Qulliq Energy Corporation

Qulliq Energy Corporation
Société d'énergie Qulliq
Qulliq Alruyaktuqtunik Ikumatjutiit

Application for Major Project Permits

MAJOR PROJECT FOR
CAMBRIDGE BAY DISTRIBUTION SYSTEM UPGRADE

February 2026

Executive Summary

Qulliq Energy Corporation (QEC) hereby applies to the Minister Responsible for Qulliq Energy Corporation pursuant to section 18.1 of the *Qulliq Energy Corporation Act*, R.S.N.W.T. 1988, c.N-2 for a major project permit to upgrade the feeder distribution system interconnecting the new power plant to the community of Cambridge Bay.

QEC is in the process of building a new power plant in Cambridge Bay with the approval of a major project permit (MPP) by the Minister responsible for QEC in August 2021 replacing the existing power plant which was constructed in 1958. The plant is expected to come in-service in 2029.

The current Cambridge Bay distribution system is fed from the existing generation plant that consists of three 1100kW and one 550kW generators with an output voltage of 4.16kV. All generators are connected to a common switchgear bus and are used to provide power to four community feeders. The switchgear is also used to provide power to other service loads. In order to improve customer power supply reliability, feeders are interconnected via a set of normally open switches. Any of these switches may be closed in the case when one of the feeder breakers is out of duty due to failure or maintenance purposes.

In the 2021 MPP application, QEC discussed that a single supply line without any alternative means of transmission would create a high risk of power interruption to the community, especially in areas with high winds and extreme cold temperatures. Accordingly, the new power plant construction scope included installation of a second line that increases reliability of the power supply and provides an alternative for electricity transmission from the plant to the community.

The proposed distribution upgrade will interconnect the new power plant to the existing community feeders via the new distribution line. The project scope has been developed with consideration of future load growth and meeting other system requirements in the community and includes the following:

- Install 4.16 kV switchgear and two 4.16/25 kV, 5 MVA, step-up transformers in the new power plant
- Construct a new substation at the North yard on the north side of Cambridge Bay comprising of one 25 kV switchgear, two 25/4.16 kV 5 MVA step-down transformers, and one 4.16KV switchgears. Existing two 25/4.16 kV 5 MVA step-down transformers from the existing power plant location shall to relocated and re-used at this new substation.
- Run two 4/0 3-phase overhead feeder lines at 25KV from the new power plant on different pole lines, interconnecting closer to town to the new substation at the North Yard on the northside of Cambridge Bay.

- Connect the existing town distribution feeders to the new power plant and substations per below:
    - Feeder 1: Will be connected to the 4.16kV switchgear in the new substation using approximately 130m of underground cables
    - Feeder 2: Will be connected to the 4.16kV switchgear in the new power plant using approximately 60m of underground cables
    - Feeder 3: Will be connected to the 4.16kV switchgear in the new substation using approximately 650m of overhead lines
    - Feeder 4: Will be connected to the 4.16kV switchgear in the new substation using approximately 1300m of overhead lines
- Perform load switching to balance loads around the feeders.

QEC's estimated cost to complete this project is $11.6 million. This would result in an estimated 0.46 cents/kWh increase in revenue requirement by the time the project is fully in service. The project will have no impact on rates until the time of QEC's first General Rate Application following the project in-service date.

The project is anticipated to be completed by the 2029/30 fiscal year.

Table of Contents

List of Tables

List of Figures

1.0 Application

Qulliq Energy Corporation (QEC) hereby applies to the Minister Responsible for Qulliq Energy Corporation pursuant to Section 18.1 of the *Qulliq Energy Corporation Act*, R.S.N.W.T. 1988, cN-2 for a major project permit to upgrade the feeder distribution system interconnecting the new power plant to the community of Cambridge Bay. QEC is requesting permission to proceed with this project. Details in support of the requested project permit are set out below.

2.0 Background

2.1 Project Background

Cambridge Bay is a hamlet located on Victoria Island in the Kitikmeot Region of Nunavut. The community had a population of 1,760 in the 2021 census. Access is mainly by air through the Cambridge Bay Airport and by sealift during the summer shipping season.

The location of the community is shown in Figure 2.1.

Figure 2.1 – Cambridge Bay Location

QEC is in the process of building a new power plant in Cambridge Bay, which was granted a major project permit by the Minister responsible for QEC in August 2021, replacing the existing power plant which was constructed in 1958. The plant is expected to come in-service in 2029.

The current Cambridge Bay distribution system is fed from the existing generation plant that consists of three 1100 kW and one 550 kW generators with an output voltage of 4.16kV. All generators are connected to a common switchgear bus and are used to provide power to four community feeders. The switchgear is also used to provide power to other service loads. In order to improve customer power supply reliability, feeders are interconnected via a set of normally open switches. Any of these switches may be closed in the case when one of the feeder breakers is out of duty due to failure or maintenance purposes.

In the 2021 MPP application, QEC discussed that a single supply line without any alternative means of transmission would create a high risk of power interruption to the community, especially in areas with high winds and extreme cold temperatures. Accordingly, the new power plant construction scope included installation of a second line that increases reliability of the power supply and provides an alternative for electricity transmission from the plant to the community.

In 2024, QEC engaged an independent engineering consulting company (Asher Engineering) to undertake a review of options to interconnect the new power plant to the existing community feeders via the new distribution line.

3.0 Assessment of Project Options

In accordance with QEC’s request, the consultant performed technical analysis of various tie-in options of the new power plant to the existing community feeders, including:

- **Option 1:** Run two 5 kV feeder circuit lines from the new power plant to the existing distribution system. Tie in to the nearest feeder point and reduce the four feeders to two feeders within the existing distribution system.
- **Option 2:** The four existing community feeders are connected to the new power plant via new 5 kV transmission lines, which includes changing all the single-phase power lines between Feeder 2 poles to be three-phase.
- **Option 3:** Run two 25 kV feeder circuit lines from the new power plant (with two 5 MVA step-up transformers) to the existing distribution system (with two 5 MVA step-down transformers).
- **Option 4:** Run two 25 kV feeder circuit lines from the new power plant (with two 5 MVA step-up transformers) to the to the North Yard location (with two 5 MVA step-down transformers and 5 kV switchgear).
- **Option 5:** Upgrade all customers’ transformers to have 25 kV primary voltage.

Since the new power plant is located in a considerably remote location that is far from the existing power plant location, the analysis of options focused on optimizing the following criteria:

- Minimizing the voltage drop across the lines. The voltage drop should not exceed 3% from the generators to each individual consumer.
- Minimizing the network active power losses.

Network model and simulation parameters were set based on the following inputs:

- **Electrical Transient Analyzer Program (ETAP) Model:** The ETAP model used was based on the model developed by Asher Engineering for the QEC Penetration Study. The model of the power plant was updated to reflect the topology of the new plant.
- **One-line Diagrams:** The network model was built using the one-line diagrams provided by QEC, which were also used to obtain the connected load and phase connection of each customer.
- **Generation Forecast:** Generation estimates for 2026-2066 period were used for feeder sizing, voltage drop, and network losses calculations.

The study used generation forecast for the years from 2026 to 2066 to calculate the demand load and demand factor for each feeder. These demand factors were applied to calculate the minimum feeder size that is required to achieve a maximum voltage drop of 3% at the customer transformer under each option.

The initial study by Asher Engineering, included in Appendix A, concluded that the option 4 preferred by QEC as presented did not accommodate the load forecast up to the year 2066, and that the off-line tap changers of both step up and step down transformers needed to be adjusted to mitigate the voltage drop due to future load increase.

Upon reviewing the initial study by Asher Engineering, QEC requested the consultant to investigate the feasibility to implement an alternative approach for voltage drop mitigation. The alternative approach involves the use of Automatic Voltage Regulators (AVRs) that are strategically placed at different parts of the network in order to maintain the voltage drop within the ±3% voltage limits while keeping the network losses at a minimum. In addition, alternatives for tie-in of Feeder 2 were considered. The alternative approach study is included in Appendix B.

The proposed distribution upgrade project will interconnect the new power plant to the existing community feeders via the new distribution line. The project scope has been developed with consideration of future load growth and meeting other system requirements in the community and includes the following:

- Install 4.16 kV switchgear and two 4.16/25 kV, 5 MVA, step-up transformers in the new power plant
- Construct a new substation at the North yard on the north side of Cambridge Bay comprising of one 25 kV switchgear, two 25/4.16 kV 5 MVA step-down transformers, and one 4.16KV switchgears. Existing two 25/4.16 kV 5 MVA step-down

transformers from the existing power plant location shall to relocated and re-used at this new substation.

- Run two 4/0 3-phase overhead feeder lines at 25KV from the new power plant on different pole lines, interconnecting closer to town to the new substation at the North Yard on the northside of Cambridge Bay.
- Connect the existing town distribution feeders to the new power plant and substations per below:
  - Feeder 1: Will be connected to the 4.16kV switchgear in the new substation using approximately 130m of underground cables
  - Feeder 2: Will be connected to the 4.16kV switchgear in the new power plant using approximately 60m of underground cables
  - Feeder 3: Will be connected to the 4.16kV switchgear in the new substation using approximately 650m of overhead lines
  - Feeder 4: Will be connected to the 4.16kV switchgear in the new substation using approximately 1300m of overhead lines
- Perform load switching to balance loads around the feeders.

The estimated cost to complete this project is $11.567 million. The project is anticipated to be completed by the 2029/30 fiscal year.

4.0 Impact of the Project on Ratepayers

QEC conducted an analysis of the impact of the project on ratepayers. It should be noted that the project will have no impact on rates until the time of QEC's General Rate Application following the project coming in-service. QEC conducted the rate impact analysis based on a territorial rate design assuming the project is completed by the 2029/30 fiscal year.

The rate impact analysis is based on QEC's estimated cost for this project of $11.567 million.

Table 4.1 summarizes the estimated incremental revenue requirement increase due to the project of $11.567 million. The estimated rate increase under territory-wide rates is 0.46 cents/kWh.

Table 4.1 Distribution Line Upgrade Project Estimated Rate Impact

Project Characteristics	
Capital Cost ($000)	11,567
Amortization Period (year)	45
2025/26 GRA Approved Return on Ratebase	5.95%
Revenue Requirement Impacts	
Amortation Expense ($000)	257
Return on Ratebase ($000)	689
sub-total: Revenue Requirement Increase ($000)	**946**
Total Revenue Requirement Impact ($000)	**946**
2029/30 Forecast Sales (MWh)	204,578
Average Territorial Rate Increase (c/kWh)	0.46

It is important to note that this analysis has been provided for illustrative purposes only. Actual rate impacts will depend on the overall revenue requirements and rate designs approved in subsequent General Rate Applications.

5.0 Grounds in Support of the Application

The implementation of the proposed project is very important to QEC's customers. The project will provide a stable, cost effective, safe, and reliable service to the community of Cambridge Bay and support the new power plant operation.

Power is an essential service in Nunavut, and QEC must plan to be able to deliver reliable electricity.

6.0 Project Timelines

Based on QEC's experience with procurement, delivery of materials and construction windows, this project is anticipated to be completed by the 2029/30 fiscal year.

Engineering Study
Final Report

Title	**Cambridge Bay Power Plant Feeder Distribution Line Studies**
Document No.	2401E001ST Cambridge Bay
Revision	Rev C
Date	November 8, 2024
Executor	Ahmed Abdelfattah, P.Eng.
Reviewed By	Dwight Alfrey, P.Eng.

Revision History

			Asher Engineering Ltd.			Qulliq Energy Corporation
Rev No.	Date	Description	Created By (Initials)	Checked by (Initials)	Approval (Name and Signature)	Received by (Name and Signature)
C	Nov. 8/24	Issued for Use	AA	SW	Dwight Alfrey P.Eng.	
					Brent Taylor P.Eng.	

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November 8, 2024

THE ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS and GEOPHYSICISTS OF THE NORTHWEST TERRITORIES
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P 361
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Table of Contents

List of Tables

Appendices

Executive Summary

Qulliq Energy Corporation (QEC) currently delivers electricity to approximately 15,000 customers in 25 communities across Nunavut using 25 standalone diesel power plants with total installed capacity of 76MW. Each community has its own independent generation and distribution system that does not have any backup from the utility grid.

QEC is planning to de-commission the existing Cambridge Bay Community power plant and build a new power plant on the south-west side of the community to provide sufficient energy to this community. Due to the remote location of the new power plant, different approaches for connecting the existing community feeders to the new power plant need to be studied.

QEC proposes five (5) options to tie-in the new power plant to the existing community feeders. Additionally, Asher has proposed rearrangements for some of these options to improve the voltage drop. These options are summarized as below:

Option 1 involves the following:

- Feeders 1 and 4 and Feeders 2 and 3 are combined into two (2) feeders.
- Two (2) new 5kV power lines are installed from the new power plant to these two feeders to tie in at the nearest locations for Feeders 1 and 2.

Option 2 involves the following:

- The four existing community feeders are connected to the new power plant using new 5kV power lines to tie in at the nearest location for each feeder.

Option 3 involves the following:

- Two (2) 4.16/25kV, 5MVA, step-up transformers are installed at the new power plant and connected via cables to the new generator distribution switchgear.
- Two (2) 25/4.16kV, 5MVA, step-down transformers with Main-Tie-Main, 5kV, switchgear are installed at the existing power plant and connected to the step-up transformers via two (2) 25kV power lines.
- The 5kV switchgear at the existing power plant is connected via four (4) new 5kV power lines to tie in at the nearest locations to the existing community feeders such that two feeders are connected to each switchgear section.

Option 3A, proposed by Asher, is similar to QEC Option 3 except that feeders are redistributed with one feeder connected to one switchgear section, while the other three feeders are connected to the other switchgear section.

Option 3B, proposed by Asher, is an alternative approach for using Option 3 where Feeder 2 is connected directly to the new switchgear in the new power plant.

Option 4 involves the following:

- Two (2) 4.16/25kV, 5MVA, step-up transformers are installed at the new power plant and connected via cables to the new generator distribution switchgear.

- Two (2) 25/4.16kV, 5MVA, step-down transformers with Main-Tie-Main, 5kV, switchgear are installed at the North Yard and connected to the step-up transformers via two (2) 25kV power lines.
- The 5kV switchgear at the North Yard is connected via four (4) new 5kV power lines to tie in at the nearest locations the existing community feeders.

Option 5 involves the following:

- Two (2) 4.16/25kV, 5MVA, step-up transformers are installed at the new power plant and connected via cables to the new generator distribution switchgear.
- Upgrade all existing community transformers to have 25kV primary voltage.
- Feeders 1 and 3 and Feeders 2 and 4 are combined into two (2) feeders and connected to the step-up transformers, via an intermediate Main-Tie-Main switchgear, at the nearest location.

The above options are discussed in detail in Section 1.3. The single-line diagrams showing the network topology for each option are included in Appendices 1.A to 1.G.

The scope of the study is to calculate the maximum voltage drop and network active power losses for each community feeder, considering each of the tie-in options and provide the option that will offer the minimum voltage drop and network losses. Additionally, the study will recommend the minimum feeders sizes required to tie-in the new power plant to the existing feeders under each option in order to achieve a maximum voltage drop of 3%.

The study considers the estimated electricity production for the years from 2026 to 2066 as shown in Appendix 2.

Recommendations provided by this study consider technical aspects only. Construction cost estimates associated with each option are presented in a separate report.

Table 3 summarizes the study results.

Table 3: Study Results Summary

Option	Operating Scenario	Min Main Feeder Line Size				Main Line Size	Transformer Tap Settings		Remarks
		Feeder 1	Feeder 2	Feeder 3	Feeder 4		Step-up Transformers	Step-Down Transformers	
1		Failed							
2		Failed							
3	A	Failed							
	B	4/0 AWG	4/0 AWG	4/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
3A	A	Failed							
	B	1/0 AWG	3/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
3B	A	2/0 AWG	1/0 AWG	2/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
	B	4/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
4	A	Failed							
	B	Failed							
5	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	-5%	N/A	
	B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	-2.5%	N/A	

Scenario A: All feeders are fed from one step-up transformer
Scenario B: Feeders are distributed across both step-up transformers

1. Introduction

1.1 Background

Qulliq Energy Corporation (QEC) currently delivers electricity to approximately 15,000 customers in 25 communities across Nunavut using 25 standalone diesel power plants with total installed capacity of 76MW. Each community has its own independent generation and distribution system that does not have any backup from the utility grid.

QEC is planning to de-commission the existing Cambridge Bay Community power plant and build a new power plant on the south-west side of the community to provide sufficient energy to this community. Due to the remote location of the new power plant, different approaches for connecting the existing community feeders to the new power plant need to be studied.

1.2 Scope of Work

The estimated electricity production for the years from 2026 to 2066, shown in Appendix 2, is used to calculate the maximum voltage drop and network active power losses for each community feeder, when each of the tie-in options is utilized and provide the option that will offer the minimum voltage drop and network losses. Additionally, the study will recommend the minimum feeders sizes required to tie-in the new power plant to the existing feeders under each option in order to achieve a maximum voltage drop of 3%.

1.3 Tie-In Options

In order to connect the new power plant to the existing community feeders, QEC proposed five (5) options to be considered. Additionally, upon further study of the load behavior when connected to the network, Asher proposed two alternative implementations of Option 3. The different options are detailed below.

1.3.1 Option 1

Run two (2) x 5kV feeder circuit lines from the new power plant to the existing distribution system. Tie in to the nearest feeder point and reduce the four (4) feeders to two (2) feeders within the existing distribution system.

- Feeders 1 and 4 are combined into one feeder by connecting the lines at Poles 50101001 in Feeder 1 and 50104002 in Feeder 4.
- Feeders 2 and 3 are combined into one feeder by connecting the lines at Pole 50102008.
- Connect the new combined feeders to the main 4.16kV switchgear at the new power plant using a new 5kV transmission line.

  The nearest tie-in location is at Pole 50104003 in Feeder 4 and Pole 50102268 in Feeder 2. This will require changing all the single-phase power lines between Poles 50102268 and 50102135 to be three-phase.

1.3.2 Option 2

The four (4) existing community feeders are connected to the new power plant via new 5kV transmission lines. The tie-in location for each feeder is as below:

- For Feeder 1: Pole 50101001.
- For Feeder 2: Pole 50102268. This will require changing all the single-phase power lines between Poles 50102268 and 50102135 to be three-phase.
- For Feeder 3: Pole 50103001.
- For Feeder 4: Pole 50104003.

1.3.3 Option 3

Run two (2) x 25kV feeder circuit lines from the new power plant (with two (2) x 5MVA step-up transformers) to the existing distribution system (with two (2) x 5MVA step-down transformers).

- Install two (2) new 4.16/25kV, 5MVA, step-up transformers in the new power plant and connect the primary side of these transformers to the new main 5kV switchgear via cables.
- Install two (2) new 25/4.16kV, 5MVA, step-down transformers and Main-Tie-Main, 5kV, switchgear at the existing power plant and connect the primary side of these transformers to the outgoing breaker of the new switchgear.
- Connect the incoming breakers of the new switchgear to the secondary side of the new step-up transformers via new transmission lines.
- Connect the existing community feeders to the existing 5kV switchgear at the existing power plant using new 5kV transmission lines. The nearest tie-in location for each feeder is as below:
  - For Feeder 1: Pole 50101001
  - For Feeder 2: Pole 50102001
  - For Feeder 3: Pole 50103001
  - For Feeder 4: Pole 50104001

For this option, two operating scenarios are considered:

- All community feeders are fed from one step-up transformer. This is considered the worst-case operating scenario.
- Each two of the community feeders are fed from one step-up transformer. The distribution of the community feeders on each transformer was decided based on the peak demand load of the four feeders such that both transformers are equally loaded.

1.3.4 Option 3A

The study of the voltage drop using Option 3 showed that Feeder 1 experiences the highest voltage drop among the other feeders. Therefore, this option suggests rearranging the feeders so that Feeder 1 is connected alone to one step-down transformer, while the other three feeders are connected to the other step-down transformer.

1.3.5 Option 3B

The study of the voltage drop using various options showed that Feeder 2 has the least voltage drop among other feeders and it can be connected directly to the 5kV switchgear without violating the voltage drop limits.

In this option, Feeder 2 is connected directly to the new switchgear in the new power plant in order to reduce the load on the transformers.

1.3.6 Option 4

Run two (2) x 25kV feeder circuit lines from the new power plant (with two (2) x 5MVA step-up transformers) to the to the North Yard location (with two (2) x 5MVA step-down transformers and 5kV switchgear).

- Install two (2) new 4.16/25kV, 5MVA, step-up transformers in the new power plant and connect the primary side of these transformers to the new main 5kV switchgear via cables.
- Install two (2) new 25/4.16kV, 5MVA, step-down transformers and Main-Tie-Main, 5kV, switchgear at the North Yard and connect the primary side of these transformers to the outgoing breaker of the new switchgear.
- Connect the incoming breakers of the new switchgear to the secondary side of the new step-up transformers via new transmission lines.
- Connect the existing community feeders to the 5kV switchgear at the North Yard via transmission lines. The tie-in location of each feeder is as below:
  - For Feeder 1: Pole 50101135
  - For Feeder 2: Pole 50102251
  - For Feeder 3: Pole 50103013
  - For Feeder 4: Pole 50104003

For this option, two operating scenarios are considered:

- All community feeders are fed from one step-up transformer. This is considered the worst-case operating scenario.
- Each two of the community feeders are fed from one step-up transformer. The distribution of the community feeders on each transformer was decided based on the peak demand load of the four feeders such that both transformers are equally loaded.

1.3.7 Option 5

Upgrade all customers' transformers to have 25kV primary voltage.

- Install two (2) new 4.16/25kV, 5MVA, step-up transformers in the new power plant and connect the primary side of these transformers to the new main 5kV switchgear via cables.
- Feeders 1 and 3 are combined into one feeder by connecting the lines at Poles 50101001 in Feeder 1 and 50103001 in Feeder 3.
- The combined feeders are connected to one step-up transformer at Pole 50101001 in Feeder 1.

- Feeders 2 and 4 are combined into one feeder by connecting the lines at Pole 50102003 in Feeder 2 and 50104003 in Feeder 4.
- The combined feeders are connected to the other step-up transformer at Pole 50102268 in Feeder 2.

The single-line diagrams showing the network topology for each option are included under Appendices 1.A to 1.G.

2. <u>**Discussion**</u>

Since the new power plant is located in a considerably remote location that is far from the existing power plant location, it became crucial to find a proper solution for the connection of the existing community feeders to the new power plant. The recommended solution optimizes the following criteria:

- Minimizing the voltage drop across the lines. The voltage drop should not exceed 3% from the generators to each individual consumer.
- Minimizing the network active power losses.

This study evaluates the five (5) options proposed by QEC and the adjustments made by Asher to determine the most technically feasible option and the provides recommendations for further aspects to be considered.

2.1 Sources of Data

Network model and simulation parameters are set based on the following inputs:

- <u>**ETAP Model:**</u>

  The ETAP model used is based on the model developed for QEC Penetration Study. The model of the power plant is updated to reflect the topology of the new plant.

- <u>**One-line Diagrams:**</u>

  The Network model is built using the provided one-line diagrams. These diagrams are also used to obtain the connected load and phase connection of each customer.

- <u>**Generation Forecast:**</u>

  QEC provided a table showing the estimated electricity produced over the years from 2026 to 2066 (See Appendix 2). These estimates are used for feeder sizing, voltage drop, and network losses calculations.

2.2 Assumptions

- The maximum demand factors of each feeder load in 2019 are calculated based on the load data reading provided by QEC. The estimated electricity production for subsequent years (Appendix 2) is used to calculate the maximum demand factor for these years.

- Normally open switches, interconnecting different feeders and used during the failure or maintenance of any of the feeder breakers, are not included in the model and the penetration study except for the options where each two feeders are combined.

- Since the specified AASC cables are not available in the standard ETAP library, AAC cables are used instead. The electrical and geometric characteristics of the selected cable are modified to match the AASC cable specifications provided by QEC.
- The new power plant main switchgear tie breaker is assumed to be open.
- The boundary conditions for the voltage limits at all networks nodes (buses) are assumed to be +/-3%.
- The maximum transmission line size to be used is 4/0 AWG with a single conductor per phase.
- QEC advised that most of the loads are non-inductive and that the overall power factor for each feeder is in the order of 0.99. For the purpose of this study, all loads are assumed to have a 0.95 power factor for more conservative values of load currents.
- Based on overhead line conductor parameters provided by QEC, resistance, reactance, and susceptance values for overhead lines are calculated using ETAP considering the following conductor configuration on the pole structure:
  - Conductor height: 34 ft (unless otherwise indicated on the single-line diagrams).
  - Spacing between phases: 2 ft.
- Generator plant service loads are not considered in the analysis.

2.3 Network Configuration

The new power plant for Cambridge Bay consists of two (2) 1500kW, two (2) 1100kW and one (1) 850kW generators with an output voltage of 4.16kV. Generator outputs are connected to a main 4.16kV switchgear with two (2) bus sections connected together via tie breaker such that one (1) 1500kW and one (1) 1100kW generators are connected to one bus section, and the one (1) 1500kW, one (1) 1100kW, and one (1) 850kW generators are connected to the other bus section.

Existing community feeders are connected to the two bus sections of the main switchgear. The connection scheme depends on the tie-in option to be studied.

In order to improve customer power supply reliability, feeders are interconnected via a set of normally open switches. Any of these switches may be closed in the case when one of the feeder breakers is out of duty due to failure or for maintenance purposes. Since the case where both feeders are connected to one feeder breaker does not represent normal network operation and is used only for maintenance purposes, these configurations are not included in the model except where two feeders are combined into one feeder. For this case, only the tie switch is considered closed.

The network ETAP model for each study option is provided in Appendices 1.A to 1.G.

2.4 Calculation Procedures

2.4.1 Load Parameters Calculations

The peak demand load for the year 2019 is obtained from the metering readings provided by QEC for this year and is used to calculated the maximum demand factor for the loads of each feeder as shown in Table 1.

Table 1: Maximum Demand (2019)

	Connected Load (kVA)	Max. Demand Load (kVA)	Max. Demand Factor (%)
Feeder 1	2537.5	989.625	39.00%
Feeder 2	3017.5	754.375	25.00%
Feeder 3	642.5	334.1	52.00%
Feeder 4	450	234	52.00%
Total	6647.5	2312.1	

The estimated electricity production (Appendix 2) is used to calculate the percentage growth of electricity demand which is, in turn, used to calculate the maximum demand for the successive years as shown in Table 2.

Table 2: Estimated Growth in Demand Load

Year	Population Demand Load Change (%)	Maximum Demand Factors			
		Feeder 1	Feeder 2	Feeder 3	Feeder 4
2019	-	39.00%	25.00%	52.00%	52.00%
2026	55.00%	60.45%	38.75%	80.60%	80.60%
2027	57.00%	61.23%	39.25%	81.64%	81.64%
2028	58.00%	61.62%	39.50%	82.16%	82.16%
2029	59.00%	62.01%	39.75%	82.68%	82.68%
2030	61.00%	62.79%	40.25%	83.72%	83.72%
2031	62.00%	63.18%	40.50%	84.24%	84.24%
2032	64.00%	63.96%	41.00%	85.28%	85.28%
2033	65.00%	64.35%	41.25%	85.80%	85.80%
2034	66.00%	64.74%	41.50%	86.32%	86.32%
2035	68.00%	65.52%	42.00%	87.36%	87.36%
2036	70.00%	66.30%	42.50%	88.40%	88.40%
2041	78.00%	69.42%	44.50%	92.56%	92.56%

Year	Population Demand Load Change (%)	Maximum Demand Factors			
		Feeder 1	Feeder 2	Feeder 3	Feeder 4
2046	87.00%	72.93%	46.75%	97.24%	97.24%
2051	98.00%	77.22%	49.50%	102.96%	102.96%
2056	110.00%	81.90%	52.50%	109.20%	109.20%
2061	123.00%	86.97%	55.75%	115.96%	115.96%
2066	138.00%	92.82%	59.50%	123.76%	123.76%

As agreed with QEC, the study considers the load demand of the first 10 years (2026 to 2036) in one-year steps, and the following 30 years (2037 to 2066) in 5-year steps.

The above demand factors are used in the ETAP model.

The maximum demand load analysis of the four feeders based on the table above shows that:

- The balanced connection of feeders for the options where two feeders are supposed to be connected, is to connect Feeders 1 and 4 together and Feeders 2 and 3 together.
- The maximum generation capacity for each bus section of the switchgear is 2500 kW. The peak demand load forecast for all the years exceeds 2500kW. Therefore, the switchgear bus-tie breaker needs to be closed such that the total load can be distributed among all the generators.
- Customer transformers connected to Feeders 3 and 4 need to be upgraded to 125% of their current ratings to accommodate the forecasted demand.

2.4.2 Design Constraints

The following design constraint are established by QEC:

- The total voltage drop from the generators to each customer load shall not exceed 3%.
- The maximum size of a transmission line is 4/0AWG with no more than one conductor per phase.
- Initial calculations are made with all transformer taps set at the zero-position. However, transformer tap settings can be changed to compensate for excessive voltage drop when needed.

2.5 Results

Electricity production estimate for the years from 2026 to 2066 is used to calculate the demand load and demand factor for each feeder. These demand factors were applied to calculate the minimum feeder size that is required to achieve a maximum voltage drop of 3% at the customer transformer using the different options detailed under Section 1.3.

The study concludes that:

- Options 1 and 2 do not satisfy the 3% voltage drop criteria due to the distance between the new power plant and the tie-ins of Feeders 1, 3, and 4. Therefore, these options cannot be utilized.
- Comparing the results of Options 3 and 4, it can be shown that Option 3 provides better results than Option 4 since the North Yard is farther away from the nearest tie-in to the community feeders than the existing power plant.

  Both Options 3 and 4 fail to satisfy the 3% voltage drop criteria when all the feeders are fed from one step-up transformer.
- The alternatives proposed for Option 3 provide better results in terms of voltage drop and active power losses. However, unlike Option 3A, Option 3B allows all feeders to be fed from one step-up transformer without violating the voltage drop criteria.

The study, also, concludes that Option 5 is the recommended option since it involves less voltage drop and active power loses along the power lines as shown by Table 4 below.

