG Sym:	13.46	13.46	13.46	13.46
LLG Gnd Return kA:	20.444	LLG:	18.90	---	---	---		Tot:	16.30	14.18	13.55	13.46
35MVC2	4,160	3 Phase:	12.74	9.68	0.02	0.19	Z1: 1.09	3Ph.Sym:	12.74	12.74	12.74	12.78
		SLG:	13.46	9.92	---	---	Z2: 1.09	Tot:	15.31	13.37	12.80	12.74
NACD:	0.92	LL:	15.78	---	---	---	Z0: 0.92	SLG Sym:	13.46	13.46	13.46	13.46
LLG Gnd Return kA:	20.441	LLG:	18.90	---	---	---		Tot:	16.29	14.17	13.54	13.46
50LS-1	4,160	3 Phase:	12.53	7.90	0.02	0.19	Z1: 1.11	3Ph.Sym:	12.53	12.53	12.53	12.53
		SLG:	13.12	7.73	---	---	Z2: 1.11	Tot:	14.32	12.80	12.53	12.53
NACD:	0.92	LL:	14.96	---	---	---	Z0: 0.96	SLG Sym:	13.12	13.12	13.12	13.12
LLG Gnd Return kA:	18.947	LLG:	17.71	---	---	---		Tot:	14.93	13.37	13.12	13.12
GENERATOR G-1	4,160	3 Phase:	2.89	20.00	0.04	0.83	Z1: 4.81	3Ph.Sym:	2.89	2.89	2.89	2.89
		SLG:	2.89	20.00	---	---	Z2: 4.81	Tot:	4.02	3.41	3.04	2.89
NACD:	0.00	LL:	3.92	---	---	---	Z0: 4.81	SLG Sym:	2.92	2.92	2.92	2.92
LLG Gnd Return kA:	4.530	LLG:	4.53	---	---	---		Tot:	4.13	3.53	3.23	3.02

APPENDIX 6

DEVICE EVALUATION REPORT

Device Evaluation Summary

Color Code	***Bus Count***	***Percentage***	***Description***
Pass	13	100%	These devices were found to have acceptable short circuit interrupting ratings when compared to system fault duties.
Marginal	0	0%	WARNING! The calculated short circuit current levels at these locations exceed 95% of the interrupting ratings! Equipment aging or small changes to the system could result in equipment that will not adequately interrupt faults when required to do so. Replacing the equipment or modifying the system configuration to reduce the available fault levels should be considered. Additional calculations and analysis should be performed when significant changes to the system are made.
Fail	0	0%	DANGER! These devices have inadequate interrupting ratings and should be replaced immediately or the system configuration should be changed because the devices could fail catastrophically whenever the conditions described for this case in report section 1.5 exist. The equipment failure could cause injury or death to personnel near the equipment.
Series	0	0%	These circuit breakers have an adequate series interrupting rating the manufacturer has produced them with a series rating or if the markings required to allow a series rating were added to the equipment. Those markings should meet the requirements given in NFPA 70 (National Electric Code) Article 110.22.
Total:	***13***	***100%***	

Date: February 16, 2022

Device Evaluation

ERS # 1075681

Client: Crowder Construction Company
Project: WJ Hooper

Bus Name	Voltage (V)	Device Type	Interrupt Rating (kA)	Series Rating (kA)	Momentary Rating (kA)	Calculated Interrupt (kA)	Calculated Momentary (kA)	Interrupt Rating (%)	Momentary Rating (%)	Evaluation	Possible Corrective Action
10SWBD-LEFT	480	Square D NW16N	65	0	0	17.33	0	27 %	0 %	Pass	
10SWBD-RIGHT	480	Square D NW16N	65	0	0	16.6	0	26 %	0 %	Pass	
2MCC-RIGHT	480	Square D PX	100	0	0	14.89	0	15 %	0 %	Pass	
35MSG	4,160	Square D VR-05035-12, VR-05035-20	46.91	0	78	13.27	21.11	28 %	27 %	Pass	
35MVATS	4,160	Square D VR-05035-20	46.91	0	78	13.37	21.41	29 %	27 %	Pass	
35MVATS.	4,160	Square D VR-05035-12	46.91	0	78	2.86	4.43	6 %	6 %	Pass	
35PP1	480	Square D EJ, LCL	65	0	0	5.89	0	9 %	0 %	Pass	
50SWBD-LEFT	480	Square D NW16N	65	0	0	16.26	0	25 %	0 %	Pass	
50SWBD-RIGHT	480	Square D NW16N	65	0	0	17.06	0	26 %	0 %	Pass	
DSW-TX-LP-G1	480	Gould Shawmut TRS	100+	0	0	2.58	0	1 %	0 %	Pass	
LP-EC1	208	Cutler-Hammer BAB	10	0	0	2.57	0	26 %	0 %	Pass (No Lib)	
LP-G1	208	Siemens SEAB/SEAM	65	0	0	2.18	0	3 %	0 %	Pass	
PP-EC1	480	Cutler-Hammer FD, JD	35	0	0	3.11	0	9 %	0 %	Pass	

APPENDIX 7

RECOMMENDED DEVICE SETTINGS

Electrical Reliability Services
Client: Crowder Construction Company
Project: WJ Hooper
Job #: 1075681

Appendix 6
Recommended Overcurrent
Relay Information

Device Location	Device Name in Model /Trip Type	CT Ratio	Device Description	Existing Settings (Range) Setting	Recommended Settings (Range) Setting
35MSG	RY-35MVC1 Electronic	400 / 5	GE MULTILIN 735 50/51	Phase Pickup(Lo) 100 % (400A) ANSI Mod Inverse 1; 10 (S;M) Ground Pickup(Lo) 15 % (7.5A) ANSI Ext Inverse 1; 3 (S;M)	Phase Pickup(Lo) 100 % (400A) ANSI Mod Inverse 1; 10 (S;M) Ground Pickup(Lo) 15 % (7.5A) ANSI Ext Inverse 1; 3 (S;M)
35MSG	RY-35MVC2 Electronic	400 / 5	GE MULTILIN 735 50/51	Phase Pickup(Lo) 100 % (400A) ANSI Mod Inverse 1; 10 (S;M) Ground Pickup(Lo) 15 % (7.5A) ANSI Mod Inverse 1; 3 (S;M)	Phase Pickup(Lo) 100 % (400A) ANSI Mod Inverse 1; 10 (S;M) Ground Pickup(Lo) 15 % (7.5A) ANSI Mod Inverse 1; 3 (S;M)
35MSG	RY-35MVSG-MAIN Electronic	1200 / 5	GE MULTILIN 750 50/51	Phase Phase OC PU 1 (1200A) Ext Inverse 1; 1 (S;M) Phase Inst OC PU 10 (12000A) Ground Ground OC PU 1 (50A) IAC Very Inv 2.72; 1 (S;M) Ground Inst OC PU 14.29 (714.5A)	Phase Phase OC PU 1 (1200A) Ext Inverse 1; 1 (S;M) Phase Inst OC PU 10 (12000A) Ground Ground OC PU 1 (50A) IAC Very Inv 2.72; 1 (S;M) Ground Inst OC PU 14.29 (714.5A)
35MSG	RY-F3-1 Electronic	600 / 5	GE MULTILIN 735 50/51	Phase Pickup(Lo) 100 % (600A) ANSI Mod Inverse 0.5; 8 (S;M) Ground Pickup(Lo) 15 % (7.5A) ANSI Mod Inverse 1; 2 (S;M)	Phase Pickup(Lo) 100 % (600A) ANSI Mod Inverse 0.5; 8 (S;M) Ground Pickup(Lo) 15 % (7.5A) ANSI Mod Inverse 1; 2 (S;M)
35MSG	RY-F4-1 Electronic	600 / 5	GE MULTILIN 735 50/51	Phase Pickup(Lo) 100 % (600A) ANSI Mod Inverse 0.5; 8 (S;M) Ground Pickup(Lo) 15 % (7.5A) ANSI Mod Inverse 1; 2 (S;M)	Phase Pickup(Lo) 100 % (600A) ANSI Mod Inverse 0.5; 8 (S;M) Ground Pickup(Lo) 15 % (7.5A) ANSI Mod Inverse 1; 2 (S;M)

Electrical Reliability Services
Client: Crowder Construction Company
Project: WJ Hooper
Job #: 1075681

Appendix 6
Recommended Overcurrent Relay Information

Device Location	Device Name in Model /Trip Type	CT Ratio	Device Description	Existing Settings (Range) Setting	Recommended Settings (Range) Setting
35MVATS	RY-35-52-F1 Electronic	2000 / 5	SEL 751 50P/51P, 5A nom.	(New Device)	51P1P, (0.5-16 x CTR) 3 (1200A) U4, Extremely Inverse 1.59 50P1P, (0.5-100 x CTR) 34.5 (13800A) 50P1D, (0.001 - 5s) 0.001 sec
35MVATS.	RY-35-52-G1 Static Relay	600 / 5	SEL 700G 50P/51P, 5A	(New Device)	Phase 50P1P 25 (3000A) 50P1D 0.5 sec Ground 50G1P 1.67 (200.4A) 50G1D 1.5 sec
35MVATS.	RY-35-52-GM Electronic	1200 / 5	SEL 751 50P/51P, 5A nom.	(New Device)	51P1P, (0.5-16 x CTR) 5 (1200A) U3, Very Inverse 1.03 50P1P, (0.5-100 x CTR) 34.5 (8280A) 50P1D, (0.001 - 5s) 0.001 sec
35MVATS.	RY-35-52-TG/LB Electronic	600 / 5	SEL 751 50P/51P, 5A nom.	(New Device)	51P1P, (0.5-16 x CTR) 6 (720A) U3, Very Inverse 3.0 50P1P, (0.5-100 x CTR) 10 (1200A) 50P1D, (0.001 - 5s) 0.001 sec
35MVATS	RY-35-52-UM Electronic	2000 / 5	SEL 751 50P/51P, 5A nom.	(New Device)	Phase 51P1P, (0.5-16 x CTR) 3 (1200A) U4, Extremely Inverse 3.0 50P1P, (0.5-100 x CTR) 69 (27600A) 50P1D, (0.001 - 5s) 0.001 sec Ground 51G1P, (0.5-16 x CTR) 1.25 (75A) U2, Inverse 2.17 50G1P, (0.5-100 x CTR) 20 (1200A) 50G1D, (0.001 - 5s) 0.001 sec

Appendix 6
Existing and Recommended
Circuit Breaker Settings

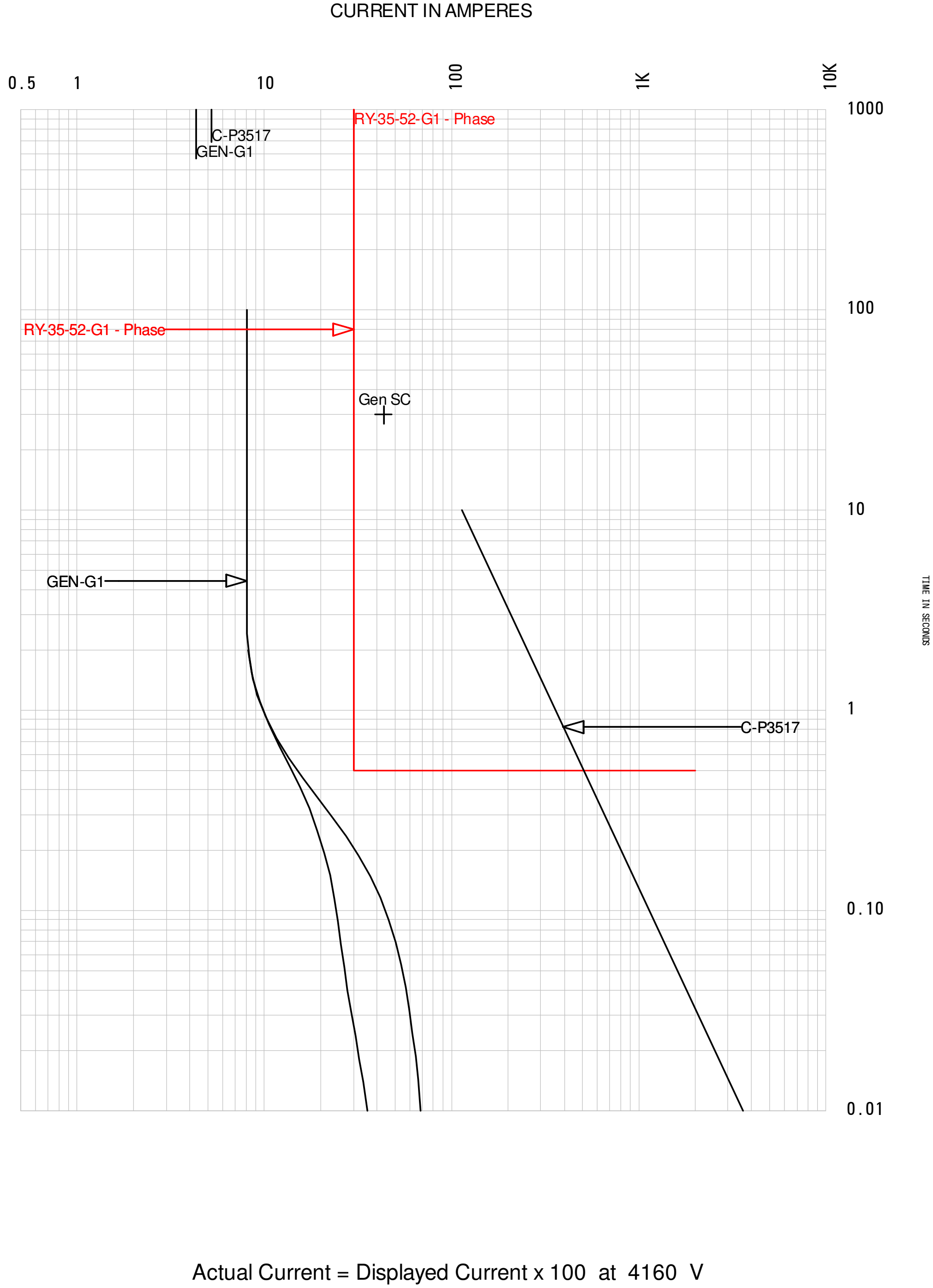
Device Location	Device Name in Model / Trip Type	Device Manufacturer / Description / Ampacity Range	Frame/ Model	Frame (A) Trip (A) Plug (A)	Existing Settings Type (Range) Setting (Value)	Recommended Settings Type (Range) Setting (Value)
10SWBD-LEFT	10SWBD MAIN 1	LSI, 400-6000AS, UL	NW16N	1600.0A	Phase	Phase
	Static Trip			800.0A	LTPU (A);LTD 1 (800A); 0.5	LTPU (A);LTD 1 (800A); 0.5
				800.0A	STPU 1.5 (1200A)	STPU 1.5 (1200A)
					STD 0.1 (I^s T Off)	STD 0.1 (I^s T Off)
					INST (NW**N) 2 (1600A)	INST (NW**N) 2 (1600A)
					Ground	Ground
					GFPU (500-1200A) A (500A)	GFPU (500-1200A) A (500A)
					GFD (0-0.4) 0.4 (I^s T Off)	GFD (0-0.4) 0.4 (I^s T Off)
10SWBD-RIGHT	10SWBD MAIN 2	LSI, 400-6000AS, UL	NW16N	1600.0A	Phase	Phase
	Static Trip			800.0A	LTPU (A);LTD 1 (800A); 0.5	LTPU (A);LTD 1 (800A); 0.5
				800.0A	STPU 1.5 (1200A)	STPU 1.5 (1200A)
					STD 0.1 (I^s T Off)	STD 0.1 (I^s T Off)
					INST (NW**N) 2 (1600A)	INST (NW**N) 2 (1600A)
					Ground	Ground
					GFPU (500-1200A) A (500A)	GFPU (500-1200A) A (500A)
					GFD (0-0.4) 0.4 (I^s T Off)	GFD (0-0.4) 0.4 (I^s T Off)
2MCC-RIGHT	2MCC MAIN 2	LSI, 600-1600A	PX	1200.0A	Phase	Phase
	Static Trip			1200.0A	LTPU (0.5-1.0 x P) 0.8 (960A)	LTPU (0.5-1.0 x P) 0.8 (960A)
				1200.0A	LTD (2-24 Sec.) 4.5	LTD (2-24 Sec.) 4.5
					STPU (2-8 x P) 8.0 (9600A)	STPU (2-8 x P) 8.0 (9600A)
					STD (0.1-0.5 Sec.) .5 (I^s T On)	STD (0.1-0.5 Sec.) .5 (I^s T On)
					INST (2.5-8 x P) 8.0 (9600A)	INST (2.5-8 x P) 8.0 (9600A)
					Ground	Ground
					GFPU (0.2-0.75 x S) 0.2 (240A)	GFPU (0.2-0.75 x S) 0.2 (240A)
					GFD (0.1-0.5 Sec.) 0.5	GFD (0.1-0.5 Sec.) 0.5
35PP1	35PP1 MAIN	300A-600A, 2-3 Pole	LCL	500.0A	Thermal Curve (Low)	Thermal Curve (Low)
	Thermal Magnetic			500.0A	INST, (Low-High) Low (2500) (2500A)	INST, (Low-High) Low (2500) (2500A)
				500.0A		
50SWBD-LEFT	50SWBD MAIN 1	LSI, 400-6000AS, UL	NW16N	1600.0A	Phase	Phase
	Static Trip			800.0A	LTPU (A);LTD 0.7 (560A); 8	LTPU (A);LTD 0.7 (560A); 8
				800.0A	STPU 6 (3360A)	STPU 6 (3360A)
					STD 0.1 (I^s T Off)	STD 0.1 (I^s T Off)
					INST OR (NW**N) Fixed (40000A)	INST OR (NW**N) Fixed (40000A)
					Ground	Ground
					GFPU (500-1200A) J (1200A)	GFPU (500-1200A) J (1200A)
					GFD (0-0.4) 0.4 (I^s T Off)	GFD (0-0.4) 0.4 (I^s T Off)