Table 3: Study Results Summary

Option	Operating Scenario	Min Main Feeder Line Size				Main Line Size	Transformer Tap Settings		Remarks
		Feeder 1	Feeder 2	Feeder 3	Feeder 4		Step-up Transformers	Step-Down Transformers	
1		Failed							
2		Failed							
3	A	Failed							
	B	4/0 AWG	4/0 AWG	4/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
3A	A	Failed							
	B	1/0 AWG	3/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
3B	A	2/0 AWG	1/0 AWG	2/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
	B	4/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
4	A	Failed							
	B	Failed							
5	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	-5%	N/A	
	B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	-2.5%	N/A	

Scenario A: All feeders are fed from one step-up transformer
Scenario B: Feeders are distributed across both step-up transformers

Table 4: Study Results Details

Year	Option	Operating Scenario	Min Main Feeder Line Size				Main Line Size	Transformer Tap Settings		Remarks
			Feeder 1	Feeder 2	Feeder 3	Feeder 4		Step-up Transformers	Step-Down Transformers	
2026	1		Failed	1/0 AWG	Failed	Failed	N/A	N/A	N/A	
	2		Failed	1/0 AWG	Failed	Failed	N/A	N/A	N/A	
	3	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
		B	4/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	3A	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	3B	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	0%	-5%	
	4	A	Failed	2/0 AWG	Failed	4/0 AWG	4/0 AWG	Failed	Failed	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
	5	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	-2.5%	N/A	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	0%	N/A	
2027	1		Failed	1/0 AWG	Failed	Failed	N/A	N/A	N/A	
	2		Failed	1/0 AWG	Failed	Failed	N/A	N/A	N/A	
	3	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
		B	4/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	3A	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	3B	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	0%	-5%	
	4	A	Failed	3/0 AWG	Failed	4/0 AWG	4/0 AWG	Failed	Failed	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
	5	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	-2.5%	N/A	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	0%	N/A	

Year	Option	Operating Scenario	Min Main Feeder Line Size				Main Line Size	Transformer Tap Settings		Remarks
			Feeder 1	Feeder 2	Feeder 3	Feeder 4		Step-up Transformers	Step-Down Transformers	
2028	1		Failed	1/0 AWG	Failed	Failed	N/A	N/A	N/A	
	2		Failed	1/0 AWG	Failed	Failed	N/A	N/A	N/A	
	3	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
		B	4/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	3A	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	3B	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	0%	-5%	
	4	A	Failed	3/0 AWG	Failed	4/0 AWG	4/0 AWG	Failed	Failed	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
	5	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	-2.5%	N/A	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	0%	N/A	
2029	1		Failed	1/0 AWG	Failed	Failed	N/A	N/A	N/A	
	2		Failed	1/0 AWG	Failed	Failed	N/A	N/A	N/A	
	3	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
		B	4/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	3A	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	3B	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	0%	-5%	
	4	A	Failed	3/0 AWG	Failed	4/0 AWG	4/0 AWG	Failed	Failed	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
	5	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	-2.5%	N/A	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	0%	N/A	

Year	Option	Operating Scenario	Min Main Feeder Line Size				Main Line Size	Transformer Tap Settings		Remarks
			Feeder 1	Feeder 2	Feeder 3	Feeder 4		Step-up Transformers	Step-Down Transformers	
2030	1		Failed	1/0 AWG	Failed	Failed	N/A	N/A	N/A	
	2		Failed	1/0 AWG	Failed	Failed	N/A	N/A	N/A	
	3	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
		B	4/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	3A	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
		B	1/0 AWG	3/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	3B	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	0%	-5%	
	4	A	Failed	4/0 AWG	Failed	4/0 AWG	4/0 AWG	Failed	Failed	
		B	1/0 AWG	2/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
	5	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	-2.5%	N/A	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	0%	N/A	
2031	1		Failed	1/0 AWG	Failed	Failed	N/A	N/A	N/A	
	2		Failed	1/0 AWG	Failed	Failed	N/A	N/A	N/A	
	3	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
		B	4/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	3A	A	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	3B	A	1/0 AWG	1/0 AWG	2/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	0%	-5%	
	4	A	Failed	1/0 AWG	Failed	4/0 AWG	4/0 AWG	Failed	Failed	
		B	1/0 AWG	2/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
	5	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	-2.5%	N/A	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	0%	N/A	

Year	Option	Operating Scenario	Min Main Feeder Line Size				Main Line Size	Transformer Tap Settings		Remarks
			Feeder 1	Feeder 2	Feeder 3	Feeder 4		Step-up Transformers	Step-Down Transformers	
2032	1		Failed	1/0 AWG	Failed	Failed	N/A	N/A	N/A	
	2		Failed	1/0 AWG	Failed	Failed	N/A	N/A	N/A	
	3	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
		B	4/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	3A	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	3B	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	0%	-5%	
	4	A	Failed	1/0 AWG	Failed	4/0 AWG	4/0 AWG	Failed	Failed	
		B	1/0 AWG	2/0 AWG	2/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
	5	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	-2.5%	N/A	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	0%	N/A	
2033	1		Failed	1/0 AWG	Failed	Failed	N/A	N/A	N/A	
	2		Failed	1/0 AWG	Failed	Failed	N/A	N/A	N/A	
	3	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
		B	4/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	3A	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	3B	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	0%	-5%	
	4	A	Failed	1/0 AWG	Failed	4/0 AWG	4/0 AWG	Failed	Failed	
		B	1/0 AWG	2/0 AWG	2/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
	5	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	-2.5%	N/A	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	0%	N/A	

Year	Option	Operating Scenario	Min Main Feeder Line Size				Main Line Size	Transformer Tap Settings		Remarks
			Feeder 1	Feeder 2	Feeder 3	Feeder 4		Step-up Transformers	Step-Down Transformers	
2034	1		Failed	1/0 AWG	Failed	Failed	N/A	N/A	N/A	
	2		Failed	1/0 AWG	Failed	Failed	N/A	N/A	N/A	
	3	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
		B	4/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	3A	A	1/0 AWG	4/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	3B	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	0%	-5%	
	4	A	Failed	1/0 AWG	Failed	4/0 AWG	4/0 AWG	Failed	Failed	
		B	1/0 AWG	3/0 AWG	2/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
	5	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	-2.5%	N/A	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	0%	N/A	
2035	1		Failed	1/0 AWG	Failed	Failed	N/A	N/A	N/A	
	2		Failed	1/0 AWG	Failed	Failed	N/A	N/A	N/A	
	3	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
		B	4/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	3A	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
		B	4/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	3B	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
		B	4/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	0%	-5%	
	4	A	Failed	1/0 AWG	Failed	4/0 AWG	4/0 AWG	Failed	Failed	
		B	1/0 AWG	3/0 AWG	2/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
	5	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	-2.5%	N/A	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	0%	N/A	

Year	Option	Operating Scenario	Min Main Feeder Line Size				Main Line Size	Transformer Tap Settings		Remarks
			Feeder 1	Feeder 2	Feeder 3	Feeder 4		Step-up Transformers	Step-Down Transformers	
2036	1		Failed	1/0 AWG	Failed	Failed	N/A	N/A	N/A	
	2		Failed	1/0 AWG	Failed	Failed	N/A	N/A	N/A	
	3	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
		B	4/0 AWG	1/0 AWG	2/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	3A	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	3B	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	4	A	Failed	1/0 AWG	Failed	4/0 AWG	4/0 AWG	Failed	Failed	
		B	1/0 AWG	3/0 AWG	3/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
	5	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	-2.5%	N/A	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	0%	N/A	
2041	1		Failed	2/0 AWG	Failed	Failed	N/A	N/A	N/A	
	2		Failed	1/0 AWG	Failed	Failed	N/A	N/A	N/A	
	3	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
		B	4/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	3A	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	3B	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	4	A	Failed	1/0 AWG	Failed	4/0 AWG	4/0 AWG	Failed	Failed	
		B	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
	5	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	-2.5%	N/A	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	0%	N/A	

Year	Option	Operating Scenario	Min Main Feeder Line Size				Main Line Size	Transformer Tap Settings		Remarks
			Feeder 1	Feeder 2	Feeder 3	Feeder 4		Step-up Transformers	Step-Down Transformers	
2046	1		Failed	2/0 AWG	Failed	Failed	N/A	N/A	N/A	
	2		Failed	1/0 AWG	Failed	Failed	N/A	N/A	N/A	
	3	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
		B	4/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	3A	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	3B	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	4	A	Failed	1/0 AWG	Failed	4/0 AWG	4/0 AWG	Failed	Failed	
		B	Failed	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	Failed	Failed	
	5	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	-2.5%	N/A	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	0%	N/A	
2051	1		Failed	3/0 AWG	Failed	Failed	N/A	N/A	N/A	
	2		Failed	1/0 AWG	Failed	Failed	N/A	N/A	N/A	
	3	A	4/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
		B	4/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	3A	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	3B	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	4	A	Failed	1/0 AWG	Failed	4/0 AWG	4/0 AWG	Failed	Failed	
		B	Failed	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	Failed	Failed	
	5	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	-2.5%	N/A	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	-2.5%	N/A	

Year	Option	Operating Scenario	Min Main Feeder Line Size				Main Line Size	Transformer Tap Settings		Remarks
			Feeder 1	Feeder 2	Feeder 3	Feeder 4		Step-up Transformers	Step-Down Transformers	
2056	1		Failed	3/0 AWG	Failed	Failed	N/A	N/A	N/A	
	2		Failed	1/0 AWG	Failed	Failed	N/A	N/A	N/A	
	3	A	Failed	1/0 AWG	Failed	4/0 AWG	4/0 AWG	Failed	Failed	
		B	4/0 AWG	4/0 AWG	4/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
	3A	A	Failed	1/0 AWG	Failed	4/0 AWG	4/0 AWG	Failed	Failed	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
	3B	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-2.5%	-5%	
	4	A	Failed	1/0 AWG	Failed	Failed	4/0 AWG	Failed	Failed	
		B	Failed	1/0 AWG	2/0 AWG	4/0 AWG	4/0 AWG	Failed	Failed	
	5	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	-2.5%	N/A	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	-2.5%	N/A	
2061	1		Failed	4/0 AWG	Failed	Failed	N/A	N/A	N/A	
	2		Failed	1/0 AWG	Failed	Failed	N/A	N/A	N/A	
	3	A	Failed	1/0 AWG	Failed	4/0 AWG	4/0 AWG	Failed	Failed	
		B	4/0 AWG	4/0 AWG	4/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
	3A	A	Failed	1/0 AWG	Failed	4/0 AWG	4/0 AWG	Failed	Failed	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
	3B	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
		B	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
	4	A	Failed	1/0 AWG	Failed	Failed	4/0 AWG	Failed	Failed	
		B	Failed	1/0 AWG	3/0 AWG	4/0 AWG	4/0 AWG	Failed	Failed	
	5	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	-5%	N/A	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	-2.5%	N/A	

Year	Option	Operating Scenario	Min Main Feeder Line Size				Main Line Size	Transformer Tap Settings		Remarks
			Feeder 1	Feeder 2	Feeder 3	Feeder 4		Step-up Transformers	Step-Down Transformers	
2066	1		Failed	4/0 AWG	Failed	Failed	N/A	N/A	N/A	
	2		Failed	1/0 AWG	Failed	Failed	N/A	N/A	N/A	
	3	A	Failed	1/0 AWG	Failed	4/0 AWG	4/0 AWG	Failed	Failed	
		B	4/0 AWG	4/0 AWG	4/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
	3A	A	Failed	1/0 AWG	Failed	4/0 AWG	4/0 AWG	Failed	Failed	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
	3B	A	2/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	4/0 AWG	-5%	-5%	
	4	A	Failed	1/0 AWG	Failed	Failed	4/0 AWG	Failed	Failed	
		B	Failed	1/0 AWG	Failed	4/0 AWG	4/0 AWG	Failed	Failed	
	5	A	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	-5%	N/A	
		B	1/0 AWG	1/0 AWG	1/0 AWG	4/0 AWG	N/A	-2.5%	N/A	

Scenario A: All feeders are fed from one step-up transformer
Scenario B: Feeders are distributed across both step-up transformers

3. **Conclusion and Recommendations**

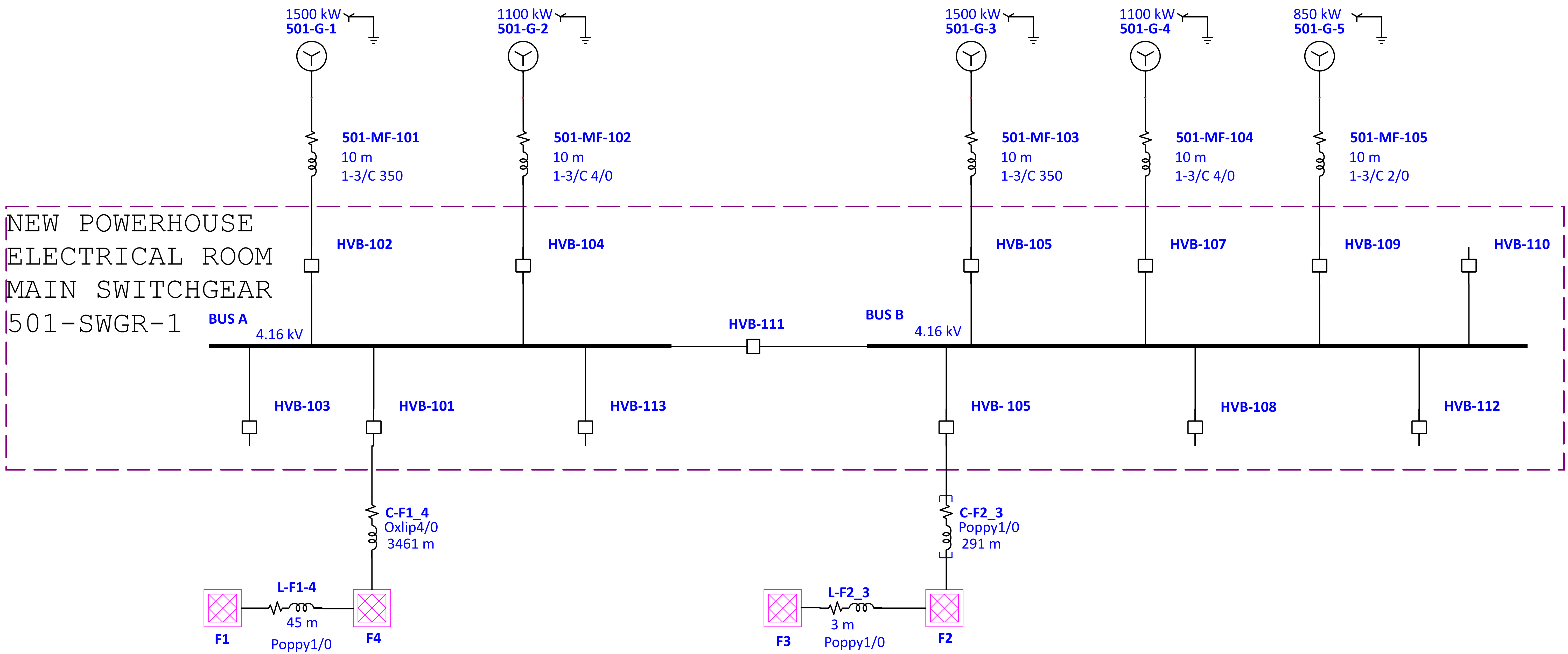
The utilization of Options 1 and 2 was found to be not feasible due to the distance between the new power plant and the tie-in locations of the community feeders particularly for Feeders 1, 3, and 4.

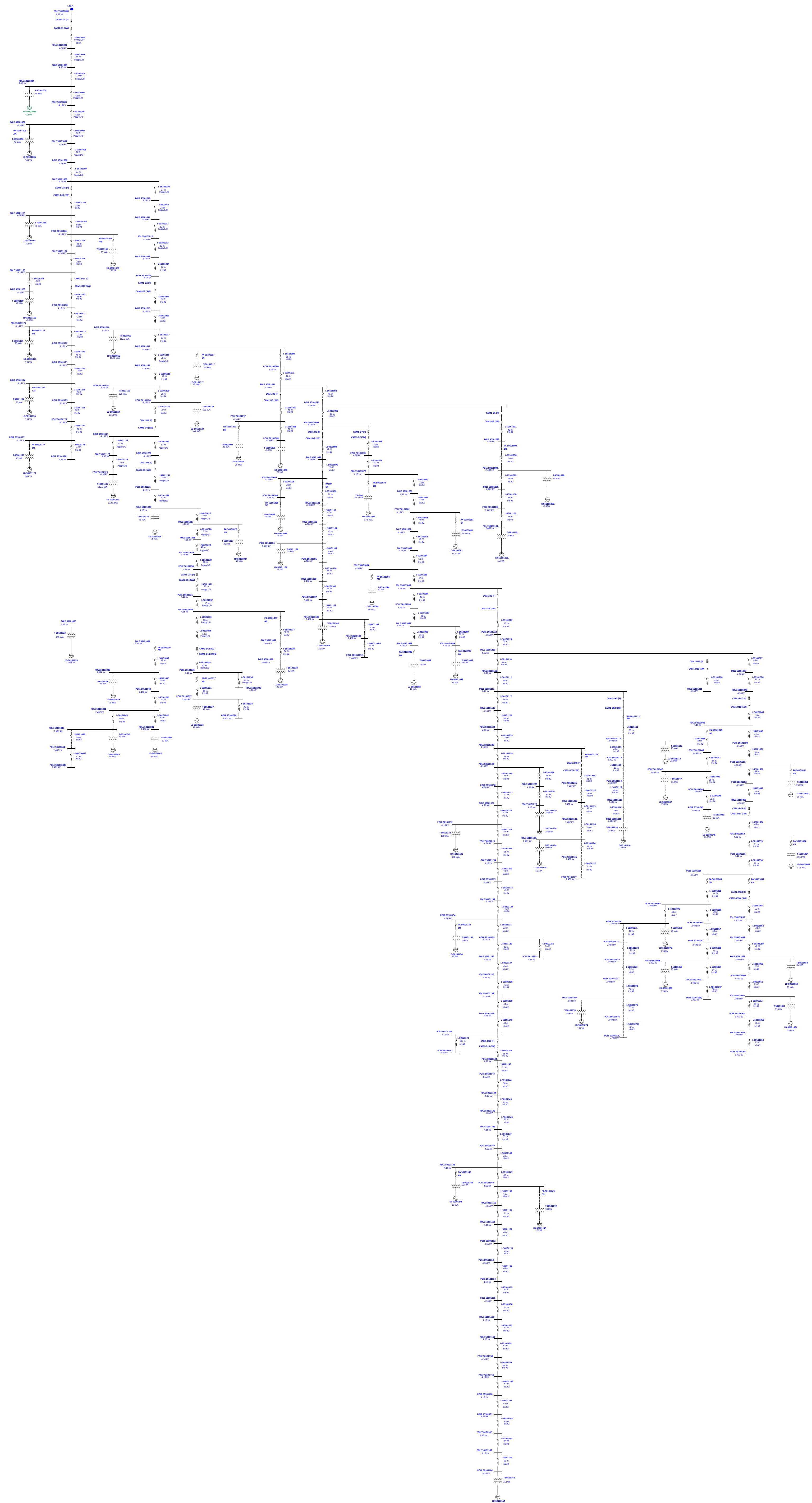
Options 3, 3A, and 4 can be utilized with the exception that all feeders cannot be fed from one step-up transformer. However, Option 3B allows the two scenarios where feeders can either be fed from one transformer or their loads is distributed on both step-up transformers.

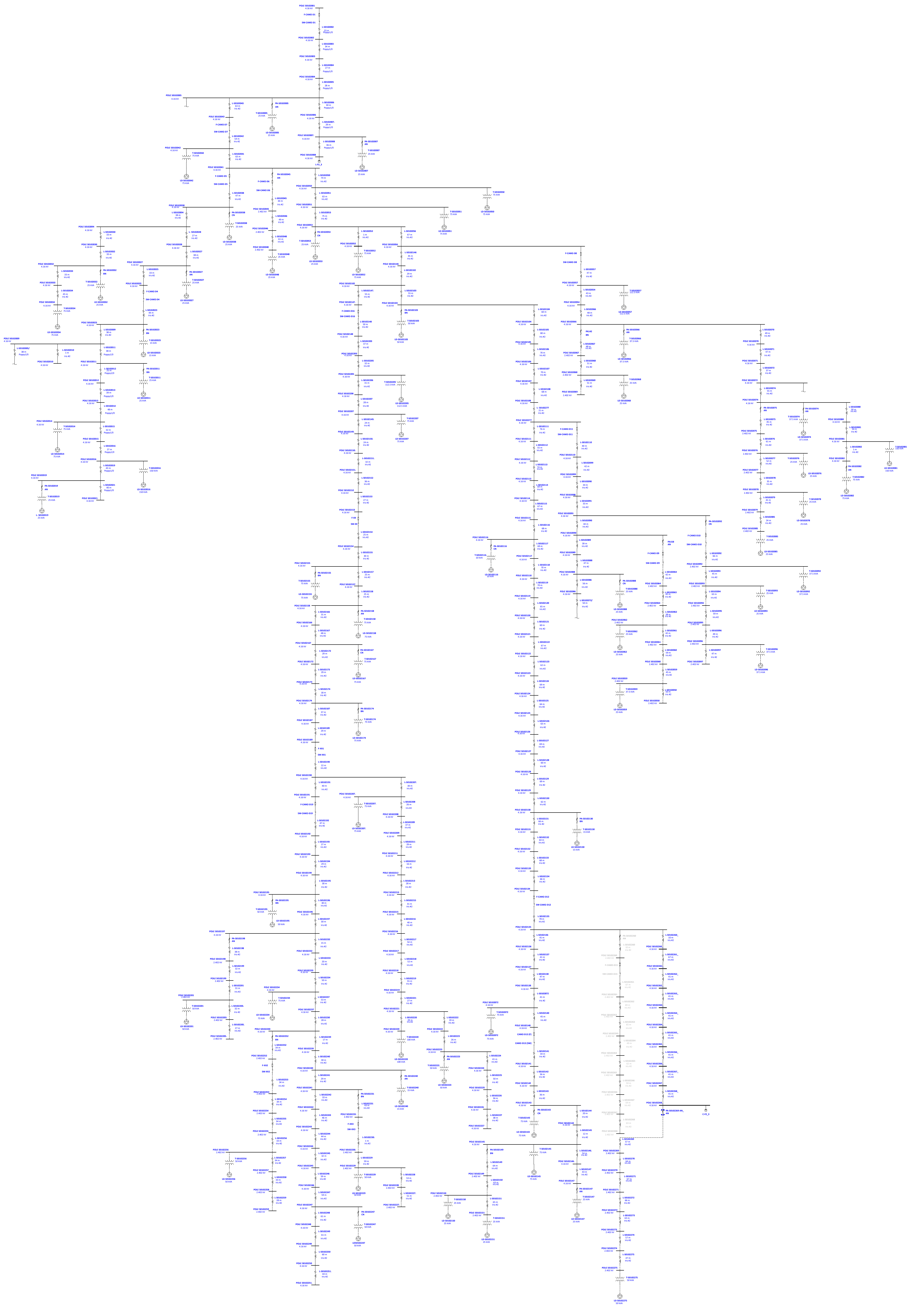
Option 5 was found to be the most technically preferred since it involves less voltage drop and active power losses.

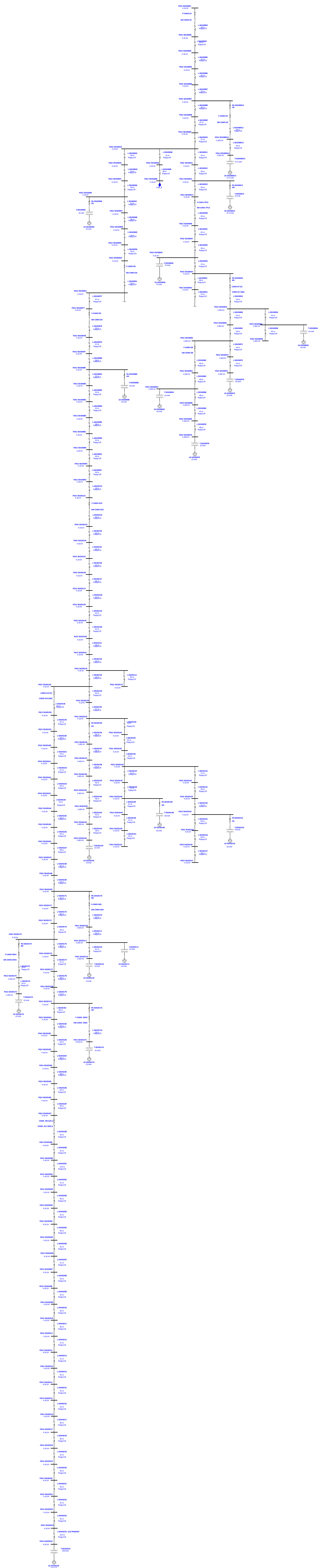
Appendix 1.A

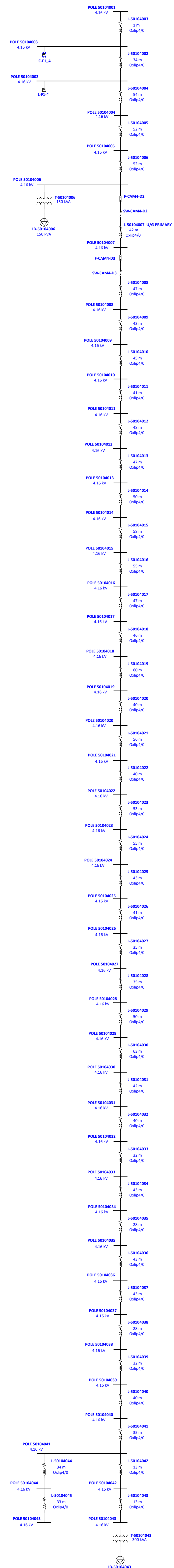
Cambridge Bay Network ETAP Model and Results – Option 1


1500 kW
501-G-1
1100 kW
501-G-2
1500 kW
501-G-3
1100 kW
501-G-4
850 kW
501-G-5
501-MF-101
10 m
1-3/C 350
501-MF-102
10 m
1-3/C 4/0
501-MF-103
10 m
1-3/C 350
501-MF-104
10 m
1-3/C 4/0
501-MF-105
10 m
1-3/C 2/0
NEW POWERHOUSE
ELECTRICAL ROOM
MAIN SWITCHGEAR
501-SWGR-1
HVB-102
HVB-104
HVB-105
HVB-107
HVB-109
HVB-110
BUS A
4.16 kV
HVB-111
BUS B
4.16 kV
HVB-103
HVB-101
HVB-113
HVB- 105
HVB-108
HVB-112
C-F1_4
Oxlip4/0
3461 m
C-F2_3
Poppy1/0
291 m
L-F1-4
45 m
Poppy1/0
F1
F4
L-F2_3
3 m
Poppy1/0
F3
F2







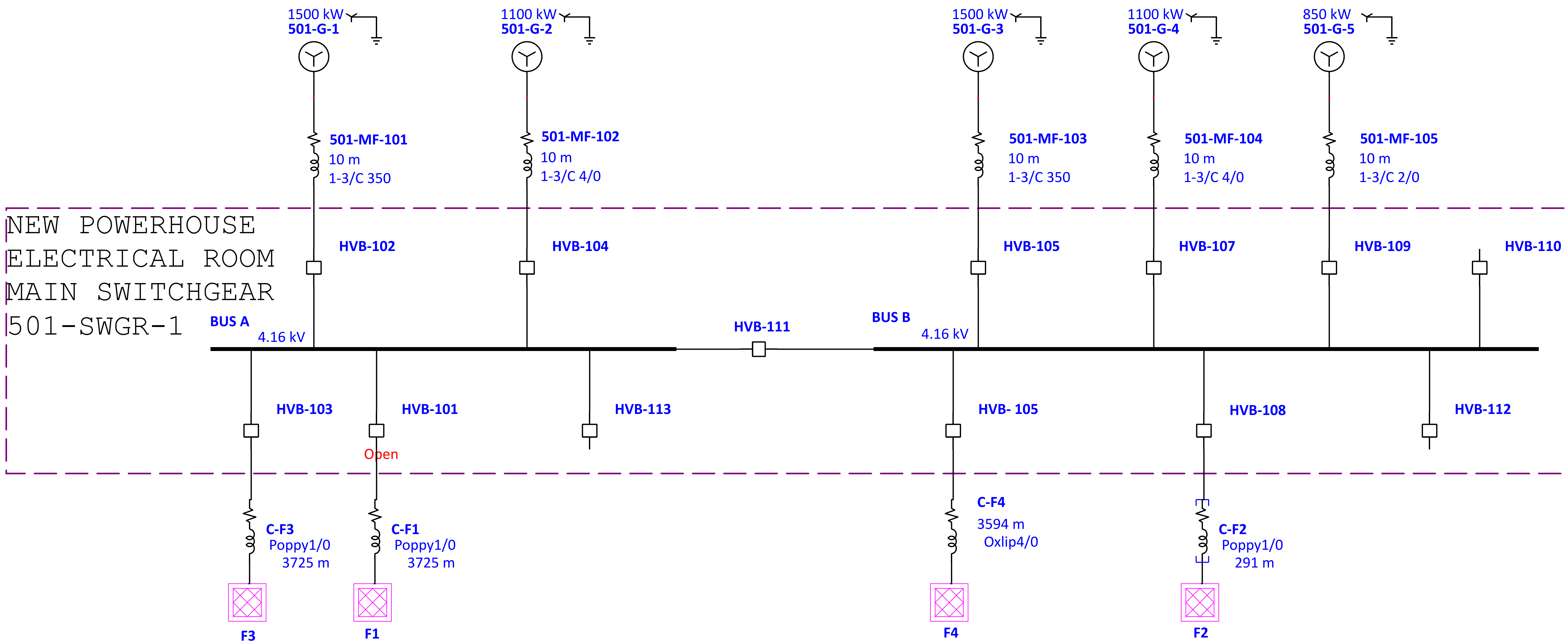

POLE 50104001
4.16 kV
L-50104003
1 m
Oxlip4/0
POLE 50104003
4.16 kV
C-F1_4
L-50104002
34 m
Oxlip4/0
POLE 50104002
4.16 kV
L-F1-4
L-50104004
54 m
Oxlip4/0
POLE 50104004
4.16 kV
L-50104005
52 m
Oxlip4/0
POLE 50104005
4.16 kV
L-50104006
52 m
Oxlip4/0
POLE 50104006
4.16 kV
T-50104006
150 kVA
LD-50104006
150 kVA
F-CAM4-D2
SW-CAM4-D2
L-50104007 U/G PRIMARY
42 m
Oxlip4/0
POLE 50104007
4.16 kV
F-CAM4-D3
SW-CAM4-D3
L-50104008
47 m
Oxlip4/0
POLE 50104008
4.16 kV
L-50104009
43 m
Oxlip4/0
POLE 50104009
4.16 kV
L-50104010
45 m
Oxlip4/0
POLE 50104010
4.16 kV
L-50104011
41 m
Oxlip4/0
POLE 50104011
4.16 kV
L-50104012
48 m
Oxlip4/0
POLE 50104012
4.16 kV
L-50104013
47 m
Oxlip4/0
POLE 50104013
4.16 kV
L-50104014
50 m
Oxlip4/0
POLE 50104014
4.16 kV
L-50104015
58 m
Oxlip4/0
POLE 50104015
4.16 kV
L-50104016
55 m
Oxlip4/0
POLE 50104016
4.16 kV
L-50104017
47 m
Oxlip4/0
POLE 50104017
4.16 kV
L-50104018
46 m
Oxlip4/0
POLE 50104018
4.16 kV
L-50104019
60 m
Oxlip4/0
POLE 50104019
4.16 kV
L-50104020
40 m
Oxlip4/0
POLE 50104020
4.16 kV
L-50104021
56 m
Oxlip4/0
POLE 50104021
4.16 kV
L-50104022
40 m
Oxlip4/0
POLE 50104022
4.16 kV
L-50104023
53 m
Oxlip4/0
POLE 50104023
4.16 kV
L-50104024
55 m
Oxlip4/0
POLE 50104024
4.16 kV
L-50104025
43 m
Oxlip4/0
POLE 50104025
4.16 kV
L-50104026
41 m
Oxlip4/0
POLE 50104026
4.16 kV
L-50104027
35 m
Oxlip4/0
POLE 50104027
4.16 kV
L-50104028
35 m
Oxlip4/0
POLE 50104028
4.16 kV
L-50104029
50 m
Oxlip4/0
POLE 50104029
4.16 kV
L-50104030
63 m
Oxlip4/0
POLE 50104030
4.16 kV
L-50104031
42 m
Oxlip4/0
POLE 50104031
4.16 kV
L-50104032
40 m
Oxlip4/0
POLE 50104032
4.16 kV
L-50104033
32 m
Oxlip4/0
POLE 50104033
4.16 kV
L-50104034
43 m
Oxlip4/0
POLE 50104034
4.16 kV
L-50104035
28 m
Oxlip4/0
POLE 50104035
4.16 kV
L-50104036
43 m
Oxlip4/0
POLE 50104036
4.16 kV
L-50104037
43 m
Oxlip4/0
POLE 50104037
4.16 kV
L-50104038
28 m
Oxlip4/0
POLE 50104038
4.16 kV
L-50104039
32 m
Oxlip4/0
POLE 50104039
4.16 kV
L-50104040
40 m
Oxlip4/0
POLE 50104040
4.16 kV
L-50104041
35 m
Oxlip4/0
POLE 50104041
4.16 kV
L-50104044
34 m
Oxlip4/0
L-50104042
13 m
Oxlip4/0
POLE 50104044
4.16 kV
L-50104045
33 m
Oxlip4/0
POLE 50104042
4.16 kV
L-50104043
13 m
Oxlip4/0
POLE 50104045
4.16 kV
POLE 50104043
4.16 kV
T-50104043
300 kVA
LD-50104043
300 kVA