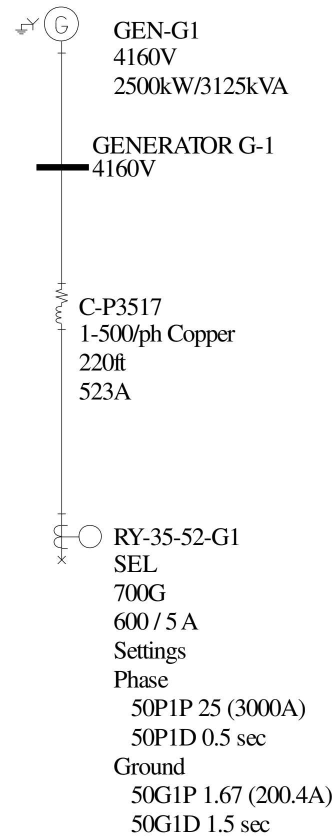
Appendix 6
Existing and Recommended
Circuit Breaker Settings

Device Location	Device Name in Model / Trip Type	Device Manufacturer / Description / Ampacity Range	Frame/ Model	Frame (A) Trip (A) Plug (A)	Existing Settings Type (Range) Setting (Value)	Recommended Settings Type (Range) Setting (Value)
50SWBD-RIGHT	50SWBD MAIN 2	LSI, 400-6000AS, UL	NW16N	1600.0A	Phase	Phase
	Static Trip			800.0A	LTPU (A);LTD 0.7 (560A); 8	LTPU (A);LTD 0.7 (560A); 8
				800.0A	STPU 6 (3360A)	STPU 6 (3360A)
					STD 0.1 (I^s T Off)	STD 0.1 (I^s T Off)
					INST OR (NW**N) Fixed (40000A)	INST OR (NW**N) Fixed (40000A)
					Ground	Ground
					GFPU (500-1200A) J (1200A)	GFPU (500-1200A) J (1200A)
					GFD (0-0.4) 0.4 (I^s T Off)	GFD (0-0.4) 0.4 (I^s T Off)
LP-G1	CB-LP-G1-MN	125AF, 125AS, 2-3 Poles	SEAB/SEAM	125.0A	Thermal Curve Fixed (125A)	Thermal Curve Fixed (125A)
	Thermal Magnetic			125.0A	INST Fixed (1250A)	INST Fixed (1250A)
				125.0A		
PP-EC1	CB-PP-EC1-MN	70-250A	JD	150.0A	Thermal Curve (Fixed)	Thermal Curve (Fixed)
	Thermal Magnetic			150.0A	INST (5-10 x Trip) 5 (750A)	INST (5-10 x Trip) 5 (750A)
				150.0A		

APPENDIX 8

TCC's

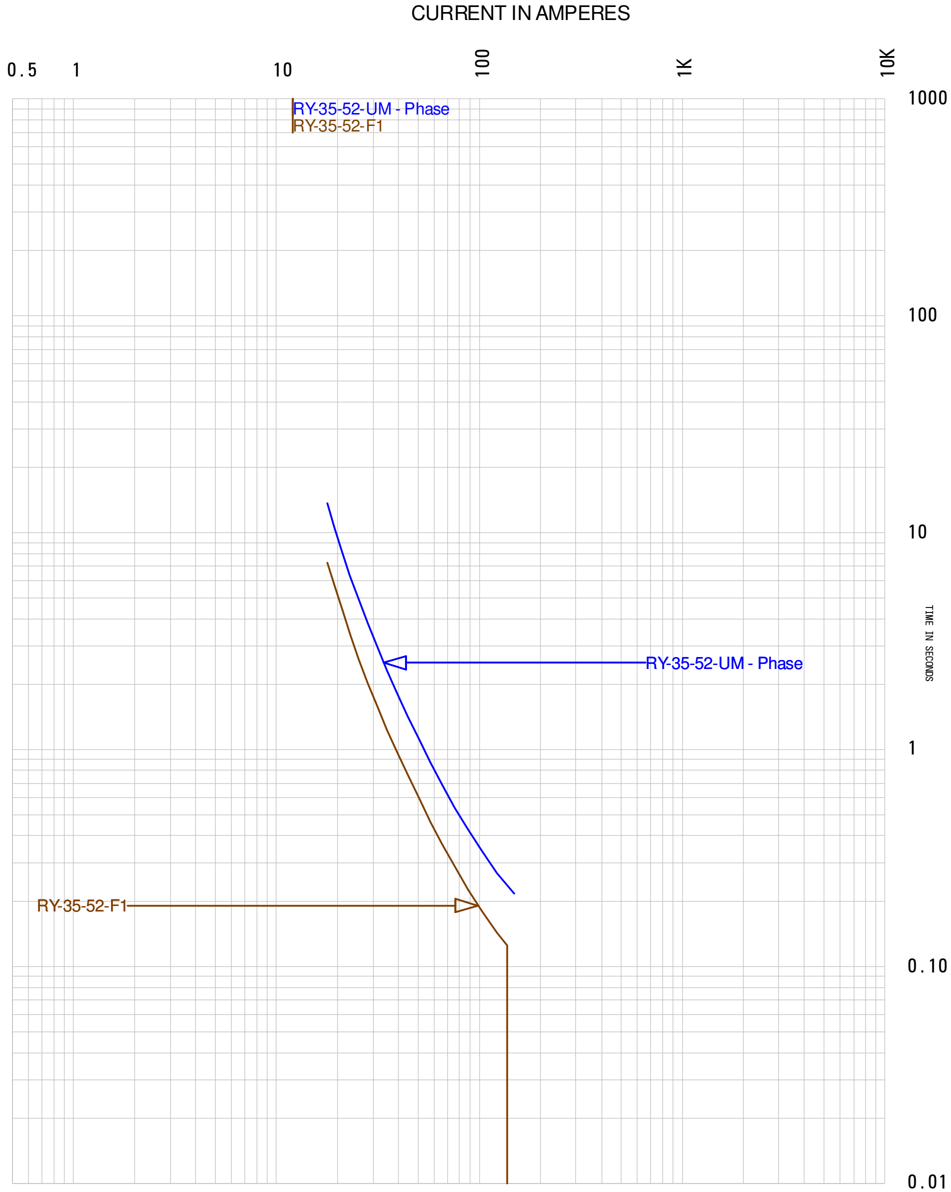




RECOMMENDED TCC-001-GENERATOR G1
Project: WJ Hooper
Client: Crowder Construction Company

March 9, 2022
Ref.: 1075681

VERTIV



RY-35-52-UM
SEL
751A
2000 / 5 A
Settings
Phase
51P1P, (0.5-16 x CTR) 3 (1200A)
U4, Extremely Inverse 3.0
50P1P, (0.5-100 x CTR) 69 (27600A)
50P1D, (0.001 - 5s) 0.001 sec
Ground
51G1P, (0.5-16 x CTR) 1.25 (500A)
U2, Inverse 2.17
50G1P, (0.5-100 x CTR) 20 (8000A)
50G1D, (0.001 - 5s) 0.001 sec

35-52-UM
SQUARE D
VR
Settings

35MVATS
4160V

35-52-F1
SQUARE D
VR
Settings

RY-35-52-F1
SEL
751A
2000 / 5 A
Settings
51P1P, (0.5-16 x CTR) 3 (1200A)
U4, Extremely Inverse 1.59
50P1P, (0.5-100 x CTR) 34.5 (13800A)
50P1D, (0.001 - 5s) 0.001 sec

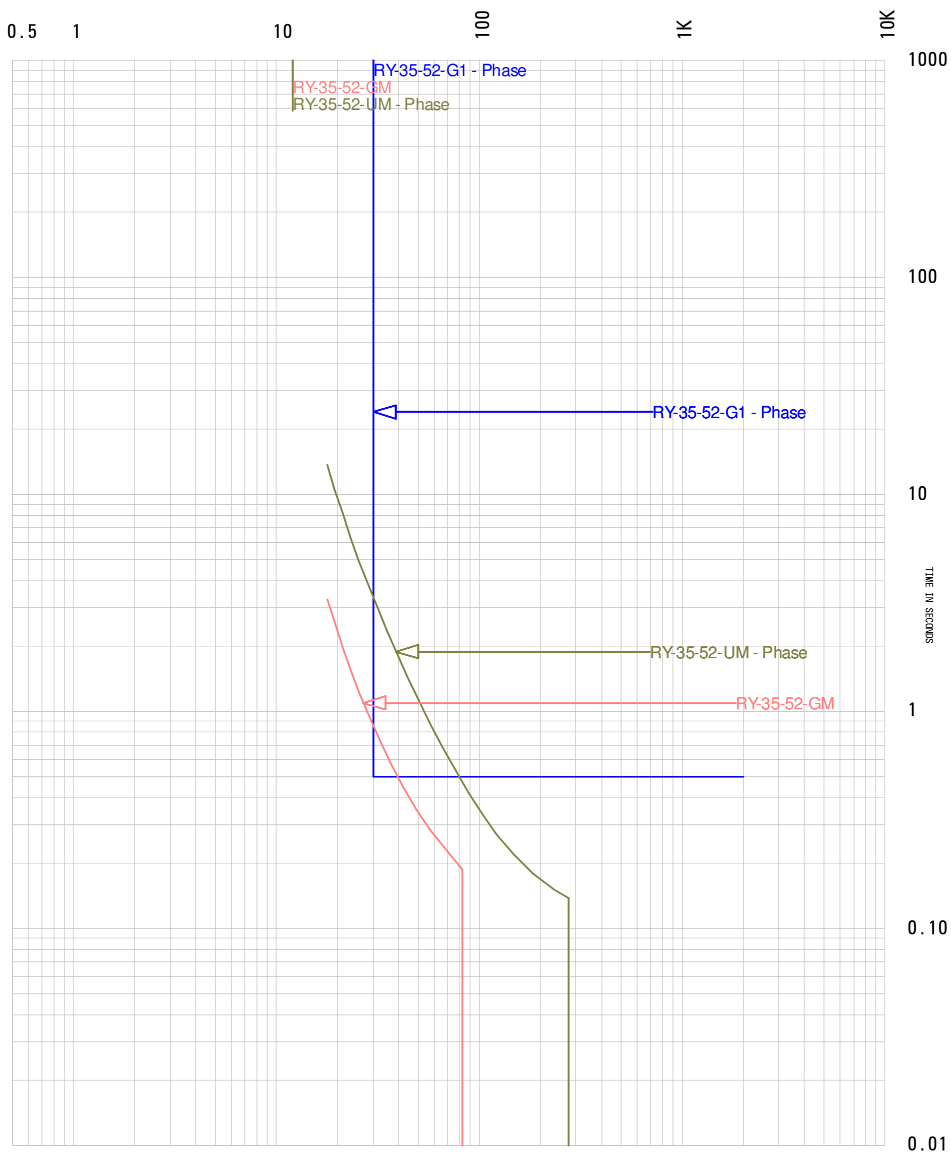
Actual Current = Displayed Current x 100 at 4160 V

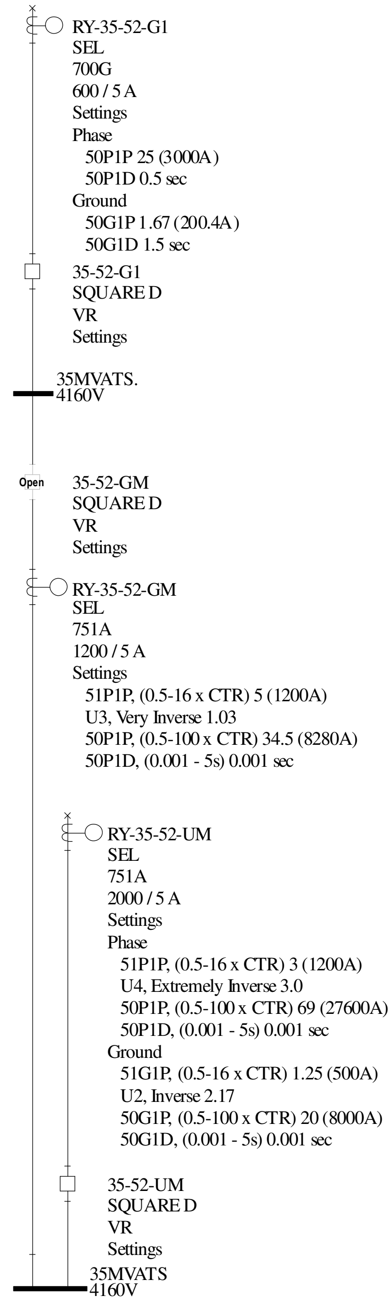
RECOMMENDED TCC-002-35-MVATS-52-F1
Project: WJ Hooper
Client: Crowder Construction Company

March 9, 2022
Ref.: 1075681

VERTIV

CURRENT IN AMPERES



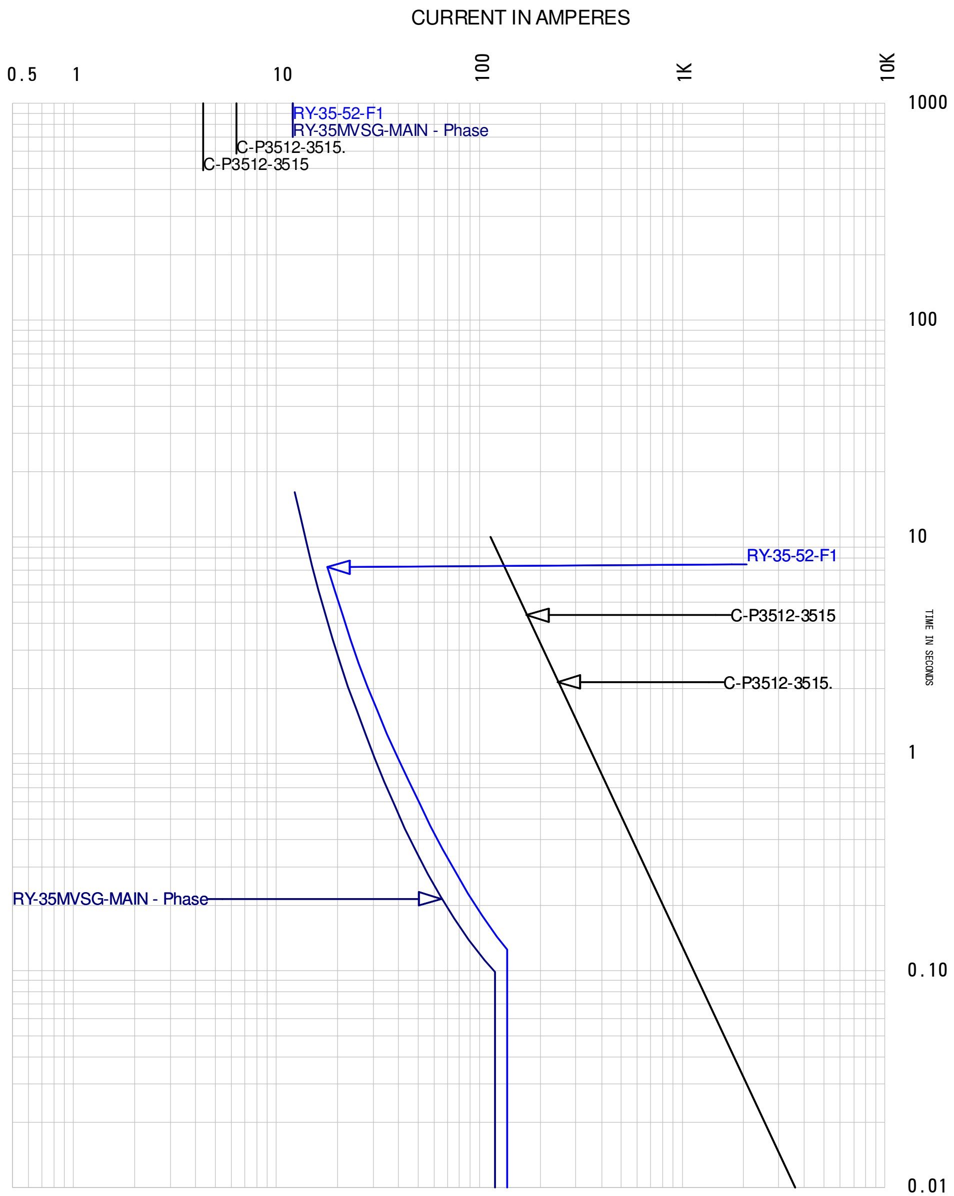


Actual Current = Displayed Current x 100 at 4160 V

RECOMMENDED TCC-003-35-MVATS-TIE
Project: WJ Hooper
Client: Crowder Construction Company

March 9, 2022
Ref.: 1075681

VERTIV



Actual Current = Displayed Current x 100 at 4160 V

35-52-F1
SQUARE D
VR
Settings

RY-35-52-F1
SEL
751A
2000 / 5 A
Settings
51P1P, (0.5-16 x CTR) 3 (1200A)
U4, Extremely Inverse 1.59
50P1P, (0.5-100 x CTR) 34.5 (13800A)
50P1D, (0.001 - 5s) 0.001 sec