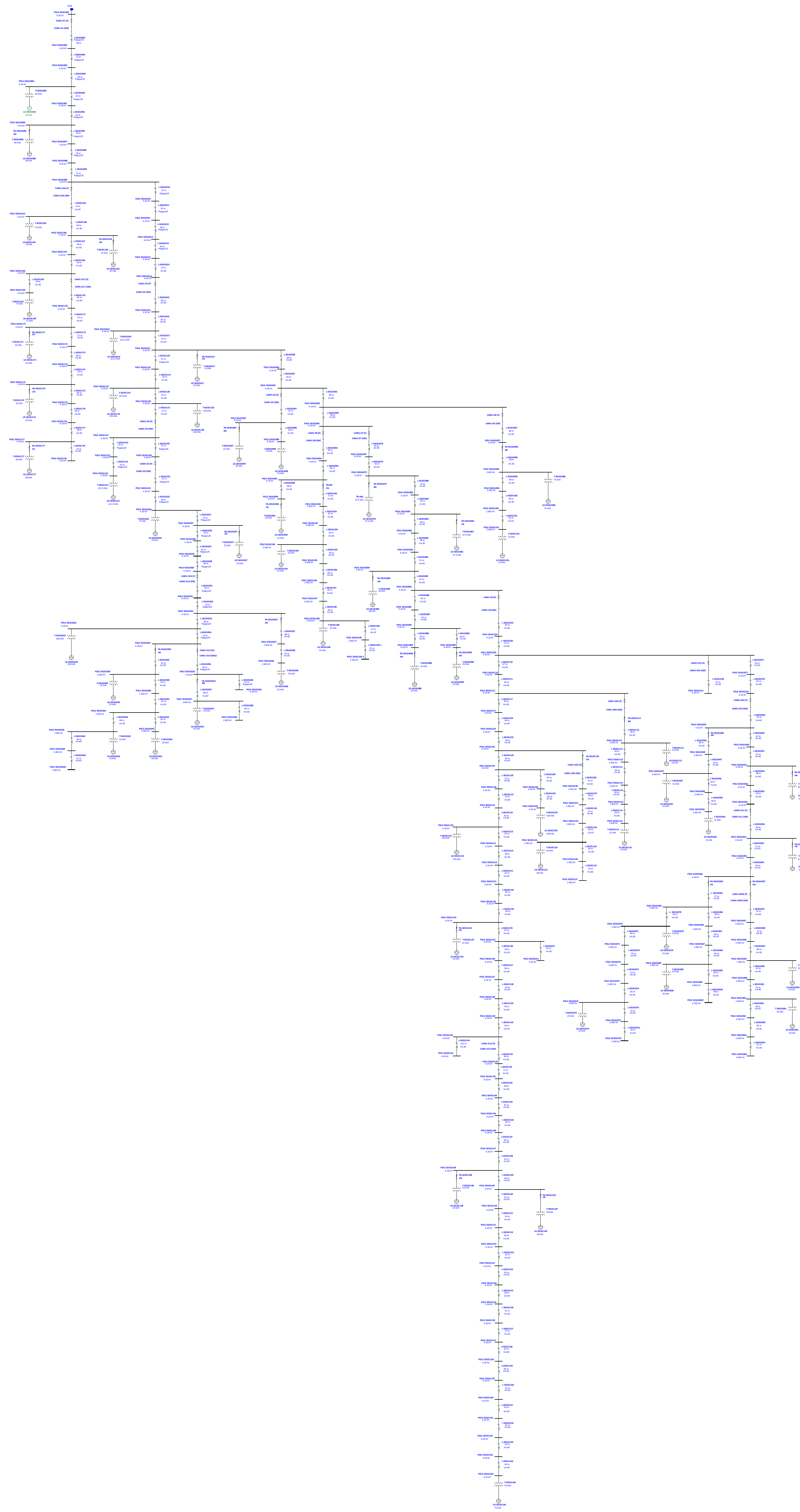
Option #1

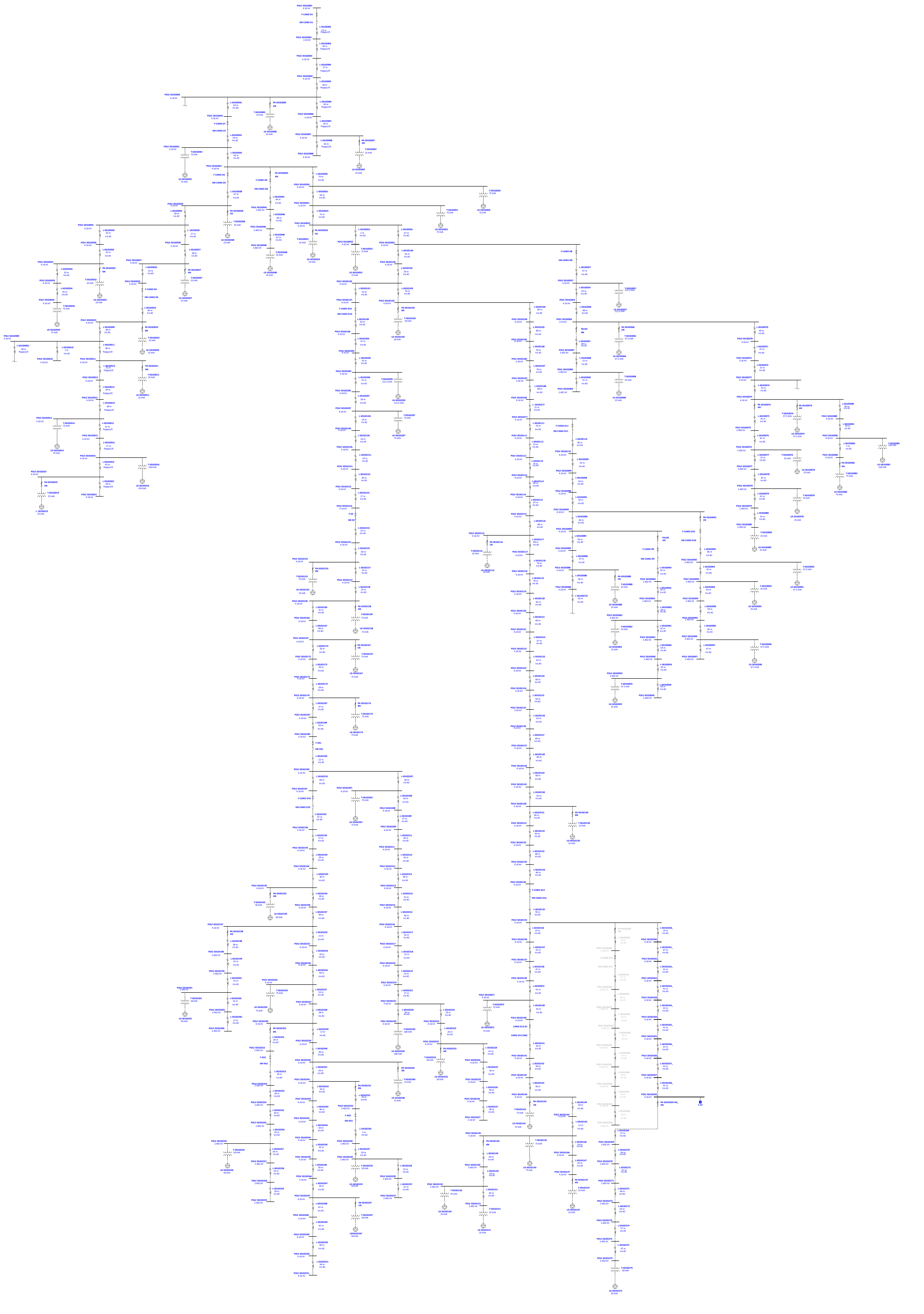
Year	F1		F2		F3		F4	
	Status	Min. Main Line Size L-F1-4	Status	Min. Main Line Size C-F2_3	Status	Min. Main Line Size L-F2_3	Status	Min. Main Line Size C-F1_4
2026	Failed		Passed	1/0 AWG	Failed		Failed	
2027	Failed		Passed	1/0 AWG	Failed		Failed	
2028	Failed		Passed	1/0 AWG	Failed		Failed	
2029	Failed		Passed	1/0 AWG	Failed		Failed	
2030	Failed		Passed	1/0 AWG	Failed		Failed	
2031	Failed		Passed	1/0 AWG	Failed		Failed	
2032	Failed		Passed	1/0 AWG	Failed		Failed	
2033	Failed		Passed	1/0 AWG	Failed		Failed	
2034	Failed		Passed	1/0 AWG	Failed		Failed	
2035	Failed		Passed	1/0 AWG	Failed		Failed	
2036	Failed		Passed	1/0 AWG	Failed		Failed	
2041	Failed		Passed	2/0 AWG	Failed		Failed	
2046	Failed		Passed	2/0 AWG	Failed		Failed	
2051	Failed		Passed	3/0 AWG	Failed		Failed	
2056	Failed		Passed	3/0 AWG	Failed		Failed	
2061	Failed		Passed	4/0 AWG	Failed		Failed	
2066	Failed		Passed	4/0 AWG	Failed		Failed	

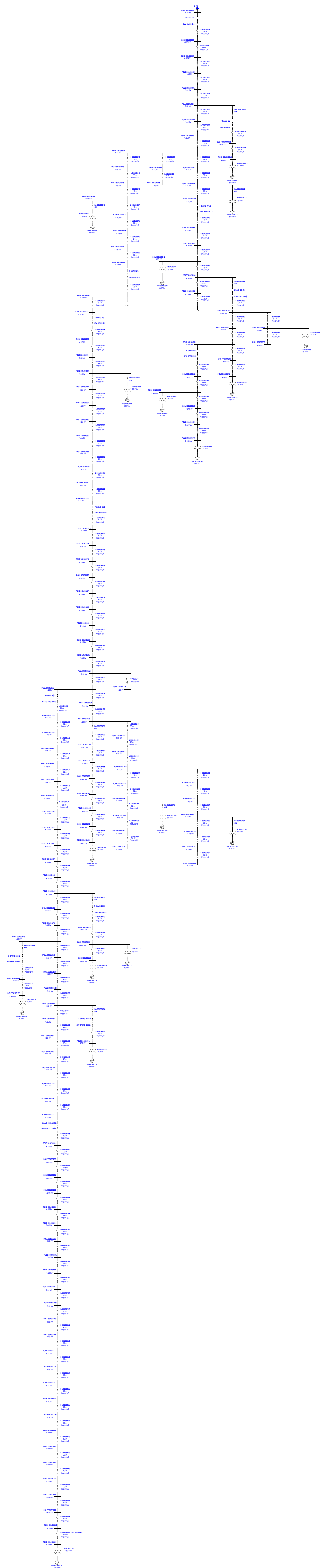
Appendix 1.B

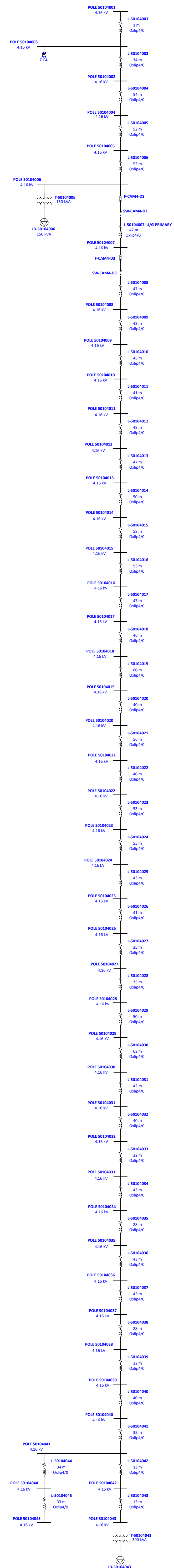
Cambridge Bay Network ETAP Model and Results – Option 2


1500 kW
501-G-1
1100 kW
501-G-2
1500 kW
501-G-3
1100 kW
501-G-4
850 kW
501-G-5
501-MF-101
10 m
1-3/C 350
501-MF-102
10 m
1-3/C 4/0
501-MF-103
10 m
1-3/C 350
501-MF-104
10 m
1-3/C 4/0
501-MF-105
10 m
1-3/C 2/0
NEW POWERHOUSE
ELECTRICAL ROOM
MAIN SWITCHGEAR
501-SWGR-1
HVB-102
HVB-104
HVB-105
HVB-107
HVB-109
HVB-110
BUS A
4.16 kV
HVB-111
BUS B
4.16 kV
HVB-103
HVB-101
HVB-113
HVB- 105
HVB-108
HVB-112
Open
C-F3
Poppy1/0
3725 m
C-F1
Poppy1/0
3725 m
C-F4
3594 m
Oxlip4/0
C-F2
Poppy1/0
291 m
F3
F1
F4
F2







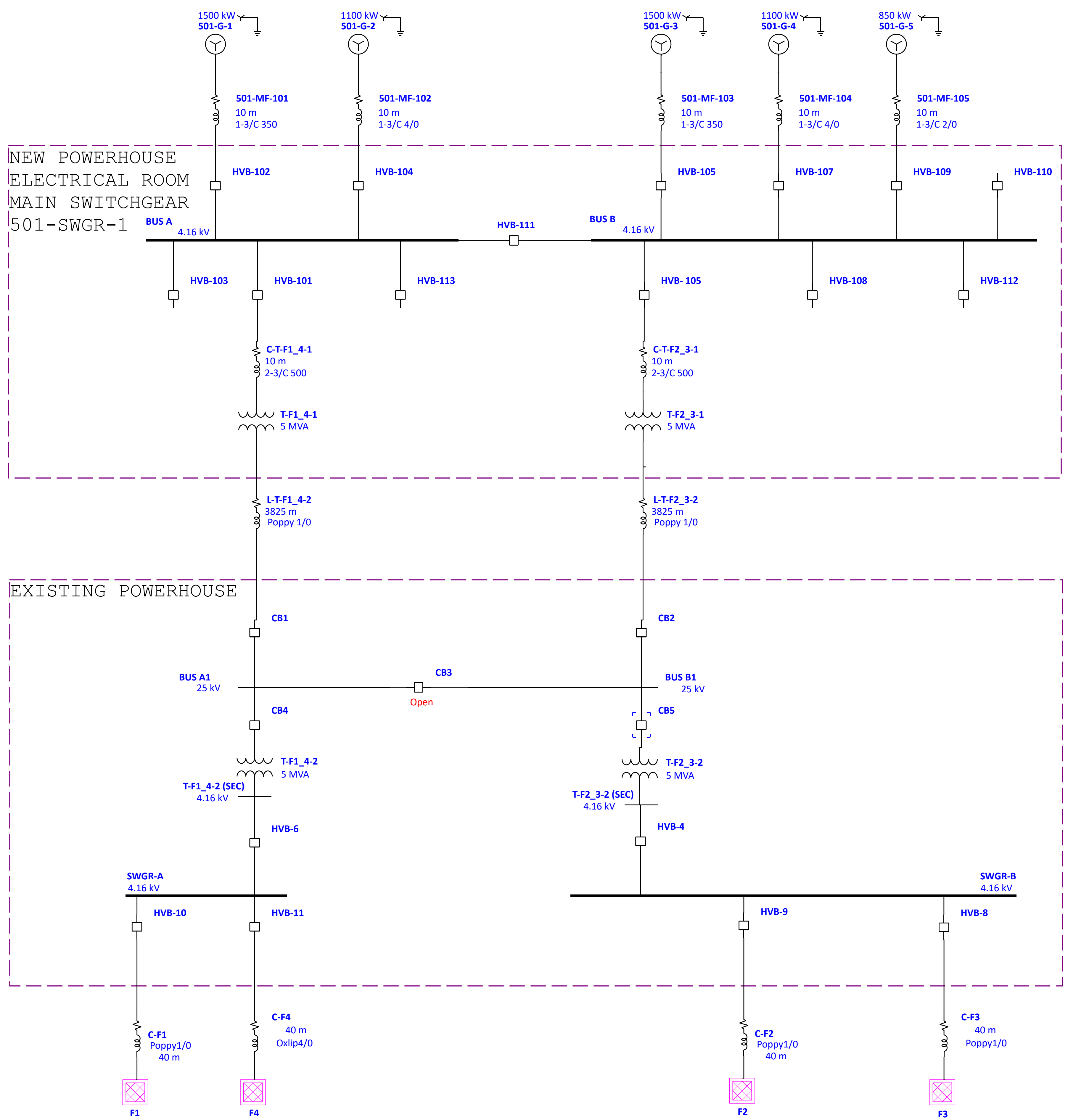

POLE 50104001
4.16 kV
L-50104003
1 m
Oxlip4/0
POLE 50104003
4.16 kV
C-F4
L-50104002
34 m
Oxlip4/0
POLE 50104002
4.16 kV
L-50104004
54 m
Oxlip4/0
POLE 50104004
4.16 kV
L-50104005
52 m
Oxlip4/0
POLE 50104005
4.16 kV
L-50104006
52 m
Oxlip4/0
POLE 50104006
4.16 kV
T-50104006
150 kVA
LD-50104006
150 kVA
F-CAM4-D2
SW-CAM4-D2
L-50104007 U/G PRIMARY
42 m
Oxlip4/0
POLE 50104007
4.16 kV
F-CAM4-D3
SW-CAM4-D3
L-50104008
47 m
Oxlip4/0
POLE 50104008
4.16 kV
L-50104009
43 m
Oxlip4/0
POLE 50104009
4.16 kV
L-50104010
45 m
Oxlip4/0
POLE 50104010
4.16 kV
L-50104011
41 m
Oxlip4/0
POLE 50104011
4.16 kV
L-50104012
48 m
Oxlip4/0
POLE 50104012
4.16 kV
L-50104013
47 m
Oxlip4/0
POLE 50104013
4.16 kV
L-50104014
50 m
Oxlip4/0
POLE 50104014
4.16 kV
L-50104015
58 m
Oxlip4/0
POLE 50104015
4.16 kV
L-50104016
55 m
Oxlip4/0
POLE 50104016
4.16 kV
L-50104017
47 m
Oxlip4/0
POLE 50104017
4.16 kV
L-50104018
46 m
Oxlip4/0
POLE 50104018
4.16 kV
L-50104019
60 m
Oxlip4/0
POLE 50104019
4.16 kV
L-50104020
40 m
Oxlip4/0
POLE 50104020
4.16 kV
L-50104021
56 m
Oxlip4/0
POLE 50104021
4.16 kV
L-50104022
40 m
Oxlip4/0
POLE 50104022
4.16 kV
L-50104023
53 m
Oxlip4/0
POLE 50104023
4.16 kV
L-50104024
55 m
Oxlip4/0
POLE 50104024
4.16 kV
L-50104025
43 m
Oxlip4/0
POLE 50104025
4.16 kV
L-50104026
41 m
Oxlip4/0
POLE 50104026
4.16 kV
L-50104027
35 m
Oxlip4/0
POLE 50104027
4.16 kV
L-50104028
35 m
Oxlip4/0
POLE 50104028
4.16 kV
L-50104029
50 m
Oxlip4/0
POLE 50104029
4.16 kV
L-50104030
63 m
Oxlip4/0
POLE 50104030
4.16 kV
L-50104031
42 m
Oxlip4/0
POLE 50104031
4.16 kV
L-50104032
40 m
Oxlip4/0
POLE 50104032
4.16 kV
L-50104033
32 m
Oxlip4/0
POLE 50104033
4.16 kV
L-50104034
43 m
Oxlip4/0
POLE 50104034
4.16 kV
L-50104035
28 m
Oxlip4/0
POLE 50104035
4.16 kV
L-50104036
43 m
Oxlip4/0
POLE 50104036
4.16 kV
L-50104037
43 m
Oxlip4/0
POLE 50104037
4.16 kV
L-50104038
28 m
Oxlip4/0
POLE 50104038
4.16 kV
L-50104039
32 m
Oxlip4/0
POLE 50104039
4.16 kV
L-50104040
40 m
Oxlip4/0
POLE 50104040
4.16 kV
L-50104041
35 m
Oxlip4/0
POLE 50104041
4.16 kV
L-50104044
34 m
Oxlip4/0
POLE 50104044
4.16 kV
L-50104045
33 m
Oxlip4/0
POLE 50104045
4.16 kV
L-50104042
13 m
Oxlip4/0
POLE 50104042
4.16 kV
L-50104043
13 m
Oxlip4/0
POLE 50104043
4.16 kV
T-50104043
300 kVA
LD-50104043
300 kVA

Option #2

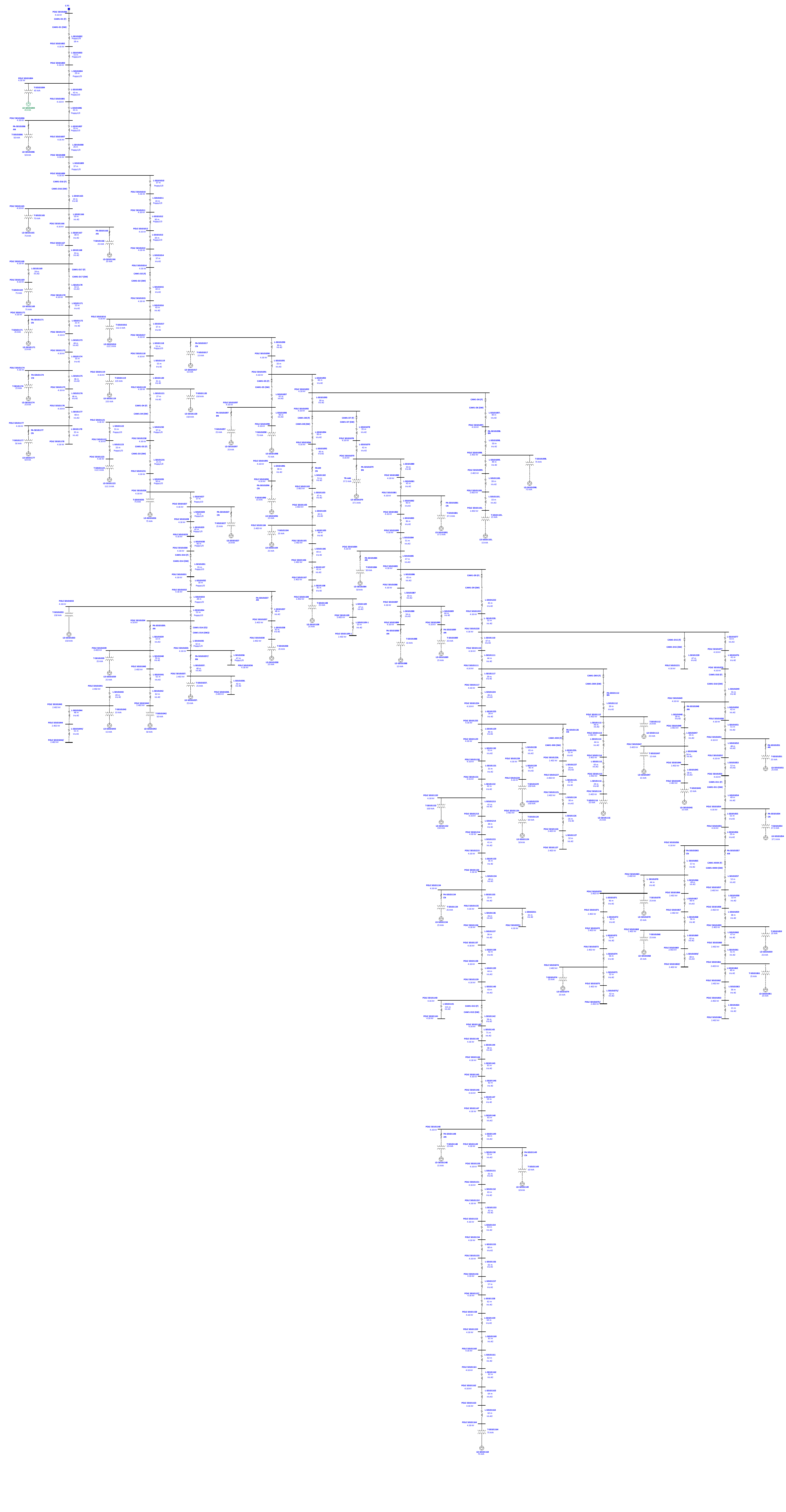
Year	F1		F2		F3		F4	
	Status	Min. Main Line Size C-F1	Status	Min. Main Line Size C-F2	Status	Min. Main Line Size C-F3	Status	Min. Main Line Size C-F4
2026	Failed		Passed	1/0 AWG	Failed		Failed	
2027	Failed		Passed	1/0 AWG	Failed		Failed	
2028	Failed		Passed	1/0 AWG	Failed		Failed	
2029	Failed		Passed	1/0 AWG	Failed		Failed	
2030	Failed		Passed	1/0 AWG	Failed		Failed	
2031	Failed		Passed	1/0 AWG	Failed		Failed	
2032	Failed		Passed	1/0 AWG	Failed		Failed	
2033	Failed		Passed	1/0 AWG	Failed		Failed	
2034	Failed		Passed	1/0 AWG	Failed		Failed	
2035	Failed		Passed	1/0 AWG	Failed		Failed	
2036	Failed		Passed	1/0 AWG	Failed		Failed	
2041	Failed		Passed	1/0 AWG	Failed		Failed	
2046	Failed		Passed	1/0 AWG	Failed		Failed	
2051	Failed		Passed	1/0 AWG	Failed		Failed	
2056	Failed		Passed	1/0 AWG	Failed		Failed	
2061	Failed		Passed	1/0 AWG	Failed		Failed	
2066	Failed		Passed	1/0 AWG	Failed		Failed	