C-P3512-3515
4-500/ph Copper
50ft
1748A

MH-MV1
4160V

C-P3512-3515.
4-500/ph Copper
50ft
2552A

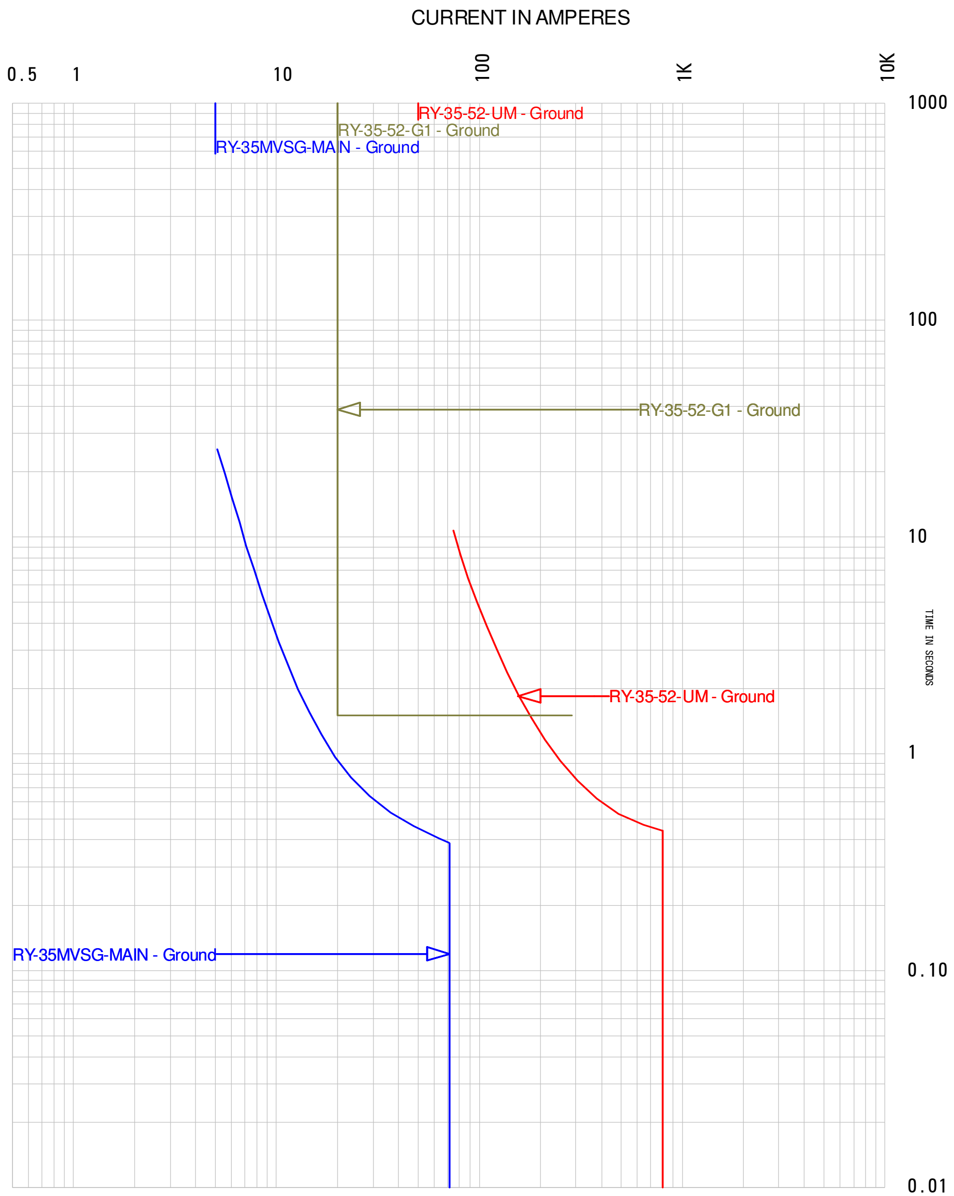
35MVSG-MAIN
SQUARE D
VR
Settings

RY-35MVSG-MAIN
GE MULTILIN
750
1200 / 5 A
Settings
Phase
Phase OC PU 1 (1200A)
Ext Inverse 1; 1 (S;M)
Phase Inst OC PU 10 (12000A)
Ground
Ground OC PU 1 (50A)
IAC Very Inv 2.72; 1 (S;M)
Ground Inst OC PU 14.29 (714.5A)

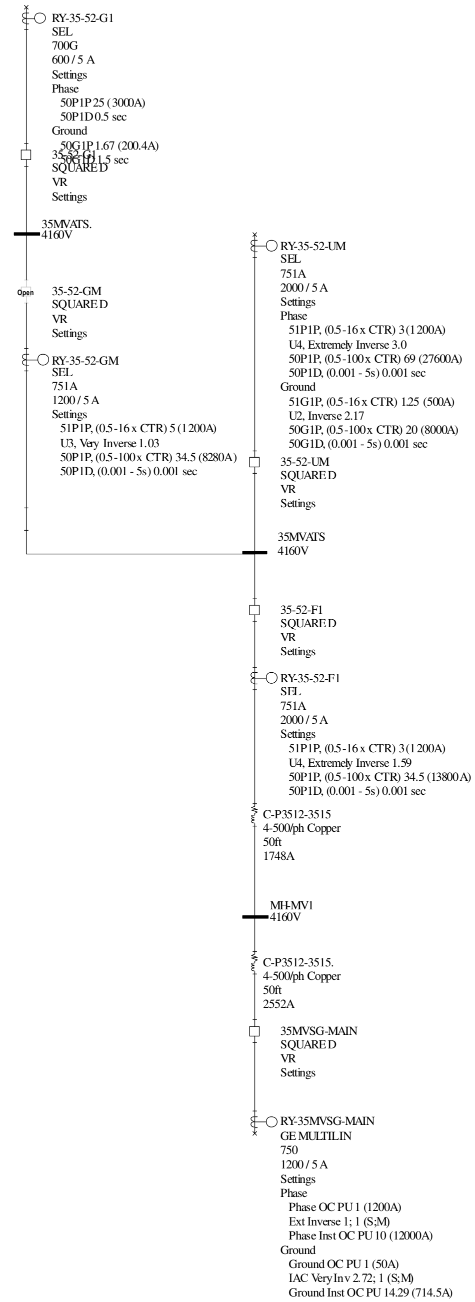
RECOMMENDED TCC-004-35-52-F1
Project: WJ Hooper
Client: Crowder Construction Company

March 9, 2022
Ref.: 1075681

VERTIV



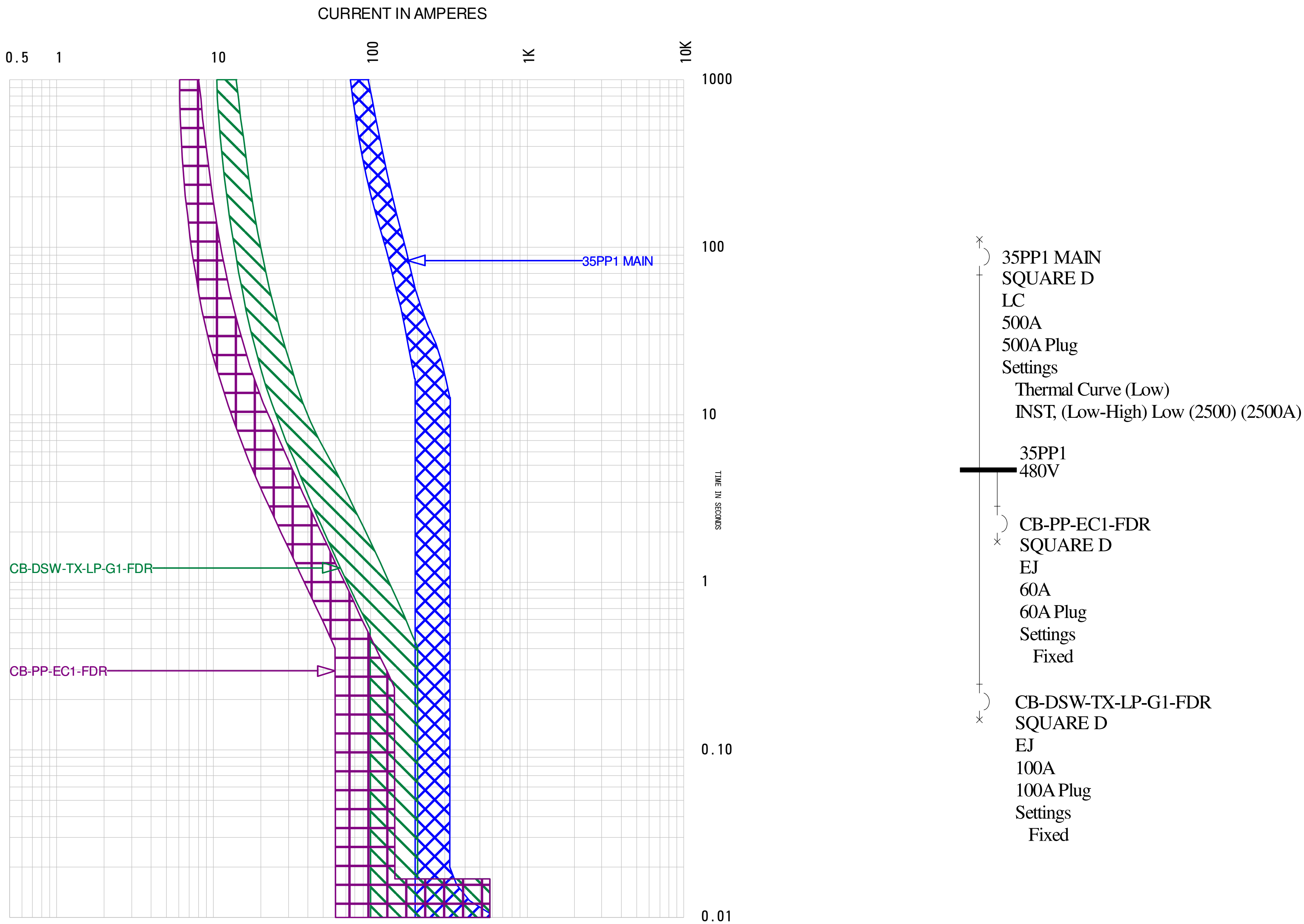
Actual Current = Displayed Current x 10 at 4160 V



RECOMMENDED TCC-005-35-52-UM-GROUND
Project: WJ Hooper
Client: Crowder Construction Company

March 9, 2022
Ref.: 1075681

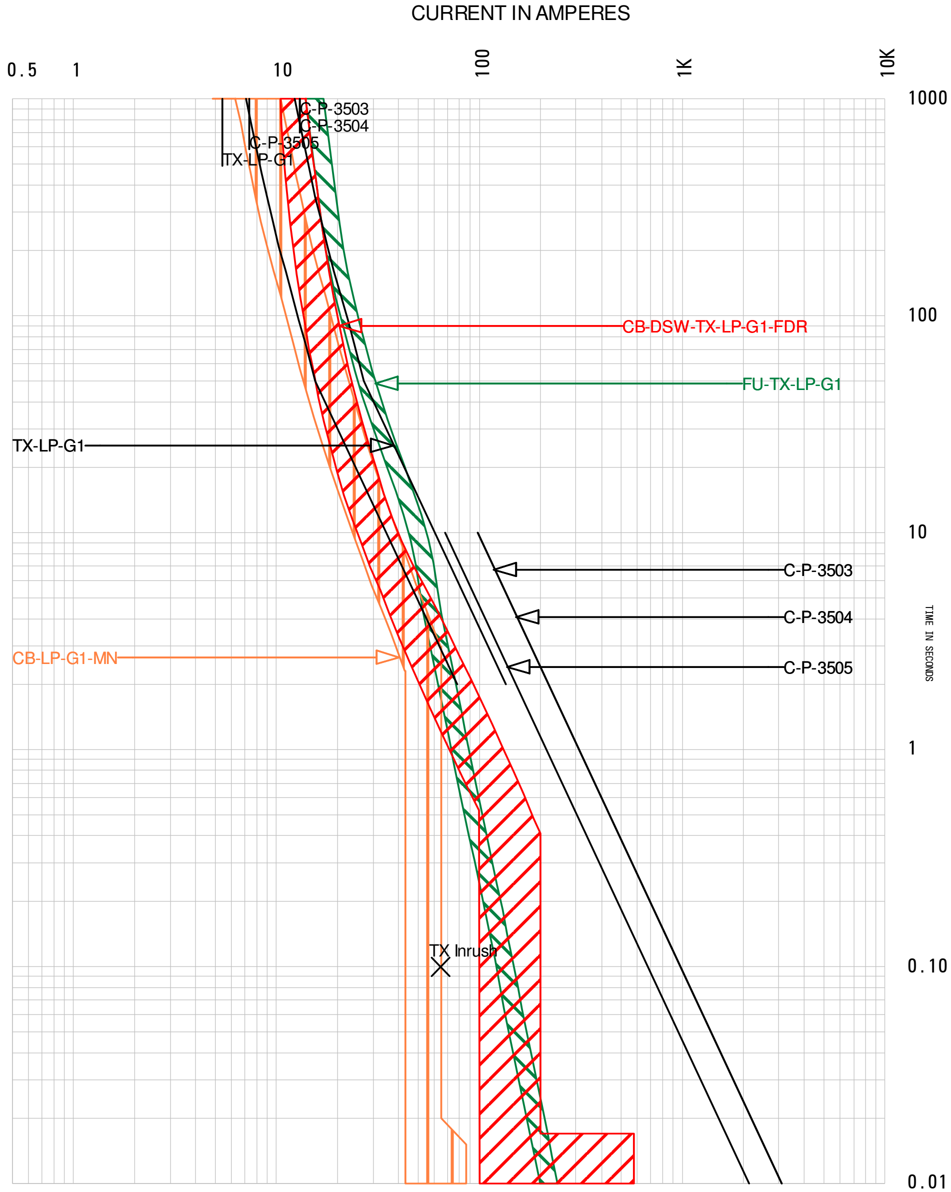
VERTIV

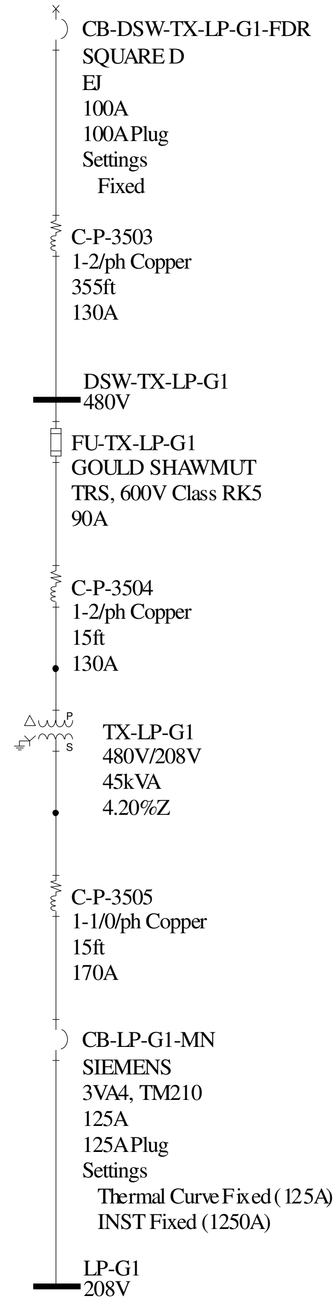


Actual Current = Displayed Current x 10 at 480 V

RECOMMENDED TCC-006-35PP1
Project: WJ Hooper
Client: Crowder Construction Company