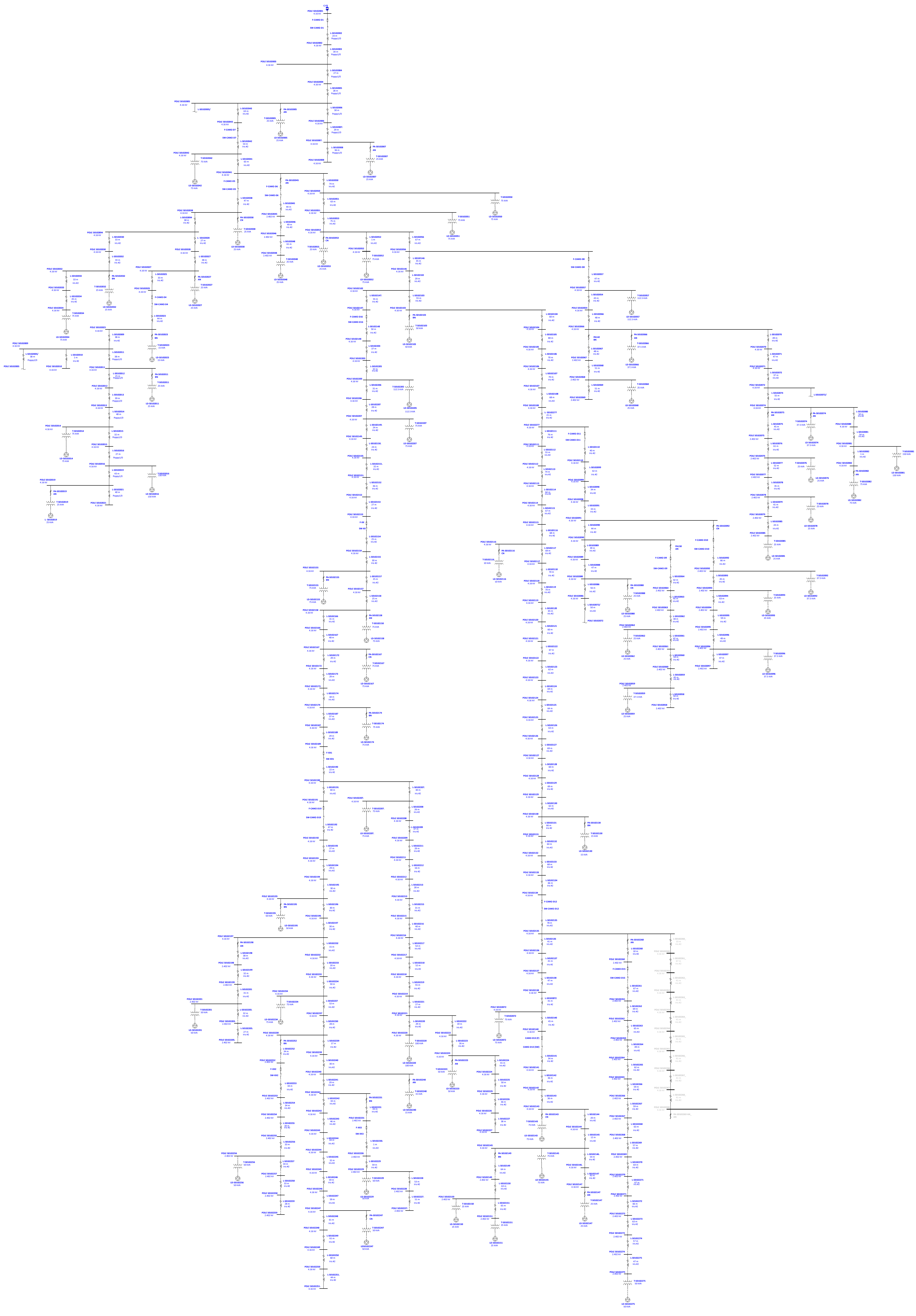
Appendix 1.C

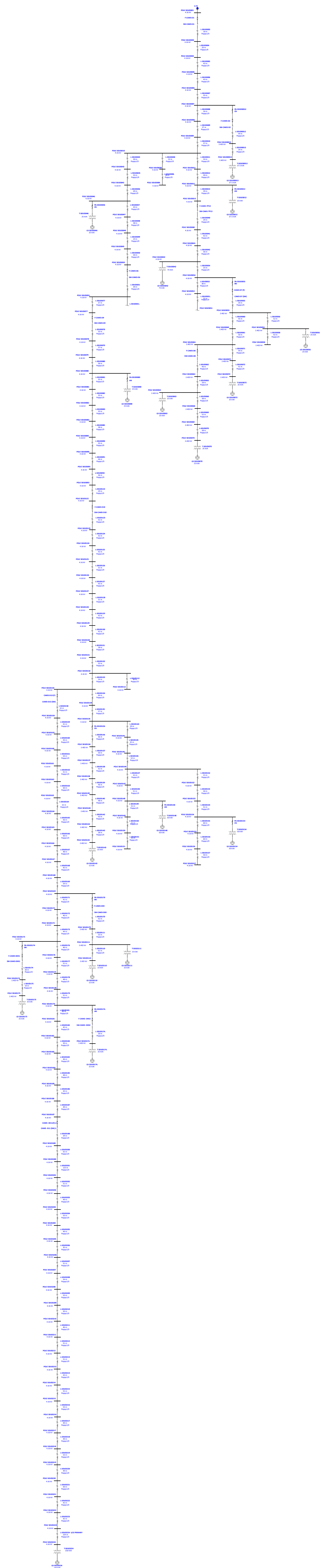
Cambridge Bay Network ETAP Model and Results – Option 3

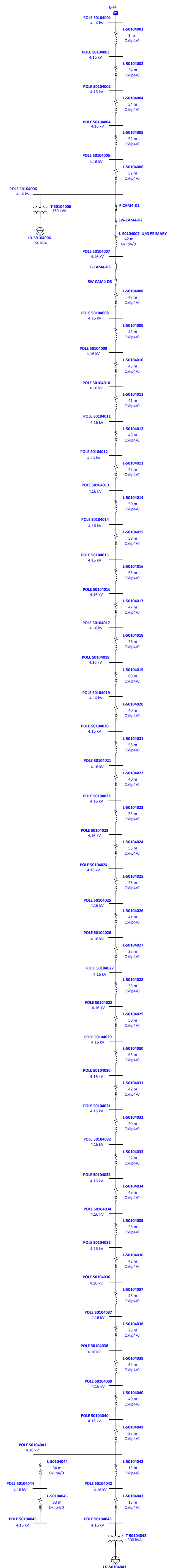


1500 kW
501-G-1
1100 kW
501-G-2
1500 kW
501-G-3
1100 kW
501-G-4
850 kW
501-G-5
501-MF-101
10 m
1-3/C 350
501-MF-102
10 m
1-3/C 4/0
501-MF-103
10 m
1-3/C 350
501-MF-104
10 m
1-3/C 4/0
501-MF-105
10 m
1-3/C 2/0
NEW POWERHOUSE
ELECTRICAL ROOM
MAIN SWITCHGEAR
501-SWGR-1
HVB-102
HVB-104
HVB-105
HVB-107
HVB-109
HVB-110
BUS A
4.16 kV
HVB-111
BUS B
4.16 kV
HVB-103
HVB-101
HVB-113
HVB- 105
HVB-108
HVB-112
C-T-F1_4-1
10 m
2-3/C 500
C-T-F2_3-1
10 m
2-3/C 500
T-F1_4-1
5 MVA
T-F2_3-1
5 MVA
L-T-F1_4-2
3825 m
Poppy 1/0
L-T-F2_3-2
3825 m
Poppy 1/0
EXISTING POWERHOUSE
CB1
CB2
BUS A1
25 kV
CB3
Open
BUS B1
25 kV
CB4
CB5
T-F1_4-2
5 MVA
T-F2_3-2
5 MVA
T-F1_4-2 (SEC)
4.16 kV
T-F2_3-2 (SEC)
4.16 kV
HVB-6
HVB-4
SWGR-A
4.16 kV
SWGR-B
4.16 kV
HVB-10
HVB-11
HVB-9
HVB-8
C-F1
Poppy1/0
40 m
C-F4
40 m
Oxlip4/0
C-F2
Poppy1/0
40 m
C-F3
40 m
Poppy1/0
F1
F4
F2
F3









Option 3: Scenario A: All Feeders are Fed from One Step-up Transformer

Year	F1								F2							
	Status	Min. Main Line Size	Transformer Taps				Transformer Min. Line Sizes		Status	Min. Main Line Size	Transformer Taps				Transformer Min. Line Sizes	
		C-F1	T-F1_4-1	T-F2_3-1	T-F1_4-2	T-F2_3-2	L-T-F1_4-2	L-T-F2_3-2		C-F2	T-F1_4-1	C-T-F2_3-1	T-F1_4-2	T-F2_3-2	L-T-F1_4-2	L-T-F2_3-2
2026	Passed	1/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0AWG	Passed	1/0 AWG	0%	0%	-5%	-5%	4/0 AWG	4/0AWG
2027	Passed	1/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0AWG	Passed	1/0 AWG	0%	0%	-5%	-5%	4/0 AWG	4/0AWG
2028	Passed	1/0 AWG	-5.00%	-5.00%	-5%	-5%	4/0 AWG	4/0AWG	Passed	1/0 AWG	0%	0%	-5%	-5%	4/0 AWG	4/0AWG
2029	Passed	1/0 AWG	-5.00%	-5.00%	-5%	-5%	4/0 AWG	4/0AWG	Passed	1/0 AWG	0%	0%	-5%	-5%	4/0 AWG	4/0AWG
2030	Passed	1/0 AWG	-5.00%	-5.00%	-5%	-5%	4/0 AWG	4/0AWG	Passed	1/0 AWG	0%	0%	-5%	-5%	4/0 AWG	4/0AWG
2031	Passed	1/0 AWG	-5.00%	-5.00%	-5%	-5%	4/0 AWG	4/0AWG	Passed	1/0 AWG	0%	0%	-5%	-5%	4/0 AWG	4/0AWG
2032	Passed	1/0 AWG	-5.00%	-5.00%	-5%	-5%	4/0 AWG	4/0AWG	Passed	1/0 AWG	0%	0%	-5%	-5%	4/0 AWG	4/0AWG
2033	Passed	1/0 AWG	-5.00%	-5.00%	-5%	-5%	4/0 AWG	4/0AWG	Passed	1/0 AWG	0%	0%	-5%	-5%	4/0 AWG	4/0AWG
2034	Passed	1/0 AWG	-5.00%	-5.00%	-5%	-5%	4/0 AWG	4/0AWG	Passed	1/0 AWG	0%	0%	-5%	-5%	4/0 AWG	4/0AWG
2035	Passed	1/0 AWG	-5.00%	-5.00%	-5%	-5%	4/0 AWG	4/0AWG	Passed	1/0 AWG	0%	0%	-5%	-5%	4/0 AWG	4/0AWG
2036	Passed	1/0 AWG	-5.00%	-5.00%	-5%	-5%	4/0 AWG	4/0AWG	Passed	1/0 AWG	0%	0%	-5%	-5%	4/0 AWG	4/0AWG
2041	Passed	1/0 AWG	-5.00%	-5.00%	-5%	-5%	4/0 AWG	4/0AWG	Passed	1/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0AWG
2046	Passed	1/0 AWG	-5.00%	-5.00%	-5%	-5%	4/0 AWG	4/0AWG	Passed	1/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0AWG
2051	Passed	4/0 AWG	-5.00%	-5.00%	-5%	-5%	4/0 AWG	4/0AWG	Passed	1/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0AWG
2056	Failed								Passed	1/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0AWG
2061	Failed								Passed	1/0 AWG	-5%	-5%	-5%	-5%	4/0 AWG	4/0AWG
2066	Failed								Passed	1/0 AWG	-5%	-5%	-5%	-5%	4/0 AWG	4/0AWG

Year	F3								F4							
	Status	Min. Main Line Size	Transformer Taps				Transformer Min. Line Sizes		Status	Min. Main Line Size	Transformer Taps				Transformer Min. Line Sizes	
		C-F3	T-F1_4-1	C-T-F2_3-1	T-F1_4-2	T-F2_3-2	L-T-F1_4-2	L-T-F2_3-2		C-F4	T-F1_4-1	C-T-F2_3-1	T-F1_4-2	T-F2_3-2	L-T-F1_4-2	L-T-F2_3-2
2026	Passed	1/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0AWG	Passed	4/0 AWG	0%	0%	-5%	-5%	4/0 AWG	4/0AWG
2027	Passed	1/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0AWG	Passed	4/0 AWG	0%	0%	-5%	-5%	4/0 AWG	4/0AWG
2028	Passed	1/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0AWG	Passed	4/0 AWG	0%	0%	-5%	-5%	4/0 AWG	4/0AWG
2029	Passed	1/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0AWG	Passed	4/0 AWG	0%	0%	-5%	-5%	4/0 AWG	4/0AWG
2030	Passed	1/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0AWG	Passed	4/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0AWG
2031	Passed	1/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0AWG	Passed	4/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0AWG
2032	Passed	1/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0AWG	Passed	4/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0AWG
2033	Passed	1/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0AWG	Passed	4/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0AWG
2034	Passed	1/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0AWG	Passed	4/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0AWG
2035	Passed	1/0 AWG	-5.00%	-5.00%	-5%	-5%	4/0 AWG	4/0AWG	Passed	4/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0AWG
2036	Passed	1/0 AWG	-5.00%	-5.00%	-5%	-5%	4/0 AWG	4/0AWG	Passed	4/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0AWG
2041	Passed	1/0 AWG	-5.00%	-5.00%	-5%	-5%	4/0 AWG	4/0AWG	Passed	4/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0AWG
2046	Passed	1/0 AWG	-5.00%	-5.00%	-5%	-5%	4/0 AWG	4/0AWG	Passed	4/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0AWG
2051	Passed	1/0 AWG	-5.00%	-5.00%	-5%	-5%	4/0 AWG	4/0AWG	Passed	4/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0AWG
2056	Failed								Passed	4/0 AWG	-5%	-5%	-5%	-5%	4/0 AWG	4/0AWG
2061	Failed								Passed	4/0 AWG	-5%	-5%	-5%	-5%	4/0 AWG	4/0AWG
2066	Failed								Passed	4/0 AWG	-5%	-5%	-5%	-5%	4/0 AWG	4/0AWG

Option 3: Scenario B: Each Two Feeders are Fed from One Step-up Transformer

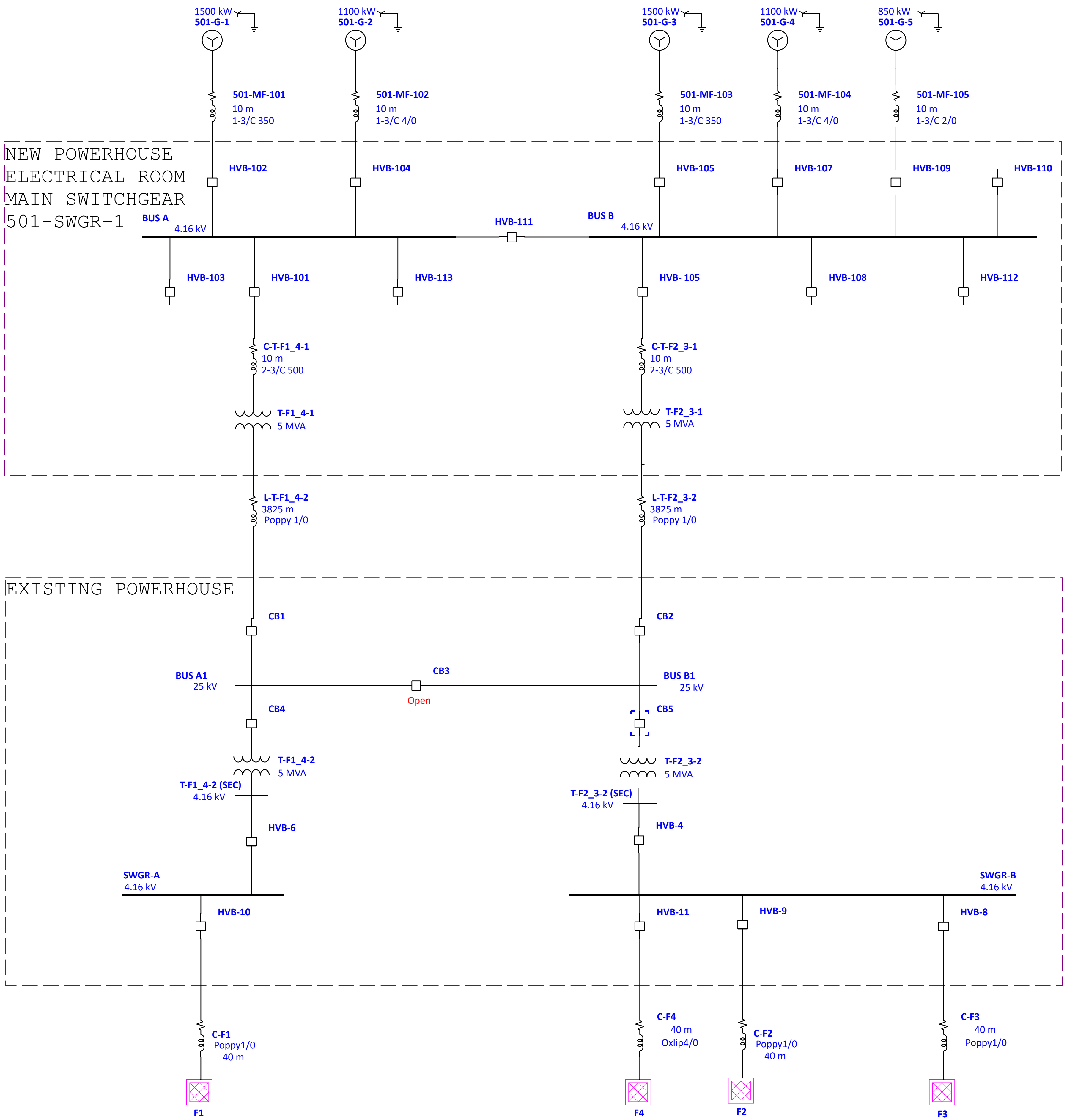
Year	F1								F2							
	Status	Min. Main Line Size	Transformer Taps				Transformer Min. Line Sizes		Status	Min. Main Line Size	Transformer Taps				Transformer Min. Line Sizes	
		C-F1	T-F1_4-1	T-F2_3-1	T-F1_4-2	T-F2_3-2	L-T-F1_4-2	L-T-F2_3-2		C-F2	T-F1_4-1	C-T-F2_3-1	T-F1_4-2	T-F2_3-2	L-T-F1_4-2	L-T-F2_3-2
2026	Passed	4/0 AWG	-2.50%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2027	Passed	4/0 AWG	-2.50%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2028	Passed	4/0 AWG	-2.50%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2029	Passed	4/0 AWG	-2.50%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2030	Passed	4/0 AWG	-2.50%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2031	Passed	4/0 AWG	-2.50%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2032	Passed	4/0 AWG	-2.50%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2033	Passed	4/0 AWG	-2.50%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2034	Passed	4/0 AWG	-2.50%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2035	Passed	4/0 AWG	-2.50%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2036	Passed	4/0 AWG	-2.50%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2041	Passed	4/0 AWG	-2.50%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2046	Passed	4/0 AWG	-2.50%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2051	Passed	4/0 AWG	-2.50%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2056	Passed	4/0 AWG	-5%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	4/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2061	Passed	4/0 AWG	-5%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	4/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2066	Passed	4/0 AWG	-5%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	4/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG

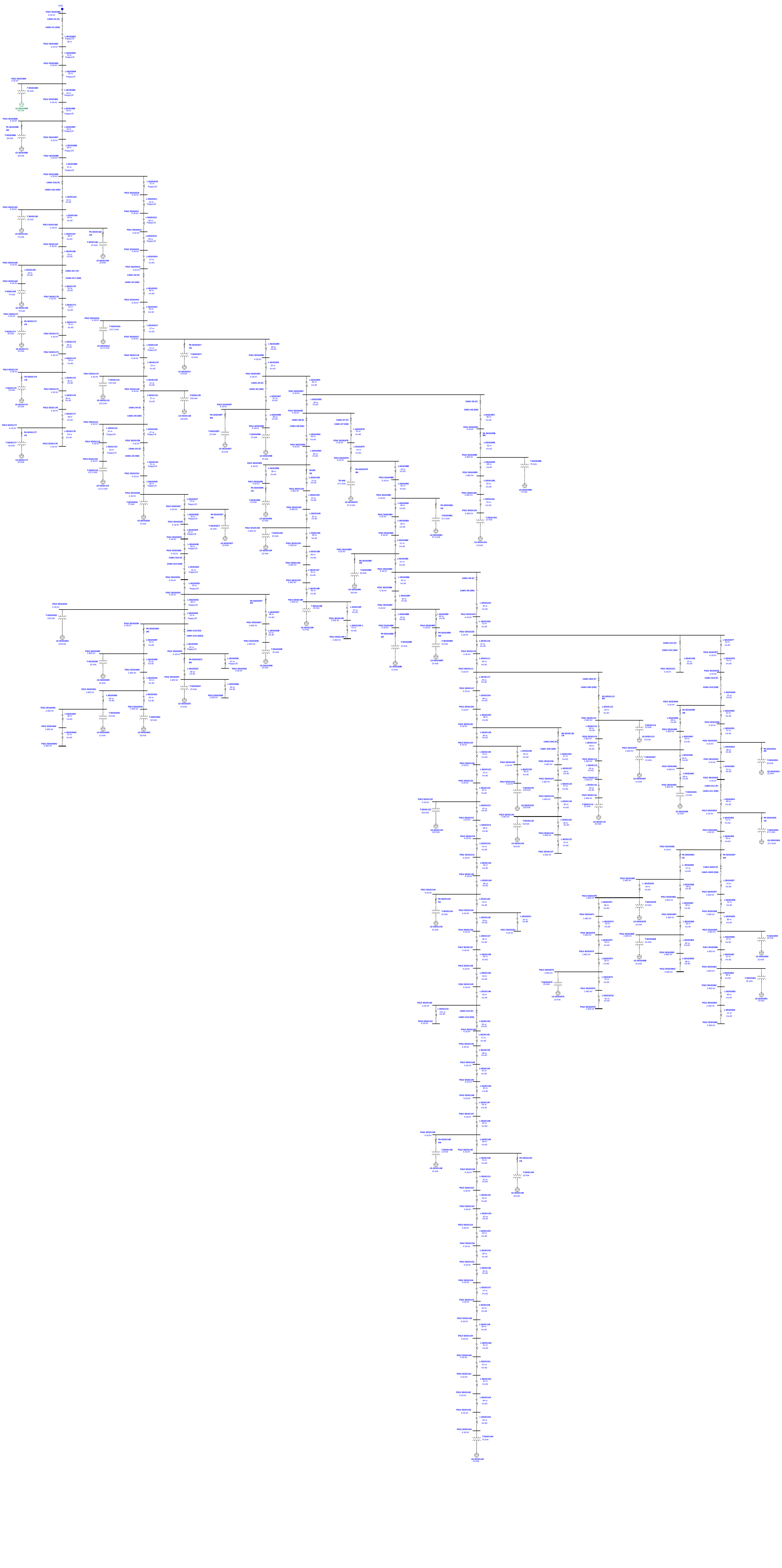
Year	F3								F4							
	Status	Min. Main Line Size	Transformer Taps				Transformer Min. Line Sizes		Status	Min. Main Line Size	Transformer Taps				Transformer Min. Line Sizes	
		C-F3	T-F1_4-1	C-T-F2_3-1	T-F1_4-2	T-F2_3-2	L-T-F1_4-2	L-T-F2_3-2		C-F4	T-F1_4-1	C-T-F2_3-1	T-F1_4-2	T-F2_3-2	L-T-F1_4-2	L-T-F2_3-2
2026	Passed	1/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	0%	N/A	-2.50%	N/A	4/0 AWG	N/A
2027	Passed	1/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	0%	N/A	-5.00%	N/A	4/0 AWG	N/A
2028	Passed	1/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	0%	N/A	-5.00%	N/A	4/0 AWG	N/A
2029	Passed	1/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	0%	N/A	-5.00%	N/A	4/0 AWG	N/A
2030	Passed	1/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	0%	N/A	-5.00%	N/A	4/0 AWG	N/A
2031	Passed	1/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	0%	N/A	-5.00%	N/A	4/0 AWG	N/A
2032	Passed	1/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	0%	N/A	-5.00%	N/A	4/0 AWG	N/A
2033	Passed	1/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	0%	N/A	-5.00%	N/A	4/0 AWG	N/A
2034	Passed	1/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	0%	N/A	-5.00%	N/A	4/0 AWG	N/A
2035	Passed	1/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	0%	N/A	-5.00%	N/A	4/0 AWG	N/A
2036	Passed	2/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	0%	N/A	-5.00%	N/A	4/0 AWG	N/A
2041	Passed	4/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	0%	N/A	-5.00%	N/A	4/0 AWG	N/A
2046	Passed	4/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	0%	N/A	-5.00%	N/A	4/0 AWG	N/A
2051	Passed	4/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	0%	N/A	-5.00%	N/A	4/0 AWG	N/A
2056	Passed	4/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	0%	N/A	-5.00%	N/A	4/0 AWG	N/A
2061	Passed	4/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	-2.50%	N/A	-5.00%	N/A	4/0 AWG	N/A
2066	Passed	4/0 AWG	N/A	-5.00%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	-2.50%	N/A	-5.00%	N/A	4/0 AWG	N/A

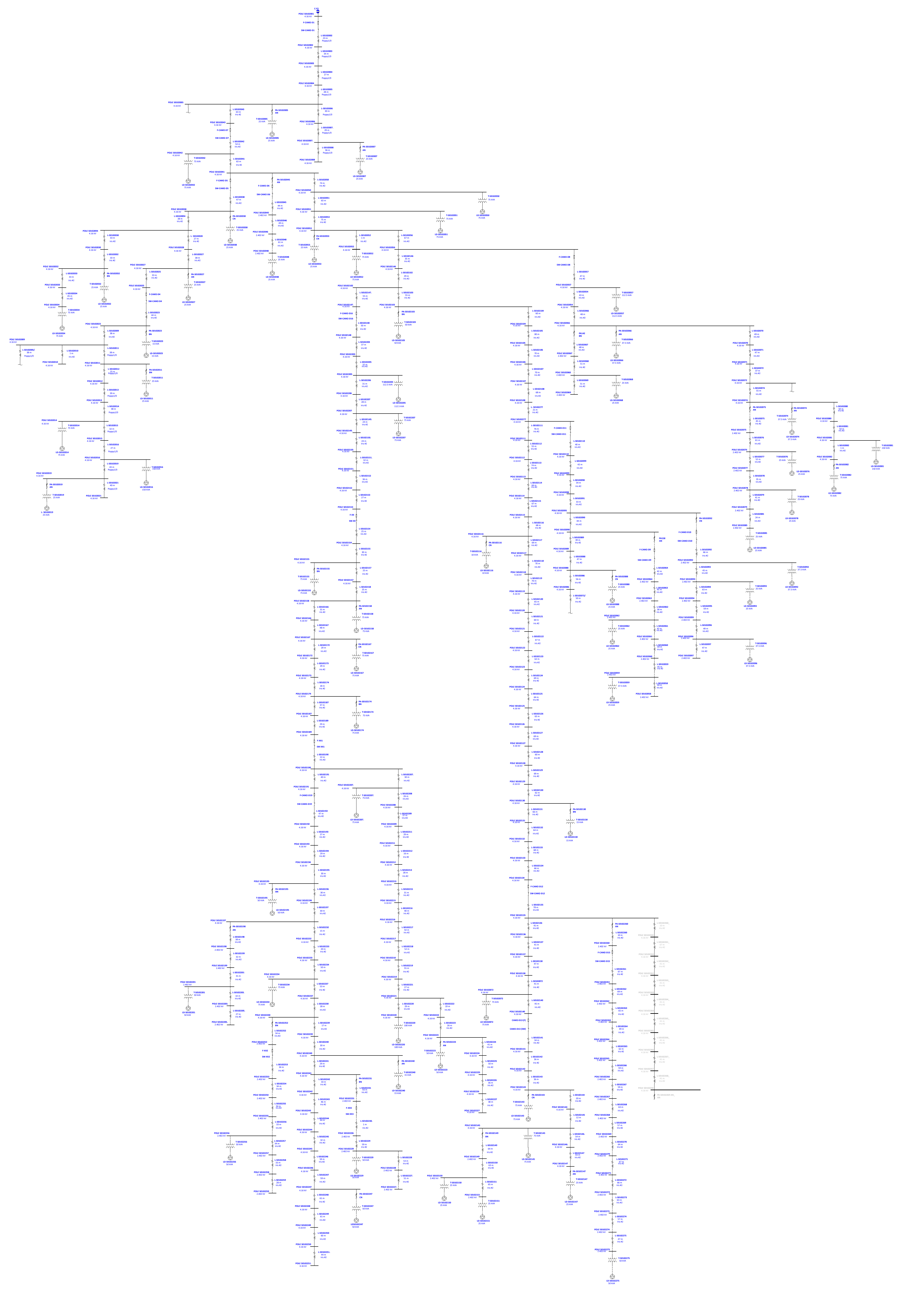
Appendix 1.D

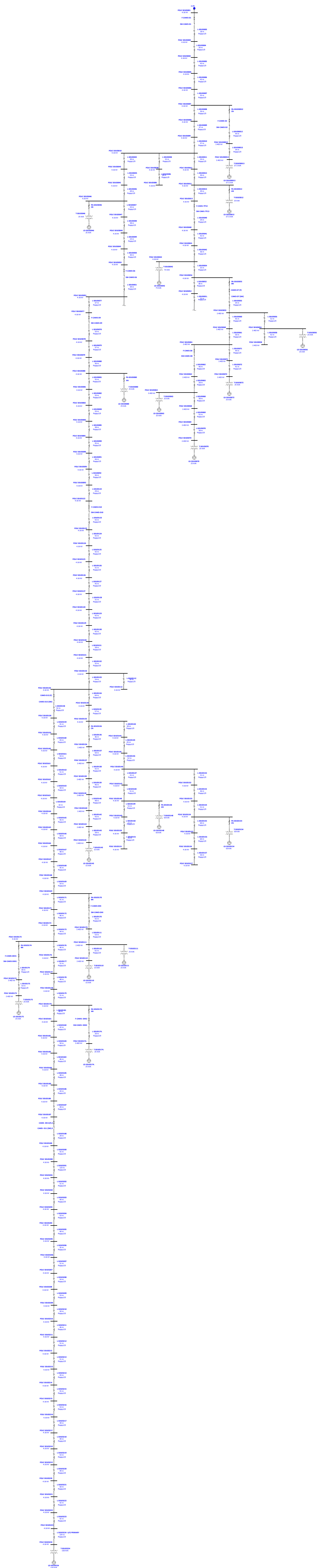
Cambridge Bay Network ETAP Model – Option 3A

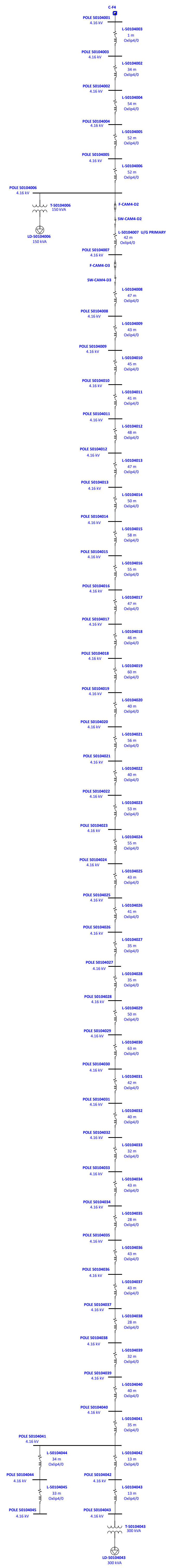
One-Line Diagram - OLV1 (Load Flow Analysis)