March 9, 2022
Ref.: 1075681



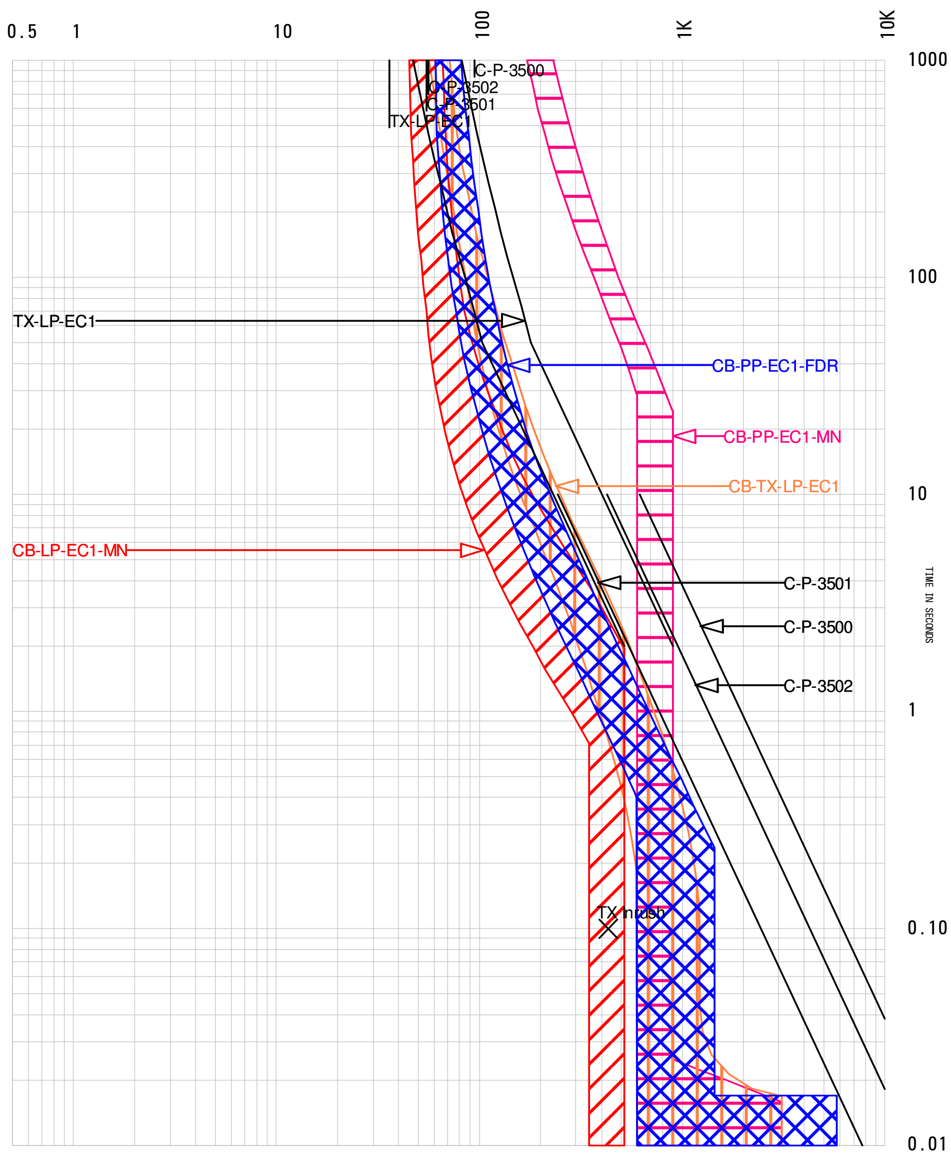


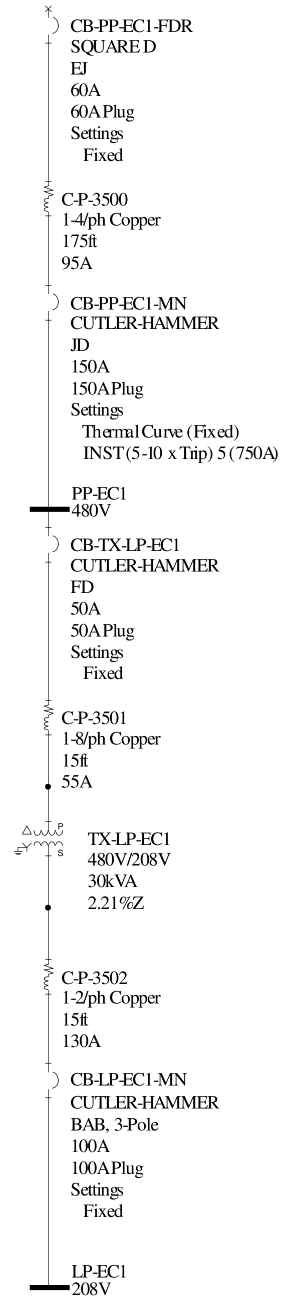
Actual Current = Displayed Current x 10 at 480 V

RECOMMENDED TCC-007-TX-LP-G1
Project: WJ Hooper
Client: Crowder Construction Company

March 9, 2022
Ref.: 1075681

CURRENT IN AMPERES





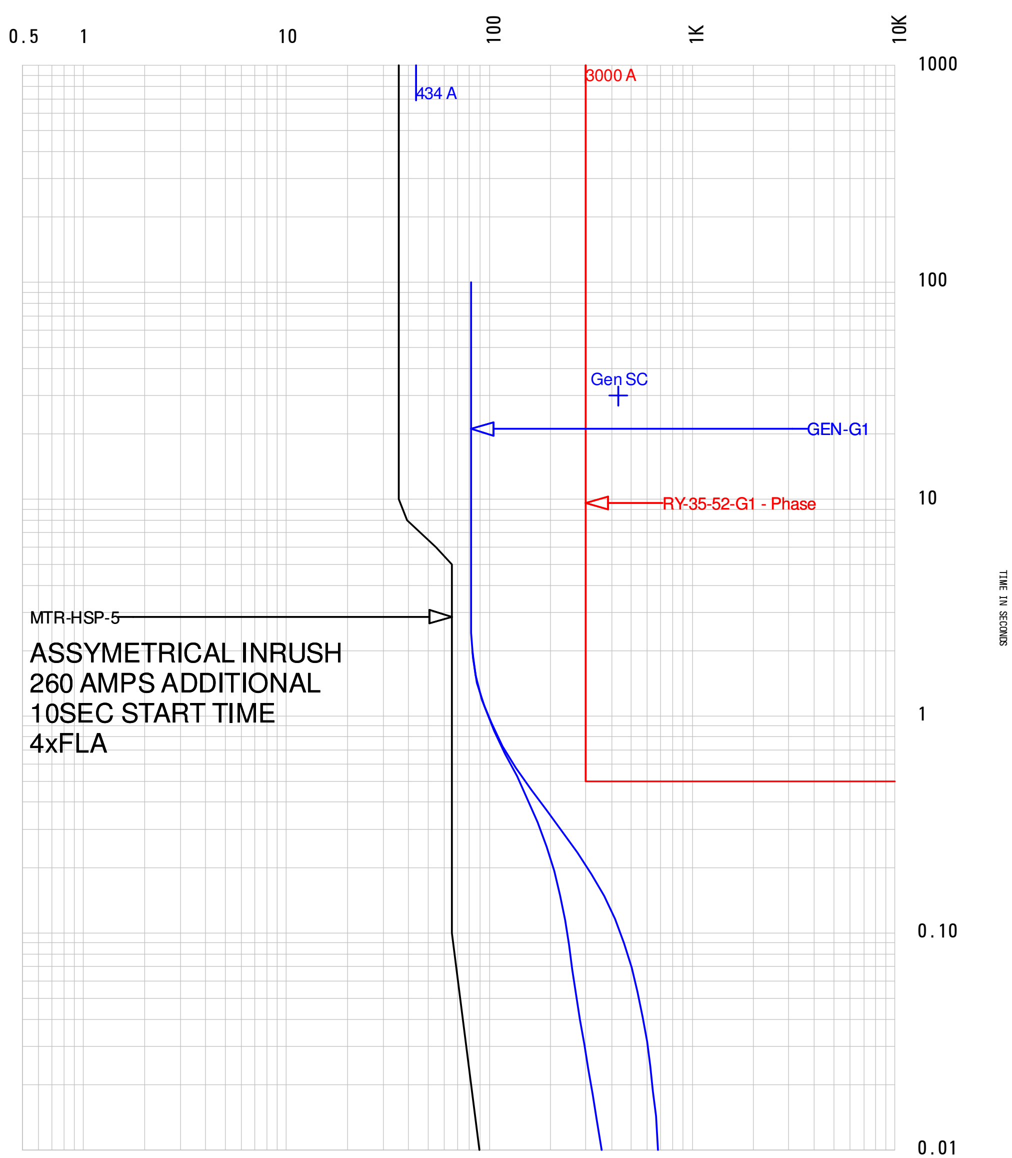
Actual Current = Displayed Current x 1 at 480 V

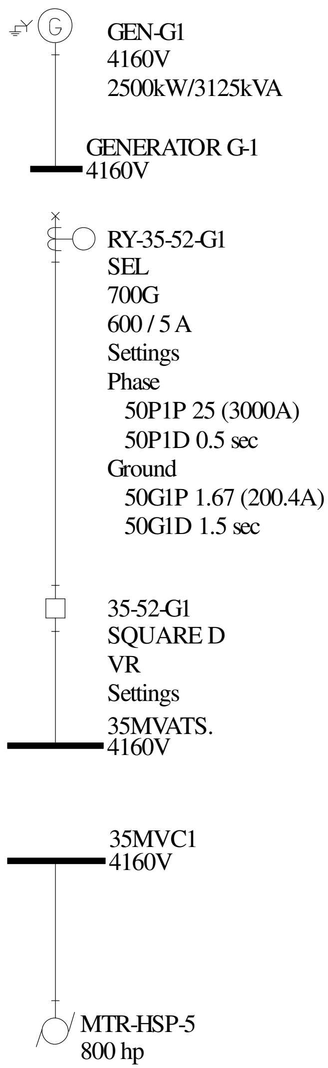
RECOMMENDED TCC-008-TX-LP-EC1
Project: WJ Hooper
Client: Crowder Construction Company

March 9, 2022
Ref.: 1075681

VERTIV

CURRENT IN AMPERES





Actual Current = Displayed Current x 10 at 4160 V

RECOMMENDED TCC-GENERATOR STARTUP
Project: WJ Hooper
Client: Crowder Construction Company