C-F4
POLE 50104001
4.16 kV
L-50104003
1 m
Oxlip4/0
POLE 50104003
4.16 kV
L-50104002
34 m
Oxlip4/0
POLE 50104002
4.16 kV
L-50104004
54 m
Oxlip4/0
POLE 50104004
4.16 kV
L-50104005
52 m
Oxlip4/0
POLE 50104005
4.16 kV
L-50104006
52 m
Oxlip4/0
POLE 50104006
4.16 kV
T-50104006
150 kVA
LD-50104006
150 kVA
F-CAM4-D2
SW-CAM4-D2
L-50104007 U/G PRIMARY
42 m
Oxlip4/0
POLE 50104007
4.16 kV
F-CAM4-D3
SW-CAM4-D3
L-50104008
47 m
Oxlip4/0
POLE 50104008
4.16 kV
L-50104009
43 m
Oxlip4/0
POLE 50104009
4.16 kV
L-50104010
45 m
Oxlip4/0
POLE 50104010
4.16 kV
L-50104011
41 m
Oxlip4/0
POLE 50104011
4.16 kV
L-50104012
48 m
Oxlip4/0
POLE 50104012
4.16 kV
L-50104013
47 m
Oxlip4/0
POLE 50104013
4.16 kV
L-50104014
50 m
Oxlip4/0
POLE 50104014
4.16 kV
L-50104015
58 m
Oxlip4/0
POLE 50104015
4.16 kV
L-50104016
55 m
Oxlip4/0
POLE 50104016
4.16 kV
L-50104017
47 m
Oxlip4/0
POLE 50104017
4.16 kV
L-50104018
46 m
Oxlip4/0
POLE 50104018
4.16 kV
L-50104019
60 m
Oxlip4/0
POLE 50104019
4.16 kV
L-50104020
40 m
Oxlip4/0
POLE 50104020
4.16 kV
L-50104021
56 m
Oxlip4/0
POLE 50104021
4.16 kV
L-50104022
40 m
Oxlip4/0
POLE 50104022
4.16 kV
L-50104023
53 m
Oxlip4/0
POLE 50104023
4.16 kV
L-50104024
55 m
Oxlip4/0
POLE 50104024
4.16 kV
L-50104025
43 m
Oxlip4/0
POLE 50104025
4.16 kV
L-50104026
41 m
Oxlip4/0
POLE 50104026
4.16 kV
L-50104027
35 m
Oxlip4/0
POLE 50104027
4.16 kV
L-50104028
35 m
Oxlip4/0
POLE 50104028
4.16 kV
L-50104029
50 m
Oxlip4/0
POLE 50104029
4.16 kV
L-50104030
63 m
Oxlip4/0
POLE 50104030
4.16 kV
L-50104031
42 m
Oxlip4/0
POLE 50104031
4.16 kV
L-50104032
40 m
Oxlip4/0
POLE 50104032
4.16 kV
L-50104033
32 m
Oxlip4/0
POLE 50104033
4.16 kV
L-50104034
43 m
Oxlip4/0
POLE 50104034
4.16 kV
L-50104035
28 m
Oxlip4/0
POLE 50104035
4.16 kV
L-50104036
43 m
Oxlip4/0
POLE 50104036
4.16 kV
L-50104037
43 m
Oxlip4/0
POLE 50104037
4.16 kV
L-50104038
28 m
Oxlip4/0
POLE 50104038
4.16 kV
L-50104039
32 m
Oxlip4/0
POLE 50104039
4.16 kV
L-50104040
40 m
Oxlip4/0
POLE 50104040
4.16 kV
L-50104041
35 m
Oxlip4/0
POLE 50104041
4.16 kV
L-50104044
34 m
Oxlip4/0
L-50104042
13 m
Oxlip4/0
POLE 50104044
4.16 kV
POLE 50104042
4.16 kV
L-50104045
33 m
Oxlip4/0
L-50104043
13 m
Oxlip4/0
POLE 50104045
4.16 kV
POLE 50104043
4.16 kV
T-50104043
300 kVA
LD-50104043
300 kVA

Option 3A: Scenario A: All Feeders are Fed from One Step-up Transformer

Year	F1								F2							
	Status	Min. Main Line Size	Transformer Taps				Transformer Min. Line Sizes		Status	Min. Main Line Size	Transformer Taps				Transformer Min. Line Sizes	
		C-F1	T-F1_4-1	T-F2_3-1	T-F1_4-2	T-F2_3-2	L-T-F1_4-2	L-T-F2_3-2		C-F2	T-F1_4-1	T-F2_3-1	T-F1_4-2	T-F2_3-2	L-T-F1_4-2	L-T-F2_3-2
2026	Passed	1/0 AWG	-2.50%	-2.50%	-5%	N/A	4/0 AWG	4/0 AWG	Passed	1/0 AWG	0%	0%	-5%	-5%	4/0 AWG	4/0 AWG
2027	Passed	1/0 AWG	-2.50%	-2.50%	-5%	N/A	4/0 AWG	4/0 AWG	Passed	1/0 AWG	0%	0%	-5%	-5%	4/0 AWG	4/0 AWG
2028	Passed	1/0 AWG	-2.50%	-2.50%	-5%	N/A	4/0 AWG	4/0 AWG	Passed	1/0 AWG	0%	0%	-5%	-5%	4/0 AWG	4/0 AWG
2029	Passed	1/0 AWG	-2.50%	-2.50%	-5%	N/A	4/0 AWG	4/0 AWG	Passed	1/0 AWG	0%	0%	-5%	-5%	4/0 AWG	4/0 AWG
2030	Passed	1/0 AWG	-2.50%	-2.50%	-5%	N/A	4/0 AWG	4/0 AWG	Passed	1/0 AWG	0%	0%	-5%	-5%	4/0 AWG	4/0 AWG
2031	Passed	2/0 AWG	-2.50%	-2.50%	-5%	N/A	4/0 AWG	4/0 AWG	Passed	1/0 AWG	0%	0%	-5%	-5%	4/0 AWG	4/0 AWG
2032	Passed	1/0 AWG	-5.00%	-5.00%	-5%	N/A	4/0 AWG	4/0 AWG	Passed	1/0 AWG	0%	0%	-5%	-5%	4/0 AWG	4/0 AWG
2033	Passed	1/0 AWG	-5.00%	-5.00%	-5%	N/A	4/0 AWG	4/0 AWG	Passed	1/0 AWG	0%	0%	-5%	-5%	4/0 AWG	4/0 AWG
2034	Passed	1/0 AWG	-5.00%	-5.00%	-5%	N/A	4/0 AWG	4/0 AWG	Passed	4/0 AWG	0%	0%	-5%	-5%	4/0 AWG	4/0 AWG
2035	Passed	1/0 AWG	-5.00%	-5.00%	-5%	N/A	4/0 AWG	4/0 AWG	Passed	1/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0 AWG
2036	Passed	1/0 AWG	-5.00%	-5.00%	-5%	N/A	4/0 AWG	4/0 AWG	Passed	1/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0 AWG
2041	Passed	1/0 AWG	-5.00%	-5.00%	-5%	N/A	4/0 AWG	4/0 AWG	Passed	1/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0 AWG
2046	Passed	1/0 AWG	-5.00%	-5.00%	-5%	N/A	4/0 AWG	4/0 AWG	Passed	1/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0 AWG
2051	Passed	1/0 AWG	-5.00%	-5.00%	-5%	N/A	4/0 AWG	4/0 AWG	Passed	1/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0 AWG
2056	Failed								Passed	1/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0 AWG
2061	Failed								Passed	1/0 AWG	-5.00%	-5.00%	-5%	-5%	4/0 AWG	4/0 AWG
2066	Failed								Passed	1/0 AWG	-5.00%	-5.00%	-5%	-5%	4/0 AWG	4/0 AWG

Year	F3								F4							
	Status	Min. Main Line Size	Transformer Taps				Transformer Min. Line Sizes		Status	Min. Main Line Size	Transformer Taps				Transformer Min. Line Sizes	
		C-F3	T-F1_4-1	T-F2_3-1	T-F1_4-2	T-F2_3-2	L-T-F1_4-2	L-T-F2_3-2		C-F4	T-F1_4-1	T-F2_3-1	T-F1_4-2	T-F2_3-2	L-T-F1_4-2	L-T-F2_3-2
2026	Passed	1/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0 AWG	Passed	4/0 AWG	0%	0%	-5%	-5%	4/0 AWG	4/0 AWG
2027	Passed	1/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0 AWG	Passed	4/0 AWG	0%	0%	-5%	-5%	4/0 AWG	4/0 AWG
2028	Passed	1/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0 AWG	Passed	4/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0 AWG
2029	Passed	1/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0 AWG	Passed	4/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0 AWG
2030	Passed	1/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0 AWG	Passed	4/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0 AWG
2031	Passed	4/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0 AWG	Passed	4/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0 AWG
2032	Passed	1/0 AWG	-5%	-5%	-5%	-5%	4/0 AWG	4/0 AWG	Passed	4/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0 AWG
2033	Passed	1/0 AWG	-5%	-5%	-5%	-5%	4/0 AWG	4/0 AWG	Passed	4/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0 AWG
2034	Passed	1/0 AWG	-5%	-5%	-5%	-5%	4/0 AWG	4/0 AWG	Passed	4/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0 AWG
2035	Passed	1/0 AWG	-5%	-5%	-5%	-5%	4/0 AWG	4/0 AWG	Passed	4/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0 AWG
2036	Passed	1/0 AWG	-5%	-5%	-5%	-5%	4/0 AWG	4/0 AWG	Passed	4/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0 AWG
2041	Passed	1/0 AWG	-5%	-5%	-5%	-5%	4/0 AWG	4/0 AWG	Passed	4/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0 AWG
2046	Passed	1/0 AWG	-5%	-5%	-5%	-5%	4/0 AWG	4/0 AWG	Passed	4/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0 AWG
2051	Passed	1/0 AWG	-5%	-5%	-5%	-5%	4/0 AWG	4/0 AWG	Passed	4/0 AWG	-2.50%	-2.50%	-5%	-5%	4/0 AWG	4/0 AWG
2056	Failed								Passed	4/0 AWG	-5%	-5%	-5%	-5%	4/0 AWG	4/0 AWG
2061	Failed								Passed	4/0 AWG	-5%	-5%	-5%	-5%	4/0 AWG	4/0 AWG
2066	Failed								Passed	4/0 AWG	-5%	-5%	-5%	-5%	4/0 AWG	4/0 AWG

Option 3A: Sceenario B: Feeder 1 is Fed from T-F1_4-2 Step-up Transformer and Feeders 2, 3, and 4 are Fed from T-F2_3-2 Step-Up Transformer

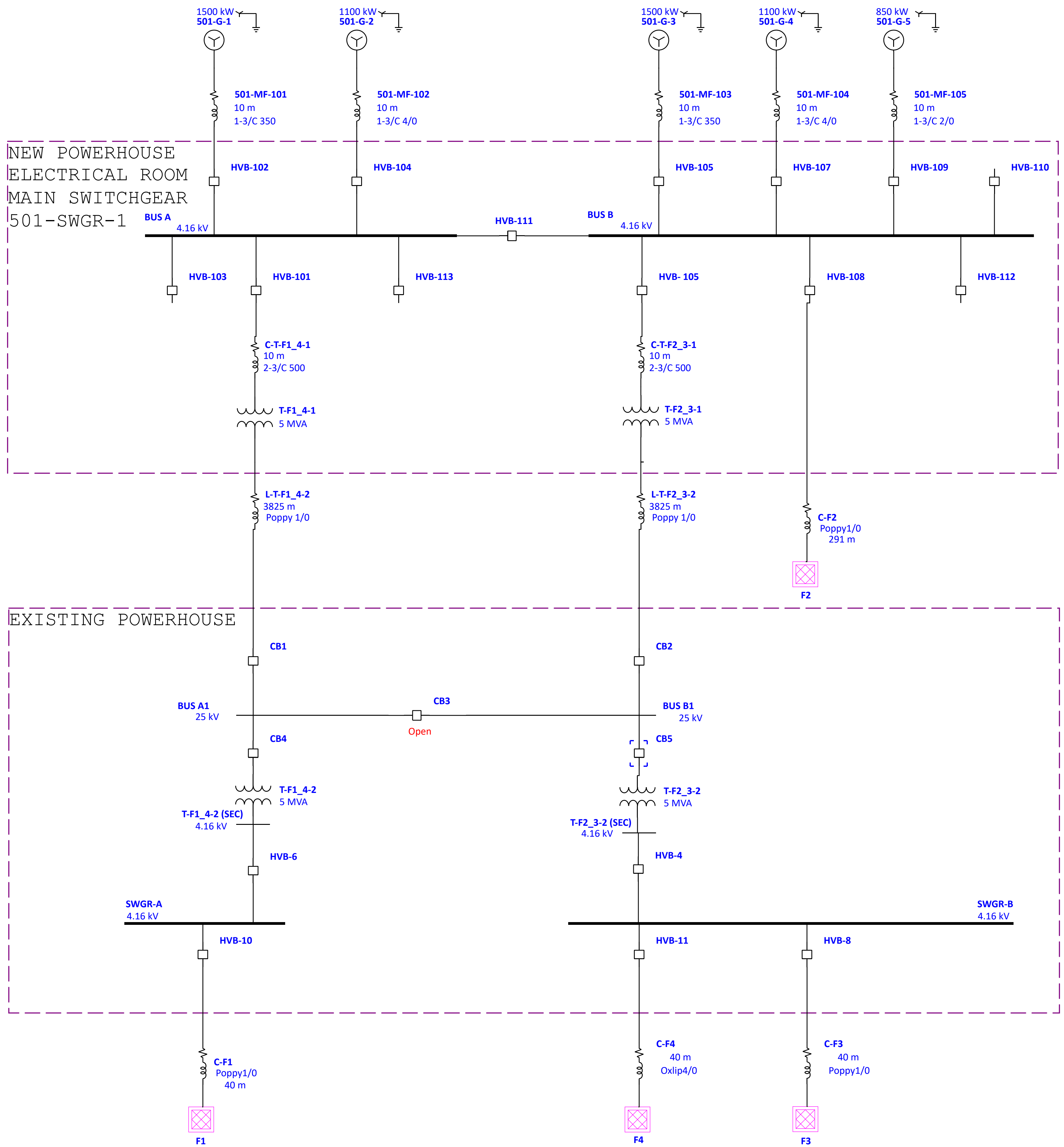
Year	F1								F2							
	Status	Min. Main Line Size	Transformer Taps				Transformer Min. Line Sizes		Status	Min. Main Line Size	Transformer Taps				Transformer Min. Line Sizes	
		C-F1	T-F1_4-1	T-F2_3-1	T-F1_4-2	T-F2_3-2	L-T-F1_4-2	L-T-F2_3-2		C-F2	T-F1_4-1	T-F2_3-1	T-F1_4-2	T-F2_3-2	L-T-F1_4-2	L-T-F2_3-2
2026	Passed	1/0 AWG	0.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2027	Passed	1/0 AWG	0.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2028	Passed	1/0 AWG	0.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2029	Passed	1/0 AWG	0.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2030	Passed	1/0 AWG	0.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	3/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2031	Passed	1/0 AWG	0.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2032	Passed	1/0 AWG	0.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2033	Passed	1/0 AWG	0.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2034	Passed	1/0 AWG	0.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2035	Passed	4/0 AWG	0.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2036	Passed	1/0 AWG	-2.50%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2041	Passed	1/0 AWG	-2.50%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2046	Passed	1/0 AWG	-2.50%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2051	Passed	1/0 AWG	-2.50%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2056	Passed	1/0 AWG	-2.50%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2061	Passed	1/0 AWG	-5.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2066	Passed	1/0 AWG	-5.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG

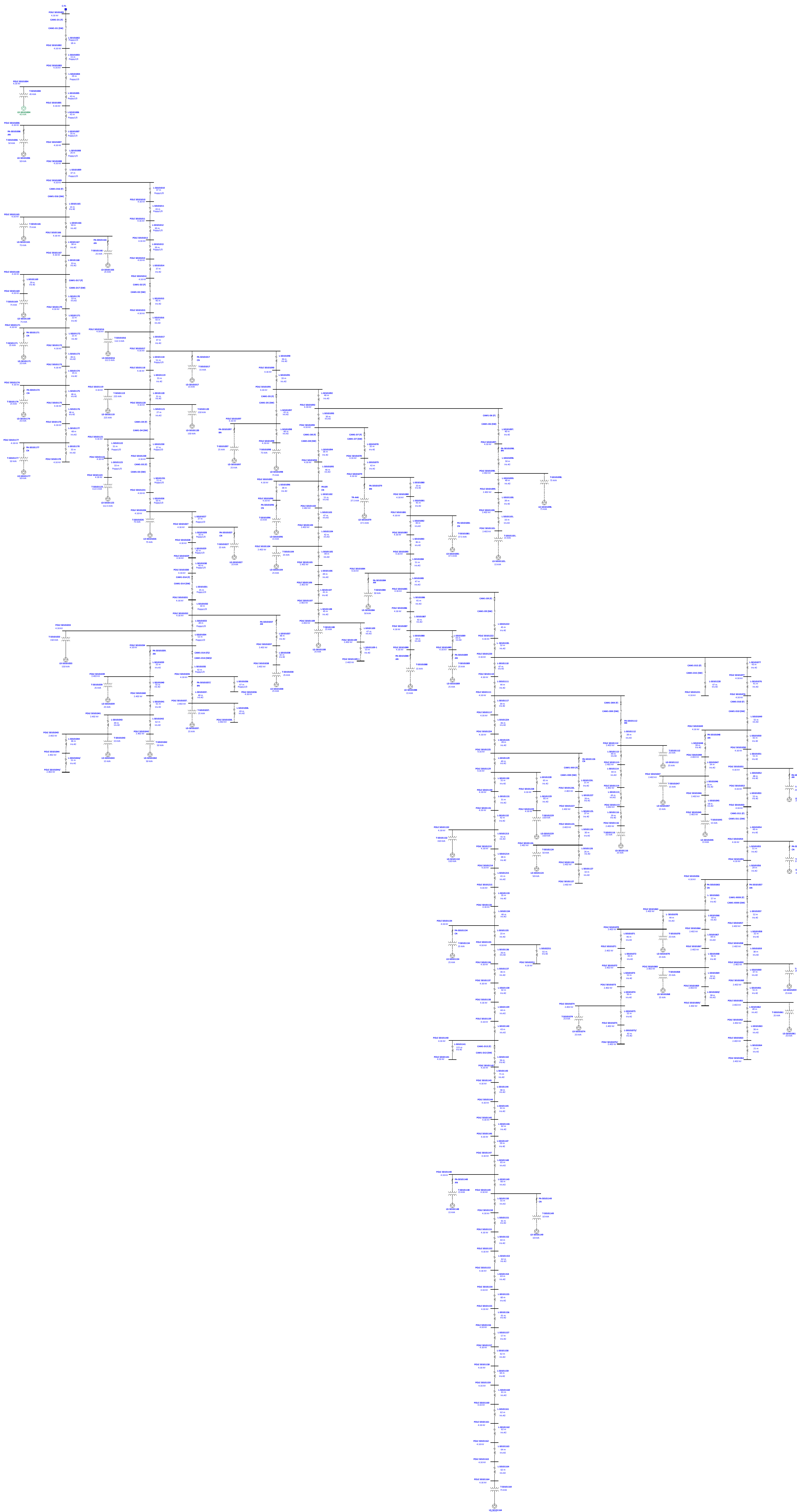
Year	F3								F4							
	Status	Min. Main Line Size	Transformer Taps				Transformer Min. Line Sizes		Status	Min. Main Line Size	Transformer Taps				Transformer Min. Line Sizes	
		C-F3	T-F1_4-1	T-F2_3-1	T-F1_4-2	T-F2_3-2	L-T-F1_4-2	L-T-F2_3-2		C-F4	T-F1_4-1	T-F2_3-1	T-F1_4-2	T-F2_3-2	L-T-F1_4-2	L-T-F2_3-2
2026	Passed	1/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2027	Passed	1/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2028	Passed	1/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2029	Passed	1/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2030	Passed	1/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2031	Passed	1/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2032	Passed	1/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2033	Passed	1/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2034	Passed	1/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2035	Passed	1/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2036	Passed	1/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2041	Passed	1/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2046	Passed	1/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2051	Passed	1/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2056	Passed	1/0 AWG	N/A	-5.00%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2061	Passed	1/0 AWG	N/A	-5.00%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG
2066	Passed	1/0 AWG	N/A	-5.00%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG

Appendix 1.E

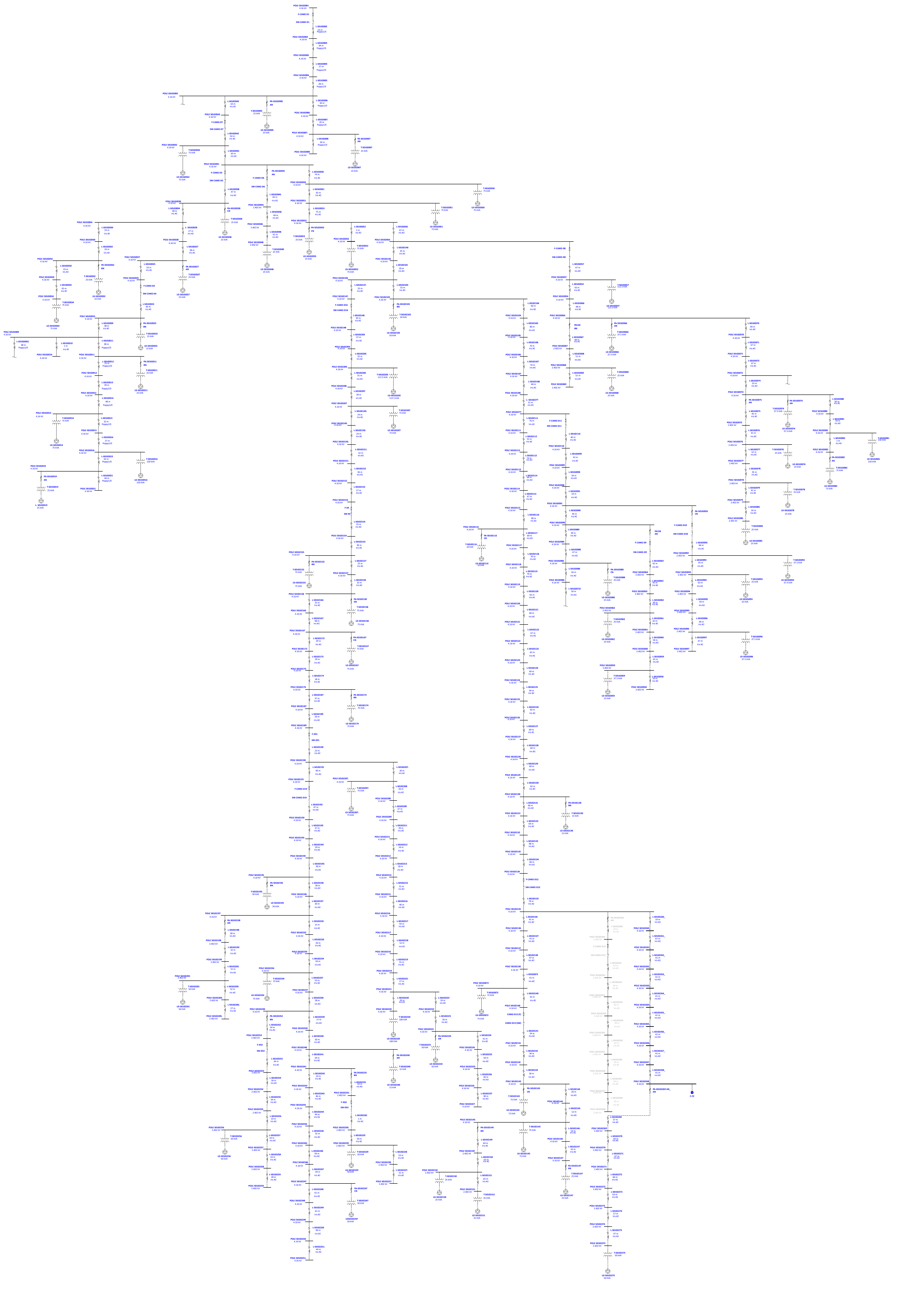
Cambridge Bay Network ETAP Model and Results – Option 3B

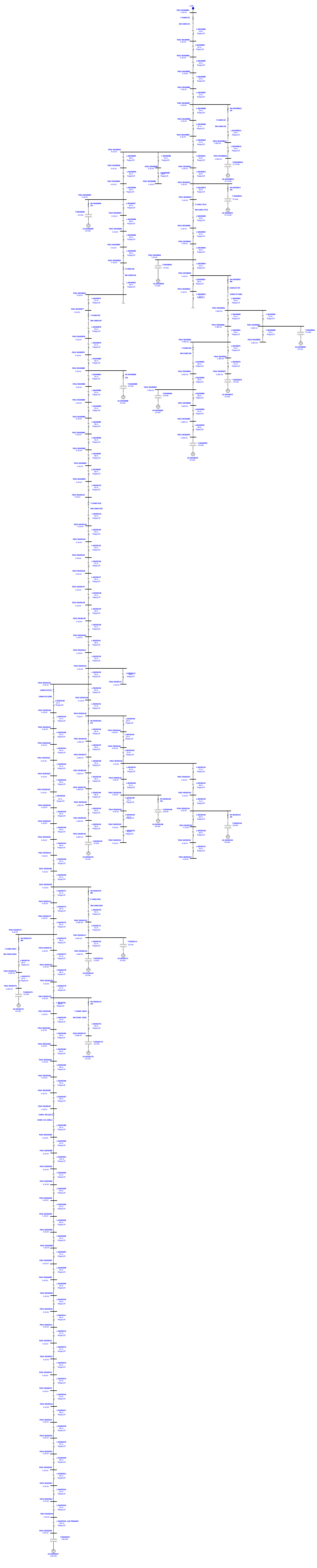
One-Line Diagram - OLV1 (Load Flow Analysis)

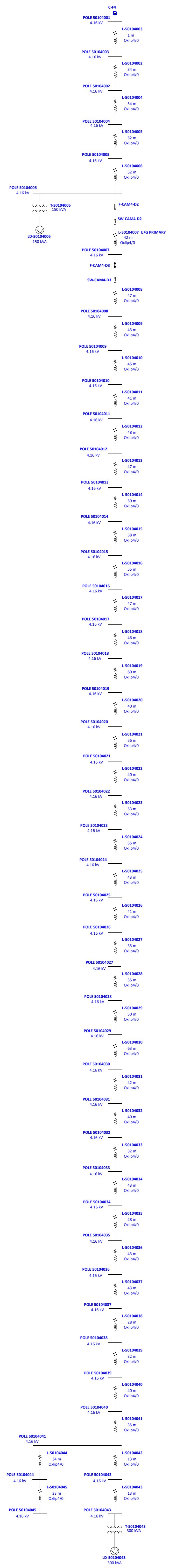




One-Line Diagram - OLV1=>F2 (Load Flow Analysis) - Ahmed.Abdelfattah(Project Editor)






C-F4
POLE S0104001
4.16 kV
L-S0104003
1 m
Oxlip4/0
POLE S0104003
4.16 kV
L-S0104002
34 m
Oxlip4/0
POLE S0104002
4.16 kV
L-S0104004
54 m
Oxlip4/0
POLE S0104004
4.16 kV
L-S0104005
52 m
Oxlip4/0
POLE S0104005
4.16 kV
L-S0104006
52 m
Oxlip4/0
POLE S0104006
4.16 kV
T-S0104006
150 kVA
LD-S0104006
150 kVA
F-CAM4-D2
SW-CAM4-D2
L-S0104007 U/G PRIMARY
42 m
Oxlip4/0
POLE S0104007
4.16 kV
F-CAM4-D3
SW-CAM4-D3
L-S0104008
47 m
Oxlip4/0
POLE S0104008
4.16 kV
L-S0104009
43 m
Oxlip4/0
POLE S0104009
4.16 kV
L-S0104010
45 m
Oxlip4/0
POLE S0104010
4.16 kV
L-S0104011
41 m
Oxlip4/0
POLE S0104011
4.16 kV
L-S0104012
48 m
Oxlip4/0
POLE S0104012
4.16 kV
L-S0104013
47 m
Oxlip4/0
POLE S0104013
4.16 kV
L-S0104014
50 m
Oxlip4/0
POLE S0104014
4.16 kV
L-S0104015
58 m
Oxlip4/0
POLE S0104015
4.16 kV
L-S0104016
55 m
Oxlip4/0
POLE S0104016
4.16 kV
L-S0104017
47 m
Oxlip4/0
POLE S0104017
4.16 kV
L-S0104018
46 m
Oxlip4/0
POLE S0104018
4.16 kV
L-S0104019
60 m
Oxlip4/0
POLE S0104019
4.16 kV
L-S0104020
40 m
Oxlip4/0
POLE S0104020
4.16 kV
L-S0104021
56 m
Oxlip4/0
POLE S0104021
4.16 kV
L-S0104022
40 m
Oxlip4/0
POLE S0104022
4.16 kV
L-S0104023
53 m
Oxlip4/0
POLE S0104023
4.16 kV
L-S0104024
55 m
Oxlip4/0
POLE S0104024
4.16 kV
L-S0104025
43 m
Oxlip4/0
POLE S0104025
4.16 kV
L-S0104026
41 m
Oxlip4/0
POLE S0104026
4.16 kV
L-S0104027
35 m
Oxlip4/0
POLE S0104027
4.16 kV
L-S0104028
35 m
Oxlip4/0
POLE S0104028
4.16 kV
L-S0104029
50 m
Oxlip4/0
POLE S0104029
4.16 kV
L-S0104030
63 m
Oxlip4/0
POLE S0104030
4.16 kV
L-S0104031
42 m
Oxlip4/0
POLE S0104031
4.16 kV
L-S0104032
40 m
Oxlip4/0
POLE S0104032
4.16 kV
L-S0104033
32 m
Oxlip4/0
POLE S0104033
4.16 kV
L-S0104034
43 m
Oxlip4/0
POLE S0104034
4.16 kV
L-S0104035
28 m
Oxlip4/0
POLE S0104035
4.16 kV
L-S0104036
43 m
Oxlip4/0
POLE S0104036
4.16 kV
L-S0104037
43 m
Oxlip4/0
POLE S0104037
4.16 kV
L-S0104038
28 m
Oxlip4/0
POLE S0104038
4.16 kV
L-S0104039
32 m
Oxlip4/0
POLE S0104039
4.16 kV
L-S0104040
40 m
Oxlip4/0
POLE S0104040
4.16 kV
L-S0104041
35 m
Oxlip4/0
POLE S0104041
4.16 kV
L-S0104044
34 m
Oxlip4/0
L-S0104042
13 m
Oxlip4/0
POLE S0104044
4.16 kV
POLE S0104042
4.16 kV
L-S0104045
33 m
Oxlip4/0
L-S0104043
13 m
Oxlip4/0
POLE S0104045
4.16 kV
POLE S0104043
4.16 kV
T-S0104043
300 kVA
LD-S0104043
300 kVA

Option 3B: Scenario A: All Feeders are Fed from One Step-up Transformer

Year	F1								F2		F3								F4							
	Status	Min. Main Line Size	Transformer Taps				Transformer Min. Line Sizes		Status	Min. Main Line Size	Status	Min. Main Line Size	Transformer Taps				Transformer Min. Line Sizes		Status	Min. Main Line Size	Transformer Taps				Transformer Min. Line Sizes	
		C-F1	T-F1_4-1	T-F2_3-1	T-F1_4-2	T-F2_3-2	L-T-F1_4-2	L-T-F2_3-2		C-F2		C-F3	T-F1_4-1	T-F2_3-1	T-F1_4-2	T-F2_3-2	L-T-F1_4-2	L-T-F2_3-2		C-F4	T-F1_4-1	T-F2_3-1	T-F1_4-2	T-F2_3-2	L-T-F1_4-2	L-T-F2_3-2
2026	Passed	1/0 AWG	-2.50%	-2.50%	-5%	N/A	4/0 AWG	4/0 AWG	Passed	1/0 AWG	Passed	1/0 AWG	0.00%	0.00%	N/A	-5%	4/0 AWG	4/0 AWG	Passed	4/0 AWG	0%	0%	N/A	-2.50%	4/0 AWG	4/0 AWG
2027	Passed	1/0 AWG	-2.50%	-2.50%	-5%	N/A	4/0 AWG	4/0 AWG	Passed	1/0 AWG	Passed	1/0 AWG	0.00%	0.00%	N/A	-5%	4/0 AWG	4/0 AWG	Passed	4/0 AWG	0%	0%	N/A	-2.50%	4/0 AWG	4/0 AWG
2028	Passed	1/0 AWG	-2.50%	-2.50%	-5%	N/A	4/0 AWG	4/0 AWG	Passed	1/0 AWG	Passed	1/0 AWG	0.00%	0.00%	N/A	-5%	4/0 AWG	4/0 AWG	Passed	4/0 AWG	0%	0%	N/A	-2.50%	4/0 AWG	4/0 AWG
2029	Passed	1/0 AWG	-2.50%	-2.50%	-5%	N/A	4/0 AWG	4/0 AWG	Passed	1/0 AWG	Passed	1/0 AWG	0.00%	0.00%	N/A	-5%	4/0 AWG	4/0 AWG	Passed	4/0 AWG	0%	0%	N/A	-2.50%	4/0 AWG	4/0 AWG
2030	Passed	1/0 AWG	-2.50%	-2.50%	-5%	N/A	4/0 AWG	4/0 AWG	Passed	1/0 AWG	Passed	1/0 AWG	0.00%	0.00%	N/A	-5%	4/0 AWG	4/0 AWG	Passed	4/0 AWG	0%	0%	N/A	-2.50%	4/0 AWG	4/0 AWG
2031	Passed	1/0 AWG	-2.50%	-2.50%	-5%	N/A	4/0 AWG	4/0 AWG	Passed	1/0 AWG	Passed	2/0 AWG	0.00%	0.00%	N/A	-5%	4/0 AWG	4/0 AWG	Passed	4/0 AWG	0%	0%	N/A	-5.00%	4/0 AWG	4/0 AWG
2032	Passed	1/0 AWG	-2.50%	-2.50%	-5%	N/A	4/0 AWG	4/0 AWG	Passed	1/0 AWG	Passed	1/0 AWG	-2.50%	-2.50%	N/A	-5%	4/0 AWG	4/0 AWG	Passed	4/0 AWG	0%	0%	N/A	-5.00%	4/0 AWG	4/0 AWG
2033	Passed	1/0 AWG	-2.50%	-2.50%	-5%	N/A	4/0 AWG	4/0 AWG	Passed	1/0 AWG	Passed	1/0 AWG	-2.50%	-2.50%	N/A	-5%	4/0 AWG	4/0 AWG	Passed	4/0 AWG	0%	0%	N/A	-5.00%	4/0 AWG	4/0 AWG
2034	Passed	1/0 AWG	-2.50%	-2.50%	-5%	N/A	4/0 AWG	4/0 AWG	Passed	1/0 AWG	Passed	1/0 AWG	-2.50%	-2.50%	N/A	-5%	4/0 AWG	4/0 AWG	Passed	4/0 AWG	0%	0%	N/A	-5.00%	4/0 AWG	4/0 AWG
2035	Passed	1/0 AWG	-2.50%	-2.50%	-5%	N/A	4/0 AWG	4/0 AWG	Passed	1/0 AWG	Passed	1/0 AWG	-2.50%	-2.50%	N/A	-5%	4/0 AWG	4/0 AWG	Passed	4/0 AWG	0%	0%	N/A	-5.00%	4/0 AWG	4/0 AWG
2036	Passed	1/0 AWG	-2.50%	-2.50%	-5%	N/A	4/0 AWG	4/0 AWG	Passed	1/0 AWG	Passed	1/0 AWG	-2.50%	-2.50%	N/A	-5%	4/0 AWG	4/0 AWG	Passed	4/0 AWG	0%	0%	N/A	-5.00%	4/0 AWG	4/0 AWG
2041	Passed	1/0 AWG	-2.50%	-2.50%	-5%	N/A	4/0 AWG	4/0 AWG	Passed	1/0 AWG	Passed	1/0 AWG	-2.50%	-2.50%	N/A	-5%	4/0 AWG	4/0 AWG	Passed	4/0 AWG	0%	0%	N/A	-5.00%	4/0 AWG	4/0 AWG
2046	Passed	1/0 AWG	-2.50%	-2.50%	-5%	N/A	4/0 AWG	4/0 AWG	Passed	1/0 AWG	Passed	1/0 AWG	-2.50%	-2.50%	N/A	-5%	4/0 AWG	4/0 AWG	Passed	4/0 AWG	0%	0%	N/A	-5.00%	4/0 AWG	4/0 AWG
2051	Passed	1/0 AWG	-5%	-5%	-5%	N/A	4/0 AWG	4/0 AWG	Passed	1/0 AWG	Passed	1/0 AWG	-2.50%	-2.50%	N/A	-5%	4/0 AWG	4/0 AWG	Passed	4/0 AWG	0%	0%	N/A	-5.00%	4/0 AWG	4/0 AWG
2056	Passed	1/0 AWG	-5%	-5%	-5%	N/A	4/0 AWG	4/0 AWG	Passed	1/0 AWG	Passed	1/0 AWG	-2.50%	-2.50%	N/A	-5%	4/0 AWG	4/0 AWG	Passed	4/0 AWG	0%	0%	N/A	-5.00%	4/0 AWG	4/0 AWG
2061	Passed	1/0 AWG	-5%	-5%	-5%	N/A	4/0 AWG	4/0 AWG	Passed	1/0 AWG	Passed	1/0 AWG	-5.00%	-5.00%	N/A	-5%	4/0 AWG	4/0 AWG	Passed	4/0 AWG	0%	0%	N/A	-5.00%	4/0 AWG	4/0 AWG
2066	Passed	2/0 AWG	-5%	-5%	-5%	N/A	4/0 AWG	4/0 AWG	Passed	1/0 AWG	Passed	1/0 AWG	-5.00%	-5.00%	N/A	-5%	4/0 AWG	4/0 AWG	Passed	4/0 AWG	-2.50%	-2.50%	N/A	-5.00%	4/0 AWG	4/0 AWG

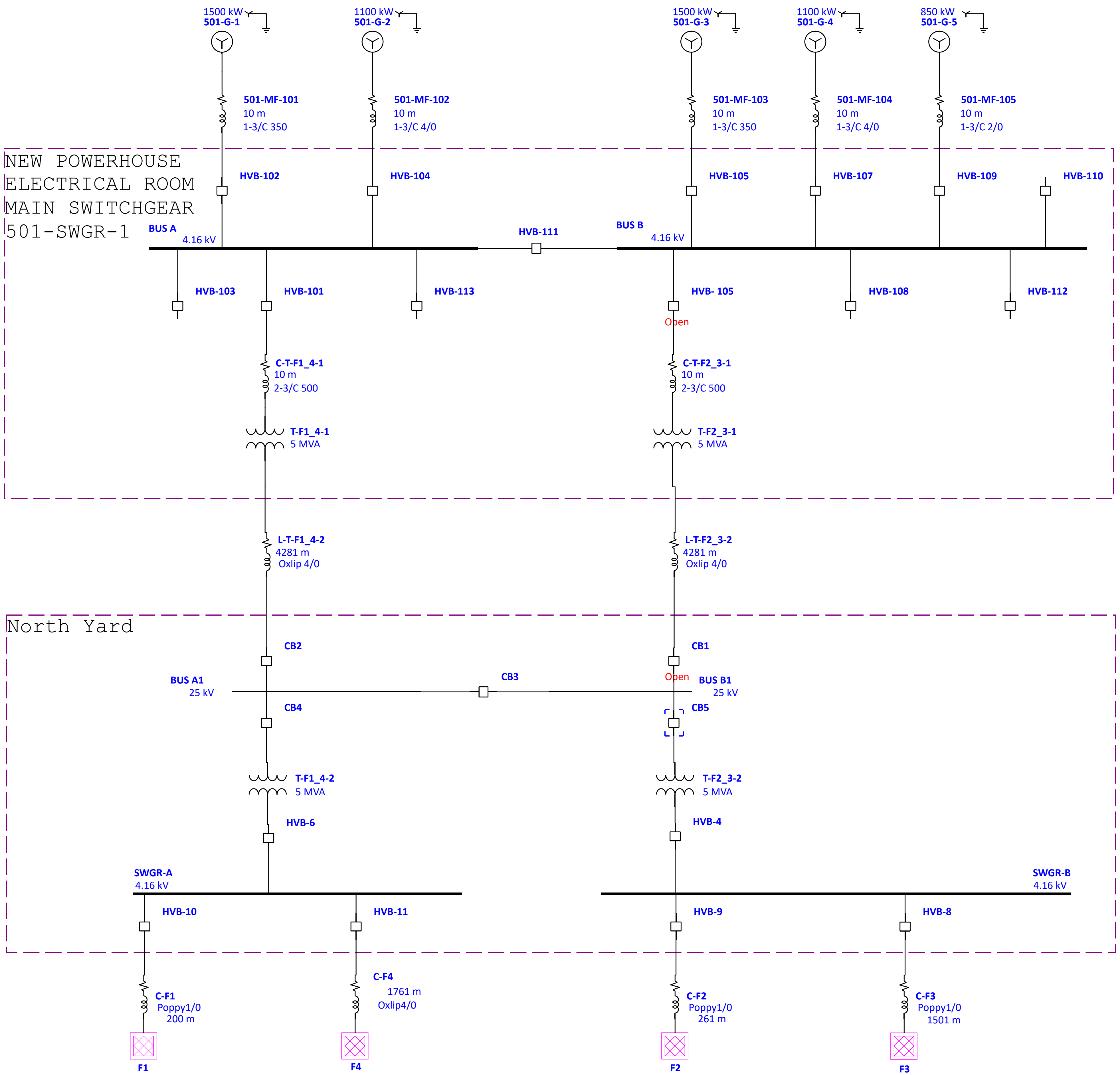
Option 3B: Scenario B: Feeder 1 is Fed from T-F1_4-2 Step-up Transformer and Feeders 3 and 4 are Fed from T-F2_3-2 Step-Up Transformer

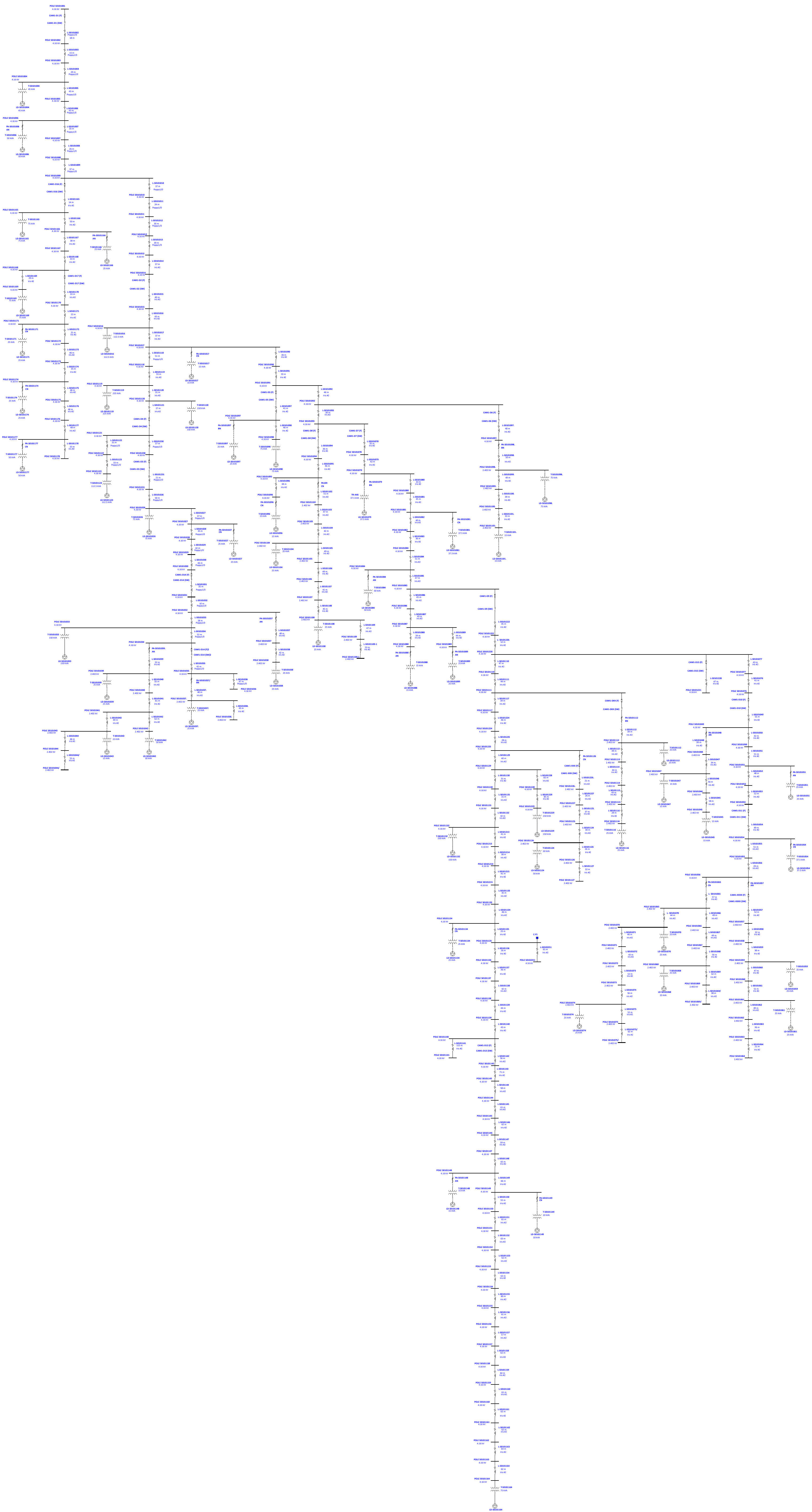
Year	F1								F2		F3								F4							
	Status	Min. Main Line Size	Transformer Taps				Transformer Min. Line Sizes		Status	Min. Main Line Size	Status	Min. Main Line Size	Transformer Taps				Transformer Min. Line Sizes		Status	Min. Main Line Size	Transformer Taps				Transformer Min. Line Sizes	
		C-F1	T-F1_4-1	T-F2_3-1	T-F1_4-2	T-F2_3-2	L-T-F1_4-2	L-T-F2_3-2		C-F2		C-F3	T-F1_4-1	T-F2_3-1	T-F1_4-2	T-F2_3-2	L-T-F1_4-2	L-T-F2_3-2		C-F4	T-F1_4-1	T-F2_3-1	T-F1_4-2	T-F2_3-2	L-T-F1_4-2	L-T-F2_3-2
2026	Passed	1/0 AWG	0.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	Passed	1/0 AWG	N/A	0.00%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2027	Passed	1/0 AWG	0.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	Passed	1/0 AWG	N/A	0.00%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2028	Passed	1/0 AWG	0.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	Passed	1/0 AWG	N/A	0.00%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2029	Passed	1/0 AWG	0.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	Passed	1/0 AWG	N/A	0.00%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2030	Passed	1/0 AWG	0.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	Passed	1/0 AWG	N/A	0.00%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2031	Passed	1/0 AWG	0.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	Passed	1/0 AWG	N/A	0.00%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2032	Passed	1/0 AWG	0.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	Passed	1/0 AWG	N/A	0.00%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2033	Passed	1/0 AWG	0.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	Passed	1/0 AWG	N/A	0.00%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2034	Passed	1/0 AWG	0.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	Passed	1/0 AWG	N/A	0.00%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2035	Passed	4/0 AWG	0.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	Passed	1/0 AWG	N/A	0.00%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2036	Passed	1/0 AWG	-2.50%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	Passed	1/0 AWG	N/A	0.00%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2041	Passed	1/0 AWG	-2.50%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	Passed	1/0 AWG	N/A	0.00%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2046	Passed	1/0 AWG	-2.50%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	Passed	1/0 AWG	N/A	0.00%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2051	Passed	1/0 AWG	-2.50%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	Passed	1/0 AWG	N/A	0.00%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2056	Passed	1/0 AWG	-2.50%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	Passed	1/0 AWG	N/A	0.00%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2061	Passed	1/0 AWG	-5.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	Passed	4/0 AWG	N/A	0.00%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2066	Passed	1/0 AWG	-5.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	Passed	1/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG

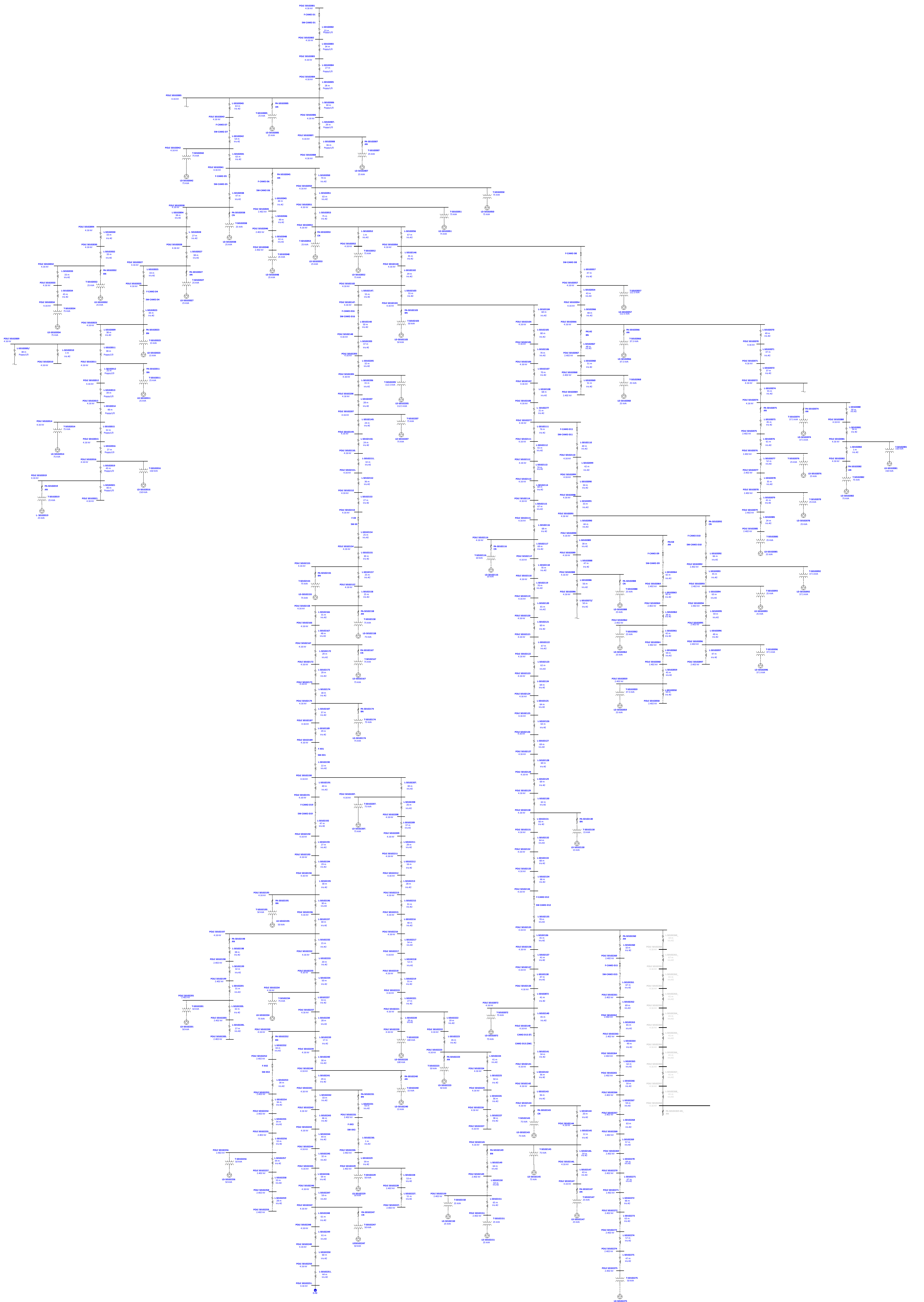
Appendix 1.F

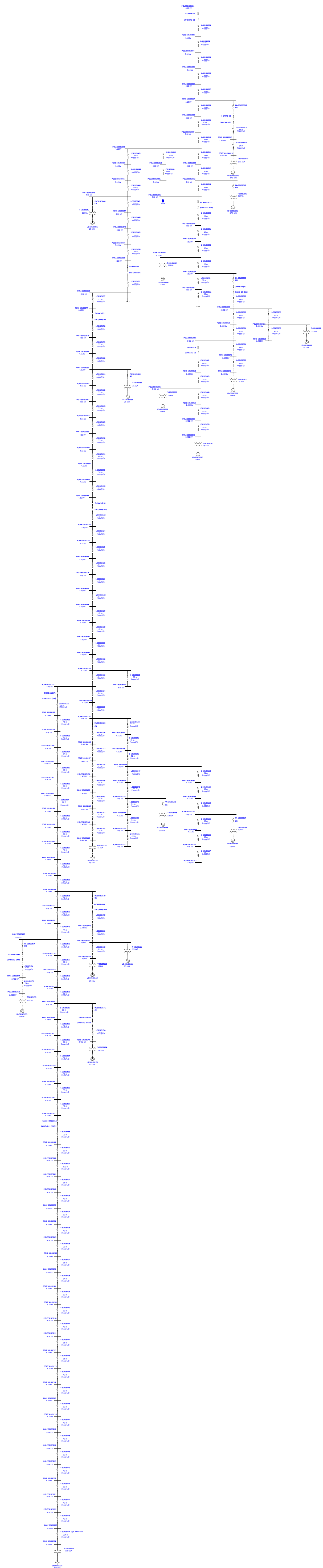
Cambridge Bay Network ETAP Model and Results – Option 4

One-Line Diagram - OLV1 (Load Flow Analysis)

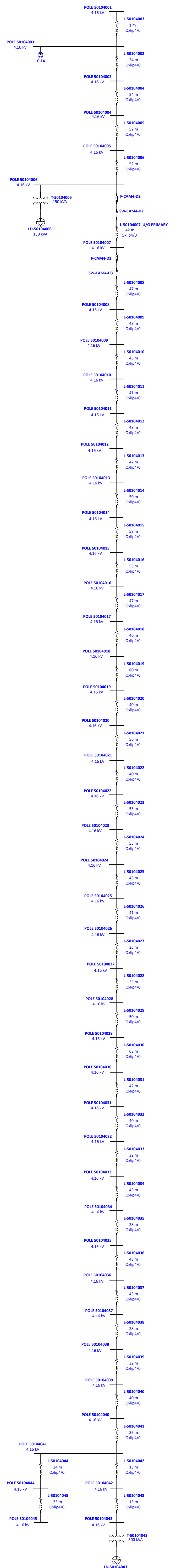








One-Line Diagram - OLV1=>F4 (Load Flow Analysis) - Ahmed.Abdelfattah(Project Editor)



Option 4: Scenario A: All Feeders are Fed from One Step-up Transformer

Year	F1								F2							
	Status	Min. Main Line Size	Transformer Taps				Transformer Min. Line Sizes		Status	Min. Main Line Size	Transformer Taps				Transformer Min. Line Sizes	
		C-F1	T-F1_4-1	T-F2_3-1	T-F1_4-2	T-F2_3-2	L-T-F1_4-2	L-T-F2_3-2		C-F2	T-F1_4-1	C-T-F2_3-1	T-F1_4-2	T-F2_3-2	L-T-F1_4-2	L-T-F2_3-2
2026	Failed								Passed	2/0 AWG	0.00%	0.00%	N/A	-5%	4/0 AWG	4/0AWG
2027	Failed								Passed	3/0 AWG	0.00%	0.00%	N/A	-5%	4/0 AWG	4/0AWG
2028	Failed								Passed	3/0 AWG	0.00%	0.00%	N/A	-5%	4/0 AWG	4/0AWG
2029	Failed								Passed	3/0 AWG	0.00%	0.00%	N/A	-5%	4/0 AWG	4/0AWG
2030	Failed								Passed	4/0 AWG	0.00%	0.00%	N/A	-5%	4/0 AWG	4/0AWG
2031	Failed								Passed	1/0 AWG	-2.50%	-2.50%	N/A	-5%	4/0 AWG	4/0AWG
2032	Failed								Passed	1/0 AWG	-2.50%	-2.50%	N/A	-5%	4/0 AWG	4/0AWG
2033	Failed								Passed	1/0 AWG	-2.50%	-2.50%	N/A	-5%	4/0 AWG	4/0AWG
2034	Failed								Passed	1/0 AWG	-2.50%	-2.50%	N/A	-5%	4/0 AWG	4/0AWG
2035	Failed								Passed	1/0 AWG	-2.50%	-2.50%	N/A	-5%	4/0 AWG	4/0AWG
2036	Failed								Passed	1/0 AWG	-2.50%	-2.50%	N/A	-5%	4/0 AWG	4/0AWG
2041	Failed								Passed	1/0 AWG	-2.50%	-2.50%	N/A	-5%	4/0 AWG	4/0AWG
2046	Failed								Passed	1/0 AWG	-2.50%	-2.50%	N/A	-5%	4/0 AWG	4/0AWG
2051	Failed								Passed	1/0 AWG	-2.50%	-2.50%	N/A	-5%	4/0 AWG	4/0AWG
2056	Failed								Passed	1/0 AWG	-5.00%	-5.00%	N/A	-5%	4/0 AWG	4/0AWG
2061	Failed								Passed	1/0 AWG	-5.00%	-5.00%	N/A	-5%	4/0 AWG	4/0AWG
2066	Failed								Passed	1/0 AWG	-5.00%	-5.00%	N/A	-5%	4/0 AWG	4/0AWG

Year	F3								F4							
	Status	Min. Main Line Size	Transformer Taps				Transformer Min. Line Sizes		Status	Min. Main Line Size	Transformer Taps				Transformer Min. Line Sizes	
		C-F3	T-F1_4-1	C-T-F2_3-1	T-F1_4-2	T-F2_3-2	L-T-F1_4-2	L-T-F2_3-2		C-F4	T-F1_4-1	C-T-F2_3-1	T-F1_4-2	T-F2_3-2	L-T-F1_4-2	L-T-F2_3-2
2026	Failed								Passed	4/0 AWG	-2.50%	-2.50%	-5.00%	N/A	4/0 AWG	4/0AWG
2027	Failed								Passed	4/0 AWG	-2.50%	-2.50%	-5.00%	N/A	4/0 AWG	4/0AWG
2028	Failed								Passed	4/0 AWG	-2.50%	-2.50%	-5.00%	N/A	4/0 AWG	4/0AWG
2029	Failed								Passed	4/0 AWG	-2.50%	-2.50%	-5.00%	N/A	4/0 AWG	4/0AWG
2030	Failed								Passed	4/0 AWG	-2.50%	-2.50%	-5.00%	N/A	4/0 AWG	4/0AWG
2031	Failed								Passed	4/0 AWG	-2.50%	-2.50%	-5.00%	N/A	4/0 AWG	4/0AWG
2032	Failed								Passed	4/0 AWG	-2.50%	-2.50%	-5.00%	N/A	4/0 AWG	4/0AWG
2033	Failed								Passed	4/0 AWG	-2.50%	-2.50%	-5.00%	N/A	4/0 AWG	4/0AWG
2034	Failed								Passed	4/0 AWG	-2.50%	-2.50%	-5.00%	N/A	4/0 AWG	4/0AWG
2035	Failed								Passed	4/0 AWG	-5.00%	-5.00%	-5.00%	N/A	4/0 AWG	4/0AWG
2036	Failed								Passed	4/0 AWG	-5.00%	-5.00%	-5.00%	N/A	4/0 AWG	4/0AWG
2041	Failed								Passed	4/0 AWG	-5.00%	-5.00%	-5.00%	N/A	4/0 AWG	4/0AWG
2046	Failed								Passed	4/0 AWG	-5.00%	-5.00%	-5.00%	N/A	4/0 AWG	4/0AWG
2051	Failed								Passed	4/0 AWG	-5.00%	-5.00%	-5.00%	N/A	4/0 AWG	4/0AWG
2056	Failed								Failed							
2061	Failed								Failed							
2066	Failed								Failed							