March 10, 2022
Ref.: 1075681

VERTIV

APPENDIX 9

ARC FLASH DATA/SUMMARY

Arc Flash Summary

Hazard Level	***Count***	***Percentage***	***PPE***
0 - 1.2 cal/cm²	1	7%	Long sleeve shirt & pants or coverall (nonmelting or untreated natural fiber), safety glasses/goggles, leather gloves, hearing protection
1.2 - 12 cal/cm²	11	79%	Arc-rated (AR) long sleeve shirt & AR pants or AR coverall or AR flash suit, AR face shield & AR balaclava or AR flash suit hood, hard hat, safety glasses/goggles, hearing protection, leather gloves, leather footwear
>12 cal/cm²	2	14%	Arc-rated (AR) long sleeve shirt & AR pants or AR coverall and/or AR flash suit, AR flash suit hood, AR gloves, hard hat, safety glasses/goggles, hearing protection, leather footwear
Inadequate	0	0%	Overdutied equipment from the short-circuit evaluation
Total:	***14***	***100%***	

Date: March 9, 2022

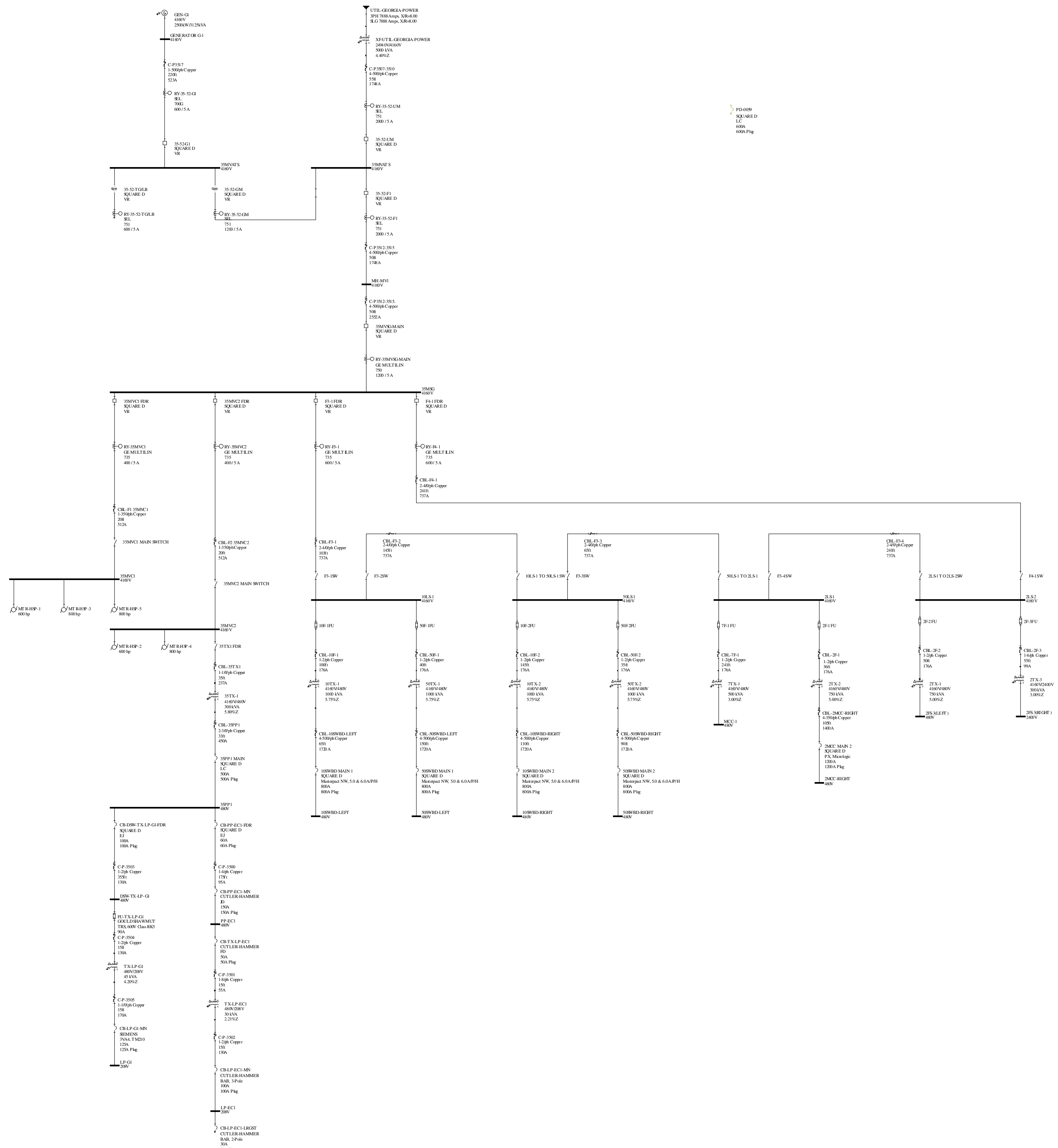
Arc Flash Table
(Based on Recommended settings)

ERS # 1075681 **Client:** Crowder Construction Company **Project:** WJ Hooper

Bus Name	Protective Device Name	Voltage (V)	Bus Bolted Fault (kA)	Prot Dev Bolted Fault (kA)	Prot Dev Arcing Fault (kA)	Trip/Delay Time (sec)	Equip Type	Electrode Config	Box Width (in)	Box Height (in)	Box Depth (in)	Gap (mm)	Glove Class	Arc Flash Boundary (in)	Working Distance (in)	Limited Approach (in)	Restricted Approach (in)	Scenario	Incident Energy (cal/cm^2)	PPE Level
10LS-1	RY-35MVSG-MAIN	4,160	14.710	11.590	10.220	0.117	SWG	HCB	36	36	36	104	1	89	36	60	26	Normal	5.66	1.2 - 12 cal/cm²
2LS-1	RY-F4-1	4,160	14.490	5.710	5.030	1.049	SWG	HCB	36	36	36	104	1	89	36	60	26	Normal	5.63	1.2 - 12 cal/cm²
2LS-2	RY-F3-1	4,160	14.540	4.410	3.890	1.167	SWG	HCB	36	36	36	104	1	89	36	60	26	Normal	5.64	1.2 - 12 cal/cm²
35MSG (LineSide)	RY-35-52-F1	4,160	14.900	11.740	10.080	0.186	SWG	HCB	36	36	36	104	1	103	36	60	26	Normal	7.33	1.2 - 12 cal/cm²
35MVATS (LineSide)	MaxTripTime @2.0s	4,160	14.950	11.800	10.430	2.000	SWG	HCB	36	36	36	104	1	324	36	60	26	Normal	51.95	>12 cal/cm²
35MVC1	RY-35MVC1	4,160	6.010	4.110	3.640	1.917	MCC	HCB	26	26	26	104	1	93	36	60	26	Emergency	6.11	1.2 - 12 cal/cm²
35MVC2	RY-35MVC2	4,160	6.010	4.740	4.200	1.917	MCC	HCB	26	26	26	104	1	93	36	60	26	Emergency	6.11	1.2 - 12 cal/cm²
35PP1 (LineSide)	RY-35MVC2	480	5.790	5.300	4.160	1.917	PNL	VCBB	20	20	9	25	00	91	18	42	12	Normal	22.51	>12 cal/cm²
50LS-1	RY-F4-1	4,160	14.530	4.530	4.000	1.152	SWG	HCB	36	36	36	104	1	89	36	60	26	Normal	5.63	1.2 - 12 cal/cm²
DSW-TX-LP-G1	CB-DSW-TX-LP-G1-FDR	480	2.580	2.580	1.760	0.537	PNL	VCBB	20	20	9	25	00	24	18	42	12	Normal	2.06	1.2 - 12 cal/cm²
GENERATOR G-1	MaxTripTime @2.0s	4,160	6.000	1.300	1.150	2.000	SWG	HCB	36	36	36	104	1	91	36	60	26	Emergency	5.85	1.2 - 12 cal/cm²
LP-EC1	CB-PP-EC1-FDR	208	2.360	2.360	1.100	2.000	PNL	VCBB	20	20	9	25	00	37	18	42	12	Normal	4.42	1.2 - 12 cal/cm²
LP-G1	CB-LP-G1-MN	208	1.980	1.980	0.920	2.000	PNL	VCBB	20	20	9	25	00	33	18	42	12	Normal	3.64	1.2 - 12 cal/cm²
PP-EC1	CB-PP-EC1-FDR	480	3.110	3.110	2.410	0.017	PNL	VCBB	20	20	9	25	00	4	18	42	12	Normal	0.09	0 - 1.2 cal/cm²

APPENDIX 10

ANALYSIS MODEL ONE-LINE DIAGRAM



Drawing: 1Line001
Project: WJ Hooper
Client: Crowder Construction Company

February 15, 2022
Ref.: 1075681