Option 4: Scenario B: Each Two Feeders are Fed from One Step-up Transformer

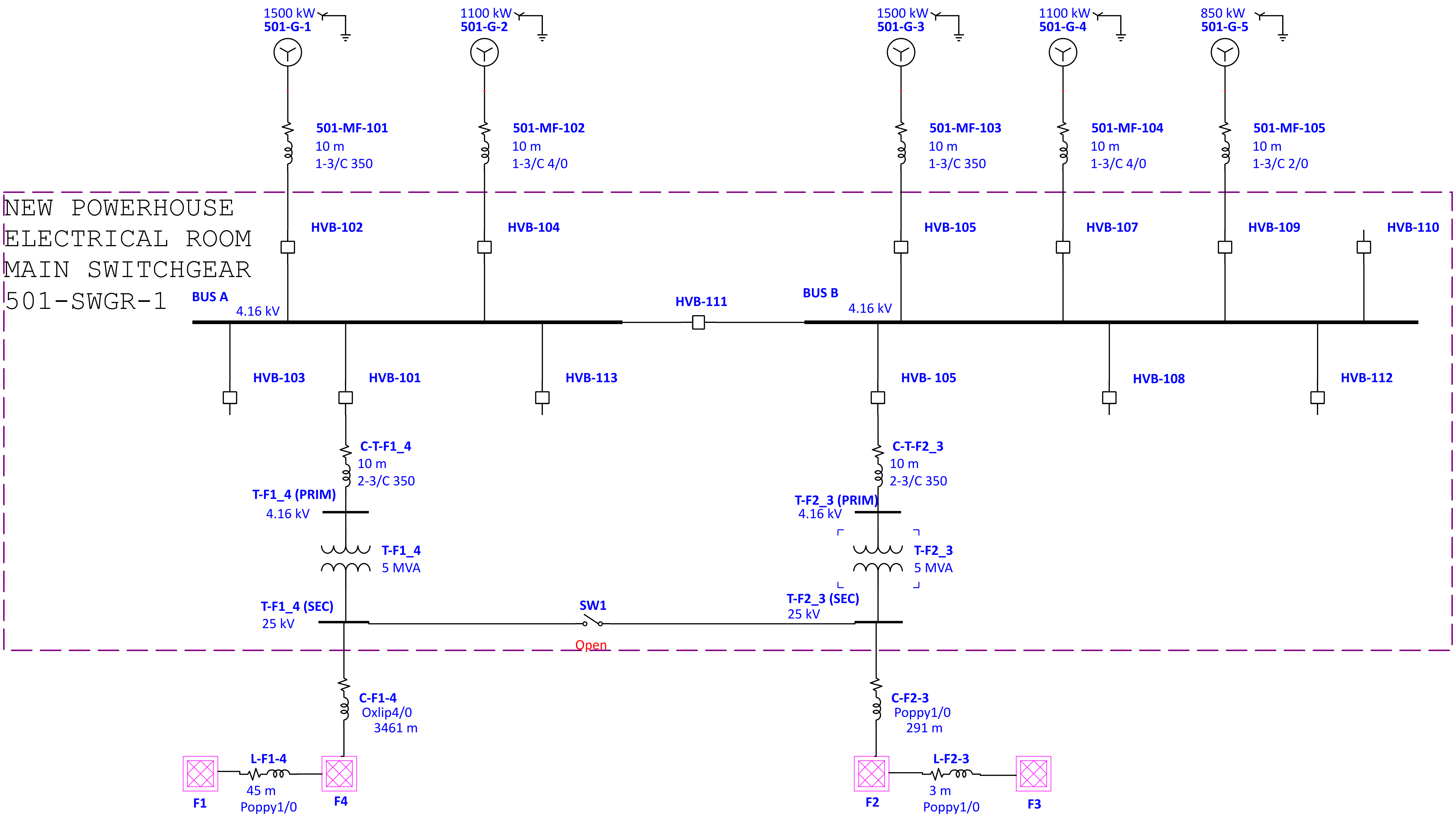
Year	F1								F2							
	Status	Min. Main Line Size	Transformer Taps				Transformer Min. Line Sizes		Status	Min. Main Line Size	Transformer Taps				Transformer Min. Line Sizes	
		C-F1	T-F1_4-1	T-F2_3-1	T-F1_4-2	T-F2_3-2	L-T-F1_4-2	L-T-F2_3-2		C-F2	T-F1_4-1	C-T-F2_3-1	T-F1_4-2	T-F2_3-2	L-T-F1_4-2	L-T-F2_3-2
2026	Passed	1/0 AWG	-5.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2027	Passed	1/0 AWG	-5.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2028	Passed	1/0 AWG	-5.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2029	Passed	1/0 AWG	-5.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2030	Passed	1/0 AWG	-5.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	2/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2031	Passed	1/0 AWG	-5.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	2/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2032	Passed	1/0 AWG	-5.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	2/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2033	Passed	1/0 AWG	-5.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	2/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2034	Passed	1/0 AWG	-5.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	3/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2035	Passed	1/0 AWG	-5.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	3/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2036	Passed	1/0 AWG	-5.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	3/0 AWG	N/A	0%	N/A	-2.50%	N/A	4/0 AWG
2041	Passed	1/0 AWG	-5.00%	N/A	-5%	N/A	4/0 AWG	N/A	Passed	1/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2046	Failed								Passed	1/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2051	Failed								Passed	1/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2056	Failed								Passed	1/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2061	Failed								Passed	1/0 AWG	N/A	0%	N/A	-5.00%	N/A	4/0 AWG
2066	Failed								Passed	1/0 AWG	N/A	-3%	N/A	-5.00%	N/A	4/0 AWG

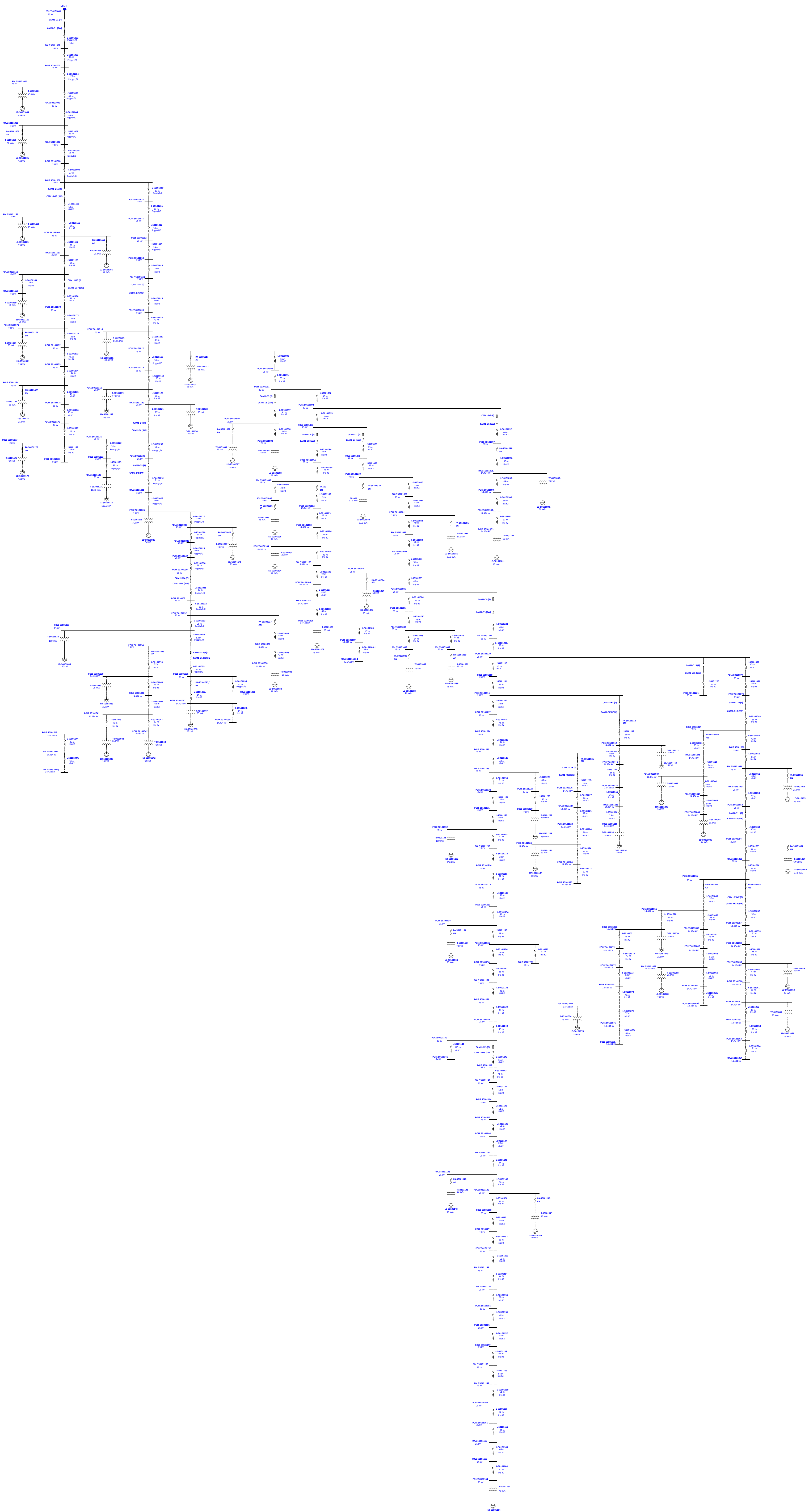
Year	F3								F4							
	Status	Min. Main Line Size	Transformer Taps				Transformer Min. Line Sizes		Status	Min. Main Line Size	Transformer Taps				Transformer Min. Line Sizes	
		C-F3	T-F1_4-1	C-T-F2_3-1	T-F1_4-2	T-F2_3-2	L-T-F1_4-2	L-T-F2_3-2		C-F4	T-F1_4-1	C-T-F2_3-1	T-F1_4-2	T-F2_3-2	L-T-F1_4-2	L-T-F2_3-2
2026	Passed	1/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	0%	N/A	-5.00%	N/A	4/0 AWG	N/A
2027	Passed	1/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	0%	N/A	-5.00%	N/A	4/0 AWG	N/A
2028	Passed	1/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	0%	N/A	-5.00%	N/A	4/0 AWG	N/A
2029	Passed	1/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	0%	N/A	-5.00%	N/A	4/0 AWG	N/A
2030	Passed	1/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	0%	N/A	-5.00%	N/A	4/0 AWG	N/A
2031	Passed	1/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	0%	N/A	-5.00%	N/A	4/0 AWG	N/A
2032	Passed	2/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	0%	N/A	-5.00%	N/A	4/0 AWG	N/A
2033	Passed	2/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	0%	N/A	-5.00%	N/A	4/0 AWG	N/A
2034	Passed	2/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	0%	N/A	-5.00%	N/A	4/0 AWG	N/A
2035	Passed	2/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	-2.50%	N/A	-5.00%	N/A	4/0 AWG	N/A
2036	Passed	3/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	-2.50%	N/A	-5.00%	N/A	4/0 AWG	N/A
2041	Passed	4/0 AWG	N/A	-2.50%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	-2.50%	N/A	-5.00%	N/A	4/0 AWG	N/A
2046	Passed	1/0 AWG	N/A	-5.00%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	-2.50%	N/A	-5.00%	N/A	4/0 AWG	N/A
2051	Passed	1/0 AWG	N/A	-5.00%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	-2.50%	N/A	-5.00%	N/A	4/0 AWG	N/A
2056	Passed	2/0 AWG	N/A	-5.00%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	-2.50%	N/A	-5.00%	N/A	4/0 AWG	N/A
2061	Passed	3/0 AWG	N/A	-5.00%	N/A	-5.00%	N/A	4/0 AWG	Passed	4/0 AWG	-5.00%	N/A	-5.00%	N/A	4/0 AWG	N/A
2066	Failed								Passed	4/0 AWG	-5.00%	N/A	-5.00%	N/A	4/0 AWG	N/A

Appendix 1.G

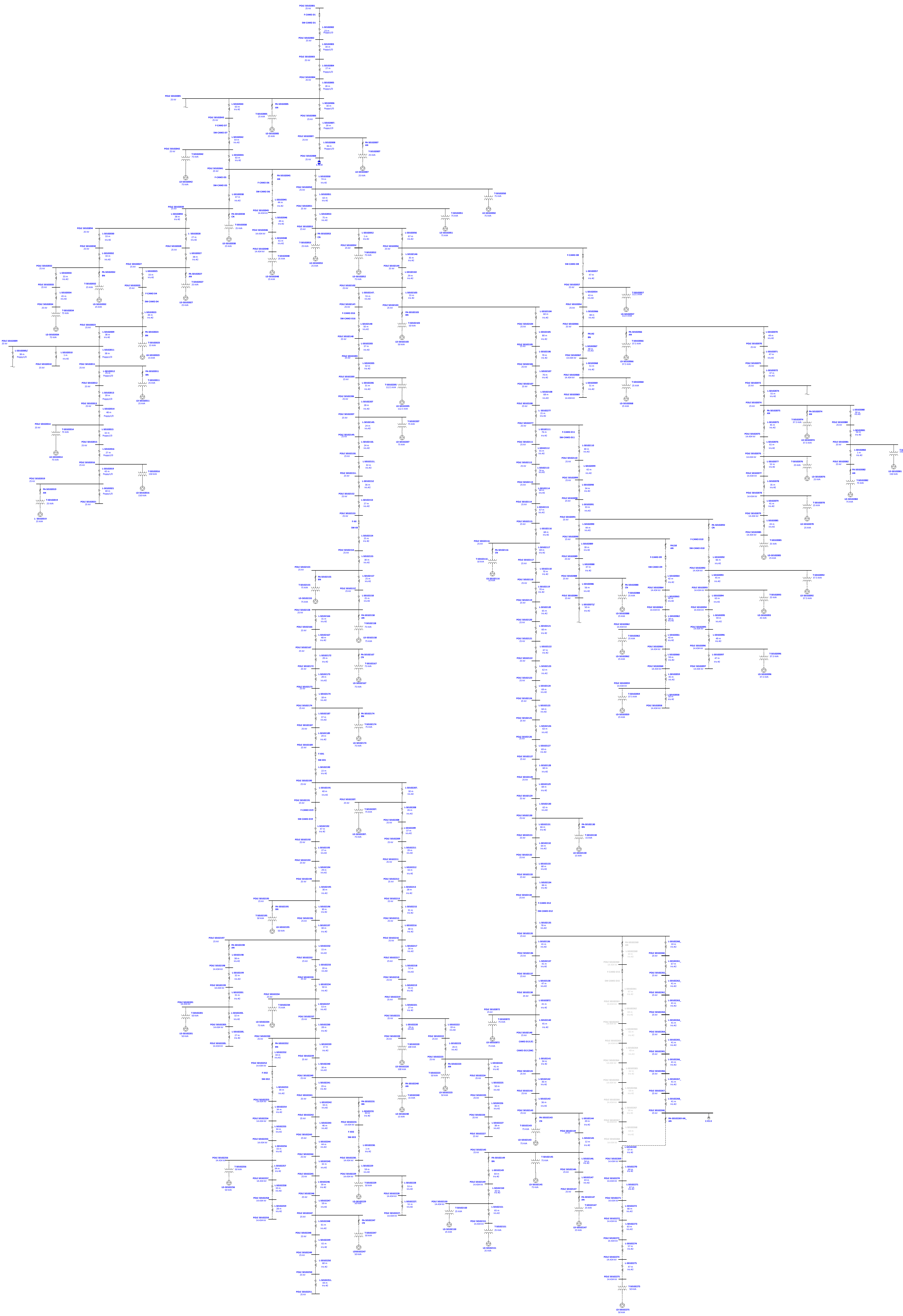
Cambridge Bay Network ETAP Model and Result – Option 5

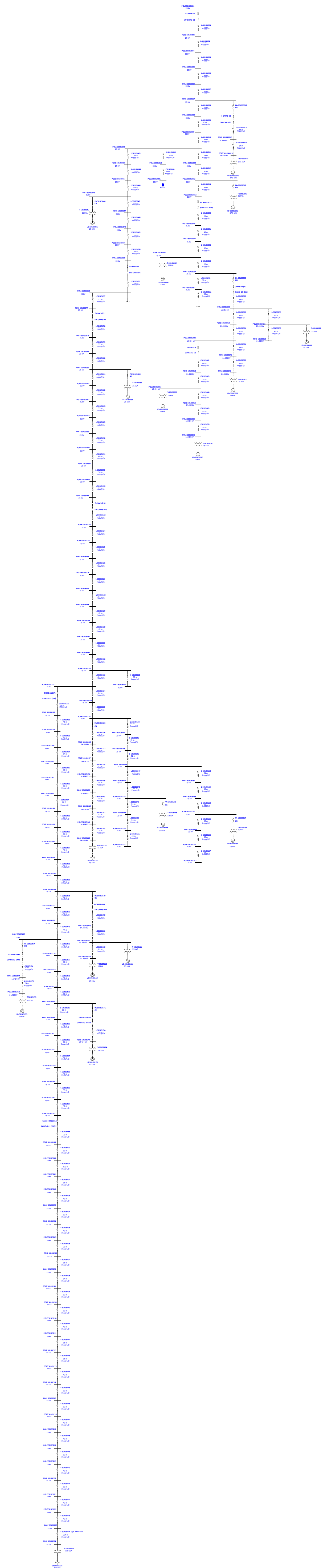
One-Line Diagram - OLV1 (Load Flow Analysis)

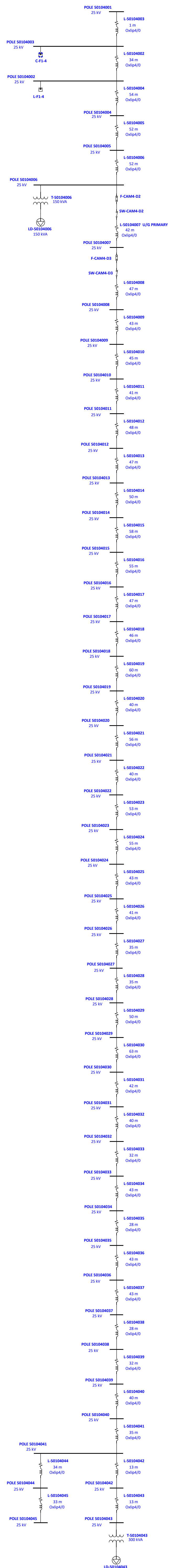




One-Line Diagram - OLV1=>F2 (Load Flow Analysis) - Ahmed.Abdelfattah(Project Editor)






POLE 50104001
25 kV
L-50104003
1 m
Oxlip4/0
POLE 50104003
25 kV
C-F1-4
L-50104002
34 m
Oxlip4/0
POLE 50104002
25 kV
L-F1-4
L-50104004
54 m
Oxlip4/0
POLE 50104004
25 kV
L-50104005
52 m
Oxlip4/0
POLE 50104005
25 kV
L-50104006
52 m
Oxlip4/0
POLE 50104006
25 kV
T-50104006
150 kVA
LD-50104006
150 kVA
F-CAM4-D2
SW-CAM4-D2
L-50104007 U/G PRIMARY
42 m
Oxlip4/0
POLE 50104007
25 kV
F-CAM4-D3
SW-CAM4-D3
L-50104008
47 m
Oxlip4/0
POLE 50104008
25 kV
L-50104009
43 m
Oxlip4/0
POLE 50104009
25 kV
L-50104010
45 m
Oxlip4/0
POLE 50104010
25 kV
L-50104011
41 m
Oxlip4/0
POLE 50104011
25 kV
L-50104012
48 m
Oxlip4/0
POLE 50104012
25 kV
L-50104013
47 m
Oxlip4/0
POLE 50104013
25 kV
L-50104014
50 m
Oxlip4/0
POLE 50104014
25 kV
L-50104015
58 m
Oxlip4/0
POLE 50104015
25 kV
L-50104016
55 m
Oxlip4/0
POLE 50104016
25 kV
L-50104017
47 m
Oxlip4/0
POLE 50104017
25 kV
L-50104018
46 m
Oxlip4/0
POLE 50104018
25 kV
L-50104019
60 m
Oxlip4/0
POLE 50104019
25 kV
L-50104020
40 m
Oxlip4/0
POLE 50104020
25 kV
L-50104021
56 m
Oxlip4/0
POLE 50104021
25 kV
L-50104022
40 m
Oxlip4/0
POLE 50104022
25 kV
L-50104023
53 m
Oxlip4/0
POLE 50104023
25 kV
L-50104024
55 m
Oxlip4/0
POLE 50104024
25 kV
L-50104025
43 m
Oxlip4/0
POLE 50104025
25 kV
L-50104026
41 m
Oxlip4/0
POLE 50104026
25 kV
L-50104027
35 m
Oxlip4/0
POLE 50104027
25 kV
L-50104028
35 m
Oxlip4/0
POLE 50104028
25 kV
L-50104029
50 m
Oxlip4/0
POLE 50104029
25 kV
L-50104030
63 m
Oxlip4/0
POLE 50104030
25 kV
L-50104031
42 m
Oxlip4/0
POLE 50104031
25 kV
L-50104032
40 m
Oxlip4/0
POLE 50104032
25 kV
L-50104033
32 m
Oxlip4/0
POLE 50104033
25 kV
L-50104034
43 m
Oxlip4/0
POLE 50104034
25 kV
L-50104035
28 m
Oxlip4/0
POLE 50104035
25 kV
L-50104036
43 m
Oxlip4/0
POLE 50104036
25 kV
L-50104037
43 m
Oxlip4/0
POLE 50104037
25 kV
L-50104038
28 m
Oxlip4/0
POLE 50104038
25 kV
L-50104039
32 m
Oxlip4/0
POLE 50104039
25 kV
L-50104040
40 m
Oxlip4/0
POLE 50104040
25 kV
L-50104041
35 m
Oxlip4/0
POLE 50104041
25 kV
L-50104044
34 m
Oxlip4/0
L-50104042
13 m
Oxlip4/0
POLE 50104044
25 kV
POLE 50104042
25 kV
L-50104045
33 m
Oxlip4/0
L-50104043
13 m
Oxlip4/0
POLE 50104045
25 kV
POLE 50104043
25 kV
T-50104043
300 kVA
LD-50104043
300 kVA

Option 5: Scenario A: All Feeders are Fed from One Step-up Transformer

Year	F1				F2				F3				F4			
	Status	Min. Main Line Size	Transformer Taps		Status	Min. Main Line Size	Transformer Taps		Status	Min. Main Line Size	Transformer Taps		Status	Min. Main Line Size	Transformer Taps	
		L-F1-4	T-F1_4	T-F2_3		C-F2-3	T-F1_4	T-F2_3		L-F2-3	T-F1_4	T-F2_3		C-F1-4	T-F1_4	T-F2_3
2026	Passed	1/0 AWG	-2.50%	-2.50%	Passed	1/0 AWG	-2.50%	-2.50%	Passed	1/0 AWG	-2.50%	-2.50%	Passed	4/0 AWG	-2.50%	-2.50%
2027	Passed	1/0 AWG	-2.50%	-2.50%	Passed	1/0 AWG	-2.50%	-2.50%	Passed	1/0 AWG	-2.50%	-2.50%	Passed	4/0 AWG	-2.50%	-2.50%
2028	Passed	1/0 AWG	-2.50%	-2.50%	Passed	1/0 AWG	-2.50%	-2.50%	Passed	1/0 AWG	-2.50%	-2.50%	Passed	4/0 AWG	-2.50%	-2.50%
2029	Passed	1/0 AWG	-2.50%	-2.50%	Passed	1/0 AWG	-2.50%	-2.50%	Passed	1/0 AWG	-2.50%	-2.50%	Passed	4/0 AWG	-2.50%	-2.50%
2030	Passed	1/0 AWG	-2.50%	-2.50%	Passed	1/0 AWG	-2.50%	-2.50%	Passed	1/0 AWG	-2.50%	-2.50%	Passed	4/0 AWG	-2.50%	-2.50%
2031	Passed	1/0 AWG	-2.50%	-2.50%	Passed	1/0 AWG	-2.50%	-2.50%	Passed	1/0 AWG	-2.50%	-2.50%	Passed	4/0 AWG	-2.50%	-2.50%
2032	Passed	1/0 AWG	-2.50%	-2.50%	Passed	1/0 AWG	-2.50%	-2.50%	Passed	1/0 AWG	-2.50%	-2.50%	Passed	4/0 AWG	-2.50%	-2.50%
2033	Passed	1/0 AWG	-2.50%	-2.50%	Passed	1/0 AWG	-2.50%	-2.50%	Passed	1/0 AWG	-2.50%	-2.50%	Passed	4/0 AWG	-2.50%	-2.50%
2034	Passed	1/0 AWG	-2.50%	-2.50%	Passed	1/0 AWG	-2.50%	-2.50%	Passed	1/0 AWG	-2.50%	-2.50%	Passed	4/0 AWG	-2.50%	-2.50%
2035	Passed	1/0 AWG	-2.50%	-2.50%	Passed	1/0 AWG	-2.50%	-2.50%	Passed	1/0 AWG	-2.50%	-2.50%	Passed	4/0 AWG	-2.50%	-2.50%
2036	Passed	1/0 AWG	-2.50%	-2.50%	Passed	1/0 AWG	-2.50%	-2.50%	Passed	1/0 AWG	-2.50%	-2.50%	Passed	4/0 AWG	-2.50%	-2.50%
2041	Passed	1/0 AWG	-2.50%	-2.50%	Passed	1/0 AWG	-2.50%	-2.50%	Passed	1/0 AWG	-2.50%	-2.50%	Passed	4/0 AWG	-2.50%	-2.50%
2046	Passed	1/0 AWG	-2.50%	-2.50%	Passed	1/0 AWG	-2.50%	-2.50%	Passed	1/0 AWG	-2.50%	-2.50%	Passed	4/0 AWG	-2.50%	-2.50%
2051	Passed	1/0 AWG	-2.50%	-2.50%	Passed	1/0 AWG	-2.50%	-2.50%	Passed	1/0 AWG	-2.50%	-2.50%	Passed	4/0 AWG	-2.50%	-2.50%
2056	Passed	1/0 AWG	-2.50%	-2.50%	Passed	1/0 AWG	-2.50%	-2.50%	Passed	1/0 AWG	-2.50%	-2.50%	Passed	4/0 AWG	-2.50%	-2.50%
2061	Passed	1/0 AWG	-5.00%	-5.00%	Passed	1/0 AWG	-5.00%	-5.00%	Passed	1/0 AWG	-5.00%	-5.00%	Passed	4/0 AWG	-5.00%	-5.00%
2066	Passed	1/0 AWG	-5.00%	-5.00%	Passed	1/0 AWG	-5.00%	-5.00%	Passed	1/0 AWG	-5.00%	-5.00%	Passed	4/0 AWG	-5.00%	-5.00%

Option 5: Scenario B: Each Two Feeders are Fed from One Step-up Transformer

Year	F1				F2				F3				F4			
	Status	Min. Main Line Size	Transformer Taps		Status	Min. Main Line Size	Transformer Taps		Status	Min. Main Line Size	Transformer Taps		Status	Min. Main Line Size	Transformer Taps	
		L-F1-4	T-F1_4	T-F2_3		C-F2-3	T-F1_4	T-F2_3		L-F2-3	T-F1_4	T-F2_3		C-F1-4	T-F1_4	T-F2_3
2026	Passed	1/0 AWG	0.00%	N/A	Passed	1/0 AWG	N/A	0.00%	Passed	1/0 AWG	N/A	0.00%	Passed	4/0 AWG	0.00%	N/A
2027	Passed	1/0 AWG	0.00%	N/A	Passed	1/0 AWG	N/A	0.00%	Passed	1/0 AWG	N/A	0.00%	Passed	4/0 AWG	0.00%	N/A
2028	Passed	1/0 AWG	0.00%	N/A	Passed	1/0 AWG	N/A	0.00%	Passed	1/0 AWG	N/A	0.00%	Passed	4/0 AWG	0.00%	N/A
2029	Passed	1/0 AWG	0.00%	N/A	Passed	1/0 AWG	N/A	0.00%	Passed	1/0 AWG	N/A	0.00%	Passed	4/0 AWG	0.00%	N/A
2030	Passed	1/0 AWG	0.00%	N/A	Passed	1/0 AWG	N/A	0.00%	Passed	1/0 AWG	N/A	0.00%	Passed	4/0 AWG	0.00%	N/A
2031	Passed	1/0 AWG	0.00%	N/A	Passed	1/0 AWG	N/A	0.00%	Passed	1/0 AWG	N/A	0.00%	Passed	4/0 AWG	0.00%	N/A
2032	Passed	1/0 AWG	0.00%	N/A	Passed	1/0 AWG	N/A	0.00%	Passed	1/0 AWG	N/A	0.00%	Passed	4/0 AWG	0.00%	N/A
2033	Passed	1/0 AWG	0.00%	N/A	Passed	1/0 AWG	N/A	0.00%	Passed	1/0 AWG	N/A	0.00%	Passed	4/0 AWG	0.00%	N/A
2034	Passed	1/0 AWG	0.00%	N/A	Passed	1/0 AWG	N/A	0.00%	Passed	1/0 AWG	N/A	0.00%	Passed	4/0 AWG	0.00%	N/A
2035	Passed	1/0 AWG	0.00%	N/A	Passed	1/0 AWG	N/A	0.00%	Passed	1/0 AWG	N/A	0.00%	Passed	4/0 AWG	0.00%	N/A
2036	Passed	1/0 AWG	0.00%	N/A	Passed	1/0 AWG	N/A	0.00%	Passed	1/0 AWG	N/A	0.00%	Passed	4/0 AWG	0.00%	N/A
2041	Passed	1/0 AWG	0.00%	N/A	Passed	1/0 AWG	N/A	0.00%	Passed	1/0 AWG	N/A	0.00%	Passed	4/0 AWG	0.00%	N/A
2046	Passed	1/0 AWG	0.00%	N/A	Passed	1/0 AWG	N/A	0.00%	Passed	1/0 AWG	N/A	0.00%	Passed	4/0 AWG	0.00%	N/A
2051	Passed	1/0 AWG	-2.50%	N/A	Passed	1/0 AWG	N/A	0.00%	Passed	1/0 AWG	N/A	0.00%	Passed	4/0 AWG	-2.50%	N/A
2056	Passed	1/0 AWG	-2.50%	N/A	Passed	1/0 AWG	N/A	0.00%	Passed	1/0 AWG	N/A	0.00%	Passed	4/0 AWG	-2.50%	N/A
2061	Passed	1/0 AWG	-2.50%	N/A	Passed	1/0 AWG	N/A	0.00%	Passed	1/0 AWG	N/A	0.00%	Passed	4/0 AWG	-2.50%	N/A
2066	Passed	1/0 AWG	-2.50%	N/A	Passed	1/0 AWG	N/A	0.00%	Passed	1/0 AWG	N/A	0.00%	Passed	4/0 AWG	-2.50%	N/A

Appendix 2

Cambridge Bay – Estimated Electricity Production

Appendix C: Calculated power plant electricity generation after 2026

Estimated yearly electricity production for the new Cambridge Bay power plant

Year	Population	Population change	Estimated electricity produced (kWh/year)
2026	2,451	+55	15,407,427
2027	2,507	+57	15,763,605
2028	2,565	+58	16,128,017
2029	2,625	+59	16,500,853
2030	2,685	+61	16,882,308
2031	2,747	+62	17,272,581
2032	2,811	+64	17,671,877
2033	2,876	+65	18,080,403
2034	2,942	+66	18,498,373
2035	3,010	+68	18,926,005
2036	3,080	+70	19,363,523
2037	3,151	+71	19,811,155
2038	3,224	+73	20,269,136
2039	3,298	+75	20,737,703
2040	3,375	+76	21,217,103
2041	3,453	+78	21,707,585
2042	3,532	+80	22,209,405
2043	3,614	+82	22,722,827
2044	3,698	+84	23,248,117
2045	3,783	+85	23,785,550
2046	3,871	+87	24,335,408
2047	3,960	+89	24,897,977
2048	4,052	+92	25,473,551
2049	4,145	+94	26,062,430
2050	4,241	+96	26,664,923
2051	4,339	+98	27,281,344
2052	4,439	+100	27,912,015
2053	4,542	+103	28,557,265
2054	4,647	+105	29,217,432
2055	4,755	+107	29,892,860
2056	4,864	+110	30,583,902
2057	4,977	+112	31,290,919
2058	5,092	+115	32,014,280
2059	5,210	+118	32,754,364
2060	5,330	+120	33,511,556
2061	5,453	+123	34,286,252
2062	5,579	+126	35,078,858
2063	5,708	+129	35,889,786
2064	5,840	+132	36,719,461
2065	5,975	+135	37,568,315
2066	6,113	+138	38,436,793

Engineering Study
Final Report

Title	**Cambridge Bay North Yard Substation Feeder Distribution Line Study**
Document No.	2401E002ST Cambridge Bay
Revision	Rev A
Date	March 10, 2024
Executor	Ahmed Abdelfattah, P.Eng.
Reviewed By	Dwight Alfrey, P.Eng.

Revision History

			Asher Engineering Ltd.			Qulliq Energy Corporation
Rev No.	Date	Description	Created By (Initials)	Checked by (Initials)	Approval (Name and Signature)	Received by (Name and Signature)
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The results presented in the report are at a conceptual level; no detailed engineering has yet been performed, nor has equipment been selected or an operational plan been defined.

Use of this Document acknowledges acceptance of the foregoing conditions.

Table of Contents

List of Tables

Appendices

Executive Summary

QEC is building a new power plant on the south-west side of Cambridge Bay to provide sufficient energy to this community. Due to the remote location of the new power plant, different approaches for connecting the existing community feeders to the new power plant were studied.

After studying the different options for the possibility of feeding the existing community feeders from the new power plant, as explained in Cambridge Bay Power Plant Feeder Distribution Line Study 2401E001ST Rev. C, QEC advised to investigate the feasibility to implement the following option (Referenced as Option 4 in the report):

- A new power plant will be constructed in the south-west part of Cambridge Bay community. The new power plant will comprise Five (5) 4.16kV generators, 4.16kV switchgear and Two (2) 4.16/25kV, 5MVA, step-up transformers.
- A new substation will be constructed at the North Yard on the north side of Cambridge Bay community. The new substation will comprise One (1) 25kV switchgear, Two (2) 25/4.16kV, 5MVA, step-down transformers, and Two (2) 4.16kV switchgears.
- The new substation will be connected to the new power plant via Two (2) 25kV transmission lines.

The above option is discussed in detail in Section 1.3. The single-line diagrams showing the network topology are included in Appendix 1.

The previous study showed that this option does not accommodate the load forecast up to the year 2066, and that the off-line tap changers of both step up and step down transformers need to be adjusted to mitigate the voltage drop due to future load increase. Therefore, an alternative approach for voltage drop mitigation was studied as part of the scope of this report. The alternative approach involves the use of Automatic Voltage Regulators (AVRs) that are strategically placed in order to maintain the voltage drop within the ±3% voltage limits while keeping the network losses at a minimum.

The study considers the estimated electricity production for the years from 2026 to 2066 as shown in Appendix 2.

The study recommends the use of AVRs in the following locations:

- Two (2), 4.16kV, 5MVA, AVRs, one on the primary side of each step-up transformer in the new power plant.
- Feeder 1: Two (2), 4.16kV, 2.5MVA, AVRs on the supply side of Poles 50101135 and 50101225.
- Feeder 2: One (1), 4.16kV, 3.5MVA, AVR on the supply side of Pole 50102135.
- Feeder 3: One (1), 4.16kV, 1MVA, AVR on the supply side of Pole 50103013.
- Feeder 4: One (1), 4.16kV, 0.8MVA, AVR on the supply side of Pole 50104003.

The current study considers that Feeder 2 is connected to the new power plant at Pole 50102260 which is the closest pole with three-phase lines. An alternative option is to connect Feeder 2 to the new power plant at Pole 50102268 which is closer to the power plant and replace the single-phase transmission lines between Poles 50102268 and 50102260 with three-phase. Although this option involves additional transmission lines to be installed, it will eliminate the need for an AVR for Feeder 2.

Table 3 summarizes the study results.

Table 3: Study Results Summary

			Operating Scenario		Remarks
			A	**B**	
Main Power Plant	**Min. Main Feeder Line Size**		4/0 AWG	1/0 AWG	
	AVR Tap Setting	**AVR-T-F1_4-1**	-5%	-2.5%	
		AVR-T-F2_3-1	-5%	-2.5%	
Feeder 1	**Min. Main Feeder Line Size**		2/0 AWG	1/0 AWG	
	AVR Tap Setting	**AVR-50101135**	-6.25%	-5.625%	
		AVR-50101225	-3.75%	-3.75%	
Feeder 2	**Min. Main Feeder Line Size**		1/0 AWG	1/0 AWG	
	AVR Tap Setting AVR-50102135		-3.75%	-3.75%	
Feeder 3	**Min. Main Feeder Line Size**		3/0 AWG	1/0 AWG	
	AVR Tap Setting AVR-50103013		-7.5%	-7.5%	
Feeder 4	**Min. Main Feeder Line Size**		4/0 AWG	4/0 AWG	
	AVR Tap Setting AVR-50104003		-4.375%	-3.75%	

Scenario A: Feeders 1, 3, and 4 are fed from one North Yard Switchgear incomer.
Scenario B: Feeders 1, 3, and 4 are fed from both North Yard Switchgear incomers.

1. Introduction

1.1 Background

QEC is building a new power plant on the south-west side of Cambridge Bay to provide sufficient energy to this community. Due to the remote location of the new power plant, different approaches for connecting the existing community feeders to the new power plant were studied. The previous study, Cambridge Bay Power Plant Feeder Distribution Line Study 2401E001ST, considered five (5) options and reviewed the associated load behaviour over the network including the voltage drop and active power losses.

QEC preferred Option 4 of the original study.

Option 4

Run two (2) x 25kV feeder circuit lines from the new power plant (with two (2) x 5MVA step-up transformers) to the to the North Yard location (with two (2) x 5MVA step-down transformers and 5kV switchgear).

- Install two (2) new 4.16/25kV, 5MVA, step-up transformers in the new power plant and connect the primary side of these transformers to the new main 5kV switchgear via cables.
- Install two (2) new 25/4.16kV, 5MVA, step-down transformers and Main-Tie-Main, 5kV, switchgear at the North Yard and connect the primary side of these transformers to the outgoing breaker of the new switchgear.
- Connect the incoming breakers of the new switchgear to the secondary side of the new step-up transformers via new transmission lines.
- Connect the existing community feeders to the 5kV switchgear at the North Yard via transmission lines. The tie-in location of each feeder is as below:
    - For Feeder 1: Pole 50101135
    - For Feeder 2: Pole 50102251
    - For Feeder 3: Pole 50103013
    - For Feeder 4: Pole 50104003

For this option, two operating scenarios are considered:

- All community feeders are fed from one step-up transformer. This is considered the worst-case operating scenario.
- Each two of the community feeders are fed from one step-up transformer. The distribution of the community feeders on each transformer was decided based on the peak demand load of the four feeders such that both transformers are equally loaded.

However further review of this option was required in order to satisfy the original criteria of the study which were:

- Minimize the voltage drop across the lines. The voltage drop should not exceed 3% from the generators to each individual consumer.

- Minimize the network active power losses.

1.2 Scope of Work

The previous study showed that Option 4 as originally assessed does not accommodate the load forecast up to the year 2066, and that the off-line tap changers of both step up and step down transformers need to be adjusted to mitigate the voltage drop due to future load increase. Therefore, an alternative approach for voltage drop mitigation was included as part of the scope. The alternative approach involves the use of Automatic Voltage Regulators (AVRs) that are strategically placed at different parts of the network in order to maintain the voltage drop within the ±3% voltage limits while keeping the network losses at a minimum. In addition, alternatives for tie-in of Feeder 2 were considered.

The estimated electricity production for the years from 2026 to 2066 used in the study is included in Appendix 2.

1.3 Tie-In Option

The Option 4 approach for tie-in of the community feeders is detailed below with modifications from the original approach in bold.

- Construct a new power plant at the south-west part of Cambridge Bay community. The new power plant will comprise Five (5) 4.16kV generators, **4.16kV switchgear** and Two (2) 4.16/25kV, 5MVA, step-up transformers.
- Construct a new substation at the North Yard on the north side of Cambridge Bay community. The new substation will comprise **One (1) 25kV switchgear**, Two (2) 25/4.16kV, 5MVA, step-down transformers, and **Two (2) 4.16kV switchgears**.
- Run two (2) x 25kV feeder circuit lines from the new power plant each line will connect the 25kV secondary side of the step-up transformer in the new power plant to the 25kV switchgear in the new substation.
- Connect the primary side of the step-up transformers to the 4.16kV switchgear in the new power plant via cables.
- Connect the 25kV switchgear in the new substation to the primary side of the step-down transformers via cables.
- Connect the secondary side of the step-down transformers in the new substation to the **4.16kV switchgear** via cables.
- Connect the existing community feeders to the new power plant and the new substation as below:
    - Feeder 1: Will be connected to the 4.16kV switchgear in the new substation at Pole 50101135.
    - **Feeder 2: Will be connected to the 4.16kV switchgear in the new power plant at Pole 50102135.**
    - Feeder 3: Will be connected to the 4.16kV switchgear in the new substation at Pole 50103013.
    - Feeder 4: Will be connected to the 4.16kV switchgear in the new substation at Pole 50104003.

Two operating scenarios are considered:

- **Community Feeders 1, 3, and 4 are fed from one step-up transformer. This is considered the worst-case operating scenario.**
- Community Feeders 1 and 4 are fed from one step-up transformer while community Feeder 3 is fed from the other step-up transformer. The distribution of the community feeders on each transformer was decided based on the peak demand load of the three feeders such that both transformers are equally loaded.

The single-line diagram showing the network topology is included under Appendix 1.

2. Discussion

As with the previous study, the solution discussed in this study uses the following criteria in order to provide recommended optimum locations of AVRs and select a tie-in location for Feeder 2:

- Minimize the voltage drop across the lines. The voltage drop should not exceed 3% from the generators to each individual consumer.
- Minimize the network active power losses.

2.1 Sources of Data

Network model and simulation parameters are set based on the following inputs:

- **ETAP Model:**

  The ETAP model used is based on the model developed for QEC Penetration Study. The model of the power plant is updated to reflect the topology of the new plant.

- **One-line Diagrams:**

  The Network model is built using the provided one-line diagrams. These diagrams are also used to obtain the connected load and phase connection of each customer.

- **Generation Forecast:**

  QEC provided a table showing the estimated electricity produced over the years from 2026 to 2066 (See Appendix 2). These estimates are used for feeder sizing, voltage drop, and network losses calculations.

2.2 Assumptions

- The maximum demand factors of each feeder load in 2019 are calculated based on the load data reading provided by QEC. The estimated electricity production for subsequent years (Appendix 2) is used to calculate the maximum demand factor for these years.

- Normally open switches, interconnecting different feeders and used during the failure or maintenance of any of the feeder breakers, are not included in the model and the penetration study except for the options where each two feeders are combined.

- Since the specified AASC cables are not available in the standard ETAP library, AAC cables are used instead. The electrical and geometric characteristics of the selected cable are modified to match the AASC cable specifications provided by QEC.
- The boundary conditions for the voltage limits at all networks nodes (buses) are assumed to be +/-3%.
- The maximum transmission line size to be used is 4/0 AWG with a single conductor per phase.
- QEC advised that most of the loads are non-inductive and that the overall power factor for each feeder is in the order of 0.99. For the purpose of this study, all loads are assumed to have a 0.95 power factor for more conservative values of load currents.
- Based on overhead line conductor parameters provided by QEC, resistance, reactance, and susceptance values for overhead lines are calculated using ETAP considering the following conductor configuration on the pole structure:
  - Conductor height: 34 ft (unless otherwise indicated on the single-line diagrams).
  - Spacing between phases: 2 ft.
- Generator plant service loads are not considered in the analysis.
- Proposed AVRs have voltage adjustment limits of ±10% with steps of 0.625%. AVR impedances are included in the study based on their assumed values as provided by ETAP software.

2.3 Network Configuration

The new power plant for Cambridge Bay consists of two (2) 1500kW, two (2) 1100kW and one (1) 850kW generators with an output voltage of 4.16kV. Generator outputs are connected to a main 4.16kV switchgear with two (2) bus sections connected together via tie breaker such that one (1) 1500kW and one (1) 1100kW generators are connected to one bus section, and one (1) 1500kW, one (1) 1100kW, and one (1) 850kW generators are connected to the other bus section.

With the exception of Feeder #2, in order to improve customer power supply reliability, feeders are interconnected via a set of normally open switches. Any of these switches may be closed in the case when one of the feeder breakers is out of duty due to failure or for maintenance purposes. Since the case where both feeders are connected to one feeder breaker does not represent normal network operation and is used only for maintenance purposes, these configurations are not included in the model except where two feeders are combined into one feeder. For this case, only the tie switch is considered closed.

The network ETAP model is provided in Appendix 1.

2.4 Calculation Procedures

2.4.1 Load Parameters Calculations

The peak demand load for the year 2019 is obtained from the metering readings provided by QEC for this year and is used to calculated the maximum demand factor for the loads of each feeder as shown in Table 1.

Table 1: Maximum Demand (2019)

	Connected Load (kVA)	Max. Demand Load (kVA)	Max. Demand Factor (%)
Feeder 1	2537.5	989.625	39.00%
Feeder 2	3017.5	754.375	25.00%
Feeder 3	642.5	334.1	52.00%
Feeder 4	450	234	52.00%
Total	6647.5	2312.1	

The estimated electricity production (Appendix 2) is used to calculate the percentage growth of electricity demand which is, in turn, used to calculate the maximum demand for the successive years as shown in Table 2.

Table 2: Estimated Growth in Demand Load

Year	Population Demand Load Change (%)	Maximum Demand Factors			
		Feeder 1	Feeder 2	Feeder 3	Feeder 4
2019	-	39.00%	25.00%	52.00%	52.00%
2026	55.00%	60.45%	38.75%	80.60%	80.60%
2027	57.00%	61.23%	39.25%	81.64%	81.64%
2028	58.00%	61.62%	39.50%	82.16%	82.16%
2029	59.00%	62.01%	39.75%	82.68%	82.68%
2030	61.00%	62.79%	40.25%	83.72%	83.72%
2031	62.00%	63.18%	40.50%	84.24%	84.24%
2032	64.00%	63.96%	41.00%	85.28%	85.28%
2033	65.00%	64.35%	41.25%	85.80%	85.80%
2034	66.00%	64.74%	41.50%	86.32%	86.32%
2035	68.00%	65.52%	42.00%	87.36%	87.36%
2036	70.00%	66.30%	42.50%	88.40%	88.40%
2041	78.00%	69.42%	44.50%	92.56%	92.56%
2046	87.00%	72.93%	46.75%	97.24%	97.24%
2051	98.00%	77.22%	49.50%	102.96%	102.96%
2056	110.00%	81.90%	52.50%	109.20%	109.20%
2061	123.00%	86.97%	55.75%	115.96%	115.96%
2066	138.00%	92.82%	59.50%	123.76%	123.76%

As agreed with QEC, the study considers the load demand of the first 10 years (2026 to 2036) in one-year steps, and the following 30 years (2037 to 2066) in 5-year steps.

The above demand factors are used in the ETAP model.

The maximum demand load analysis of the four feeders based on the table above shows that:

- The maximum generation capacity for each bus section of the switchgear is 2500 kW. The peak demand load forecast for all the years exceeds 2500kW. Therefore, the switchgear bus-tie breaker needs to be closed such that the total load can be distributed among all the generators.
- Customer transformers connected to Feeders 3 and 4 need to be upgraded to 125% of their current ratings to accommodate the forecasted demand.

2.4.2 Design Constraints

The following design constraint are established by QEC:

- The total voltage drop from the generators to each customer load shall not exceed 3%.
- The maximum size of a transmission line is 4/0AWG with no more than one conductor per phase.
- Initial calculations are made with all transformer taps set at the zero-position. Voltage drop compensation is achieved using AVRs.

2.5 Results

Electricity production estimate for the years from 2026 to 2066 is used to calculate the demand load and demand factor for each feeder. These demand factors were applied to calculate the minimum feeder size that is required to achieve maximum voltage drop of 3% at the customer transformer using the tie-in option detailed under Section 1.3.

An iterative method is used to find the optimum connection locations for the AVR. The objective constraints used in this method is to:

1) Maintain the voltages at different poles within the ±3% voltage drop limits.
2) Minimize the active power losses in the network.
3) Minimize the number of AVRs to be used.

The results of this iterative method show that the AVR are best located near the heaviest loaded lines.

The study concludes that the tie-in configuration discussed in this study will provide the required energy to the community feeders up to the forecasted load for the year 2066 when using AVRs strategically located at different points of the network to compensate for potential voltage drops and to minimize network losses.

Table 3: Study Results Summary

			Operating Scenario		Remarks
			A	**B**	
Main Power Plant	**Min. Main Feeder Line Size**		4/0 AWG	1/0 AWG	
	AVR Tap Setting	**AVR-T-F1_4-1**	-5%	-2.5%	
		AVR-T-F2_3-1	-5%	-2.5%	
Feeder 1	**Min. Main Feeder Line Size**		2/0 AWG	1/0 AWG	
	AVR Tap Setting	**AVR-50101135**	-6.25%	-5.625%	
		AVR-50101225	-3.75%	-3.75%	
Feeder 2	**Min. Main Feeder Line Size**		1/0 AWG	1/0 AWG	
	AVR Tap Setting AVR-50102135		-3.75%	-3.75%	
Feeder 3	**Min. Main Feeder Line Size**		3/0 AWG	1/0 AWG	
	AVR Tap Setting AVR-50103013		-7.5%	-7.5%	
Feeder 4	**Min. Main Feeder Line Size**		4/0 AWG	4/0 AWG	
	AVR Tap Setting AVR-50104003		-4.375%	-3.75%	

Scenario A: Feeders 1, 3, and 4 are fed from one North Yard Switchgear incomer.
Scenario B: Feeders 1, 3, and 4 are fed from both North Yard Switchgear incomers.

Table 4: Study Results Details

Year	Operating Scenario	Main Power Plant			Feeder 1			Feeder 2		Feeder 3		Feeder 4	
		Min. Main Feeder Line Size	AVR Tap Setting		Min. Main Feeder Line Size	AVR Tap Setting		Min. Main Feeder Line Size	AVR Tap Setting	Min. Main Feeder Line Size	AVR Tap Setting	Min. Main Feeder Line Size	AVR Tap Setting
			AVR-T-F1_4-1	AVR-T-F2_3-1		AVR-50101135	AVR-50101225		AVR-50102135		AVR-50103013		AVR-50104003
2026	A	1/0 AWG	-3.75%	-3.75%	1/0 AWG	-3.75%	-1.25%	1/0 AWG	-1.875%	1/0 AWG	-4.375%	4/0 AWG	-1.875%
	B	1/0 AWG	-2.5%	-2.5%	1/0 AWG	-2.5%	-2.5%	1/0 AWG	-1.875%	1/0 AWG	-3.125%	4/0 AWG	-1.25%
2027	A	1/0 AWG	-3.75%	-3.75%	1/0 AWG	-3.75%	-1.25%	1/0 AWG	-1.875%	1/0 AWG	-4.375%	4/0 AWG	-1.875%
	B	1/0 AWG	-2.5%	-2.5%	1/0 AWG	-2.5%	-2.5%	1/0 AWG	-1.875%	1/0 AWG	-3.125%	4/0 AWG	-1.25%
2028	A	1/0 AWG	-3.75%	-3.75%	1/0 AWG	-3.75%	-1.875%	1/0 AWG	-1.875%	1/0 AWG	-4.375%	4/0 AWG	-1.875%
	B	1/0 AWG	-2.5%	-2.5%	1/0 AWG	-2.5%	-2.5%	1/0 AWG	-1.875%	1/0 AWG	-3.125%	4/0 AWG	-1.25%
2029	A	1/0 AWG	-3.75%	-3.75%	1/0 AWG	-3.75%	-1.875%	1/0 AWG	-1.875%	1/0 AWG	-4.375%	4/0 AWG	-1.875%
	B	1/0 AWG	-2.5%	-2.5%	1/0 AWG	-2.5%	-2.5%	1/0 AWG	-1.875%	1/0 AWG	-3.125%	4/0 AWG	-1.25%
2030	A	1/0 AWG	-3.75%	-3.75%	1/0 AWG	-3.75%	-1.875%	1/0 AWG	-1.875%	1/0 AWG	-4.375%	4/0 AWG	-1.875%
	B	1/0 AWG	-2.5%	-2.5%	1/0 AWG	-2.5%	-2.5%	1/0 AWG	-1.875%	1/0 AWG	-3.125%	4/0 AWG	-1.25%
2031	A	1/0 AWG	-3.75%	-3.75%	1/0 AWG	-3.75%	-1.875%	1/0 AWG	-1.875%	1/0 AWG	-5%	4/0 AWG	-1.875%
	B	1/0 AWG	-2.5%	-2.5%	1/0 AWG	-2.5%	-2.5%	1/0 AWG	-1.875%	1/0 AWG	-3.125%	4/0 AWG	-1.875%
2032	A	1/0 AWG	-3.75%	-3.75%	1/0 AWG	-3.75%	-1.875%	1/0 AWG	-1.875%	1/0 AWG	-5%	4/0 AWG	-1.875%
	B	1/0 AWG	-2.5%	-2.5%	1/0 AWG	-3.125%	-2.5%	1/0 AWG	-1.875%	1/0 AWG	-3.75%	4/0 AWG	-1.875%
2033	A	1/0 AWG	-3.75%	-3.75%	1/0 AWG	-3.75%	-1.875%	1/0 AWG	-1.875%	1/0 AWG	-5%	4/0 AWG	-2.5%
	B	1/0 AWG	-2.5%	-2.5%	1/0 AWG	-3.125%	-2.5%	1/0 AWG	-1.875%	1/0 AWG	-3.75%	4/0 AWG	-1.875%
2034	A	1/0 AWG	-3.75%	-3.75%	1/0 AWG	-3.75%	-2.5%	1/0 AWG	-1.875%	1/0 AWG	-5%	4/0 AWG	-2.5%
	B	1/0 AWG	-2.5%	-2.5%	1/0 AWG	-3.125%	-2.5%	1/0 AWG	-1.875%	1/0 AWG	-3.75%	4/0 AWG	-1.875%
2035	A	1/0 AWG	-3.75%	-3.75%	1/0 AWG	-3.75%	-2.5%	1/0 AWG	-1.875%	1/0 AWG	-5%	4/0 AWG	-2.5%
	B	1/0 AWG	-2.5%	-2.5%	1/0 AWG	-3.125%	-2.5%	1/0 AWG	-1.875%	1/0 AWG	-3.75%	4/0 AWG	-1.875%
2036	A	1/0 AWG	-3.75%	-3.75%	1/0 AWG	-3.75%	-2.5%	1/0 AWG	-1.875%	1/0 AWG	-5.625%	4/0 AWG	-2.5%
	B	1/0 AWG	-2.5%	-2.5%	1/0 AWG	-3.125%	-2.5%	1/0 AWG	-1.875%	1/0 AWG	-3.75%	4/0 AWG	-1.875%
2041	A	1/0 AWG	-3.75%	-3.75%	1/0 AWG	-4.375%	-2.5%	1/0 AWG	-1.875%	1/0 AWG	-6.25%	4/0 AWG	-3.125%
	B	1/0 AWG	-2.5%	-2.5%	1/0 AWG	-3.125%	-2.5%	1/0 AWG	-1.875%	1/0 AWG	-4.375%	4/0 AWG	-1.875%

Year	Operating Scenario	Main Power Plant			Feeder 1			Feeder 2		Feeder 3		Feeder 4	
		Min. Main Feeder Line Size	AVR Tap Setting		Min. Main Feeder Line Size	AVR Tap Setting		Min. Main Feeder Line Size	AVR Tap Setting	Min. Main Feeder Line Size	AVR Tap Setting	Min. Main Feeder Line Size	AVR Tap Setting
			AVR-T-F1_4-1	AVR-T-F2_3-1		AVR-50101135	AVR-50101225		AVR-50102135		AVR-50103013		AVR-50104003
2046	A	1/0 AWG	-4.375%	-4.375%	1/0 AWG	-4.375%	-2.5%	1/0 AWG	-2.5%	1/0 AWG	-6.25%	4/0 AWG	-3.125%
	B	1/0 AWG	-2.5%	-2.5%	1/0 AWG	-3.125%	-3.125%	1/0 AWG	-2.5%	1/0 AWG	-5%	4/0 AWG	-1.875%
2051	A	1/0 AWG	-4.375%	-4.375%	1/0 AWG	-5%	-3.125%	1/0 AWG	-2.5%	1/0 AWG	-6.875%	4/0 AWG	-3.125%
	B	1/0 AWG	-2.5%	-2.5%	1/0 AWG	-3.75%	-3.125%	1/0 AWG	-2.5%	1/0 AWG	-5%	4/0 AWG	-2.5%
2056	A	3/0 AWG	-4.375%	-4.375%	1/0 AWG	-5%	-3.75%	1/0 AWG	-3.125%	1/0 AWG	-7.5%	4/0 AWG	-3.75%
	B	1/0 AWG	-2.5%	-2.5%	1/0 AWG	-5%	-3.125%	1/0 AWG	-3.125%	1/0 AWG	-6.25%	4/0 AWG	-3.125%
2061	A	3/0 AWG	-5%	-5%	1/0 AWG	-5%	-3.75%	1/0 AWG	-3.125%	1/0 AWG	-7.5%	4/0 AWG	-3.75%
	B	1/0 AWG	-2.5%	-2.5%	1/0 AWG	-5%	-3.125%	1/0 AWG	-3.125%	1/0 AWG	-6.875%	4/0 AWG	-3.125%
2066	A	4/0 AWG	-5%	-5%	2/0 AWG	-6.25%	-3.75%	1/0 AWG	-3.75%	3/0 AWG	-7.5%	4/0 AWG	-4.375%
	B	1/0 AWG	-2.5%	-2.5%	1/0 AWG	-5.625%	-3.75%	1/0 AWG	-3.75%	1/0 AWG	-7.5%	4/0 AWG	-3.75%

Scenario A: Feeders 1, 3, and 4 are fed from one North Yard Switchgear incomer.
Scenario B: Feeders 1, 3, and 4 are fed from both North Yard Switchgear incomers.

3. **Conclusion and Recommendations**

The tie-in configuration discussed in this study will provide the required energy to the community feeders up to the forecasted load for the year 2066 when using AVRs strategically located at different points of the network to compensate for potential voltage drops and to minimize network losses.

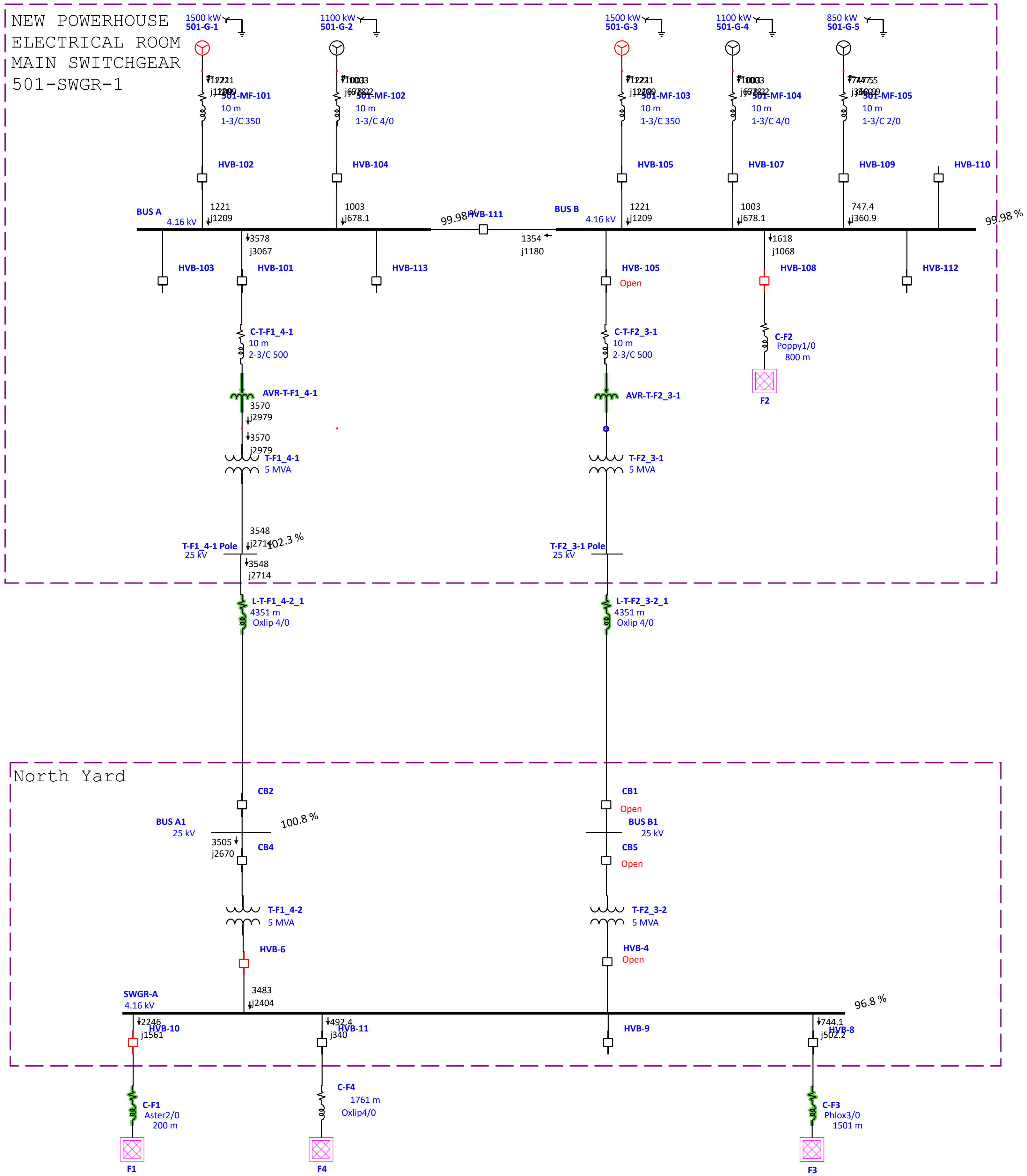
The current study considers that Feeder 2 is connected to the new power plant at Pole 50102135 which is the closest pole with three-phase lines. An alternative recommendation would be to connect Feeder 2 to the new power plant at Pole 50102268 which is closer to the power plant and replace the single-phase transmission lines between Poles 50102268 and 50102135 with three-phase. Although this option involves additional transmission lines, it would eliminate the need for an AVR for Feeder 2.

The study can be revisited upon the final selection of the AVRs to verify their connection locations based on their tap setting range and impedances.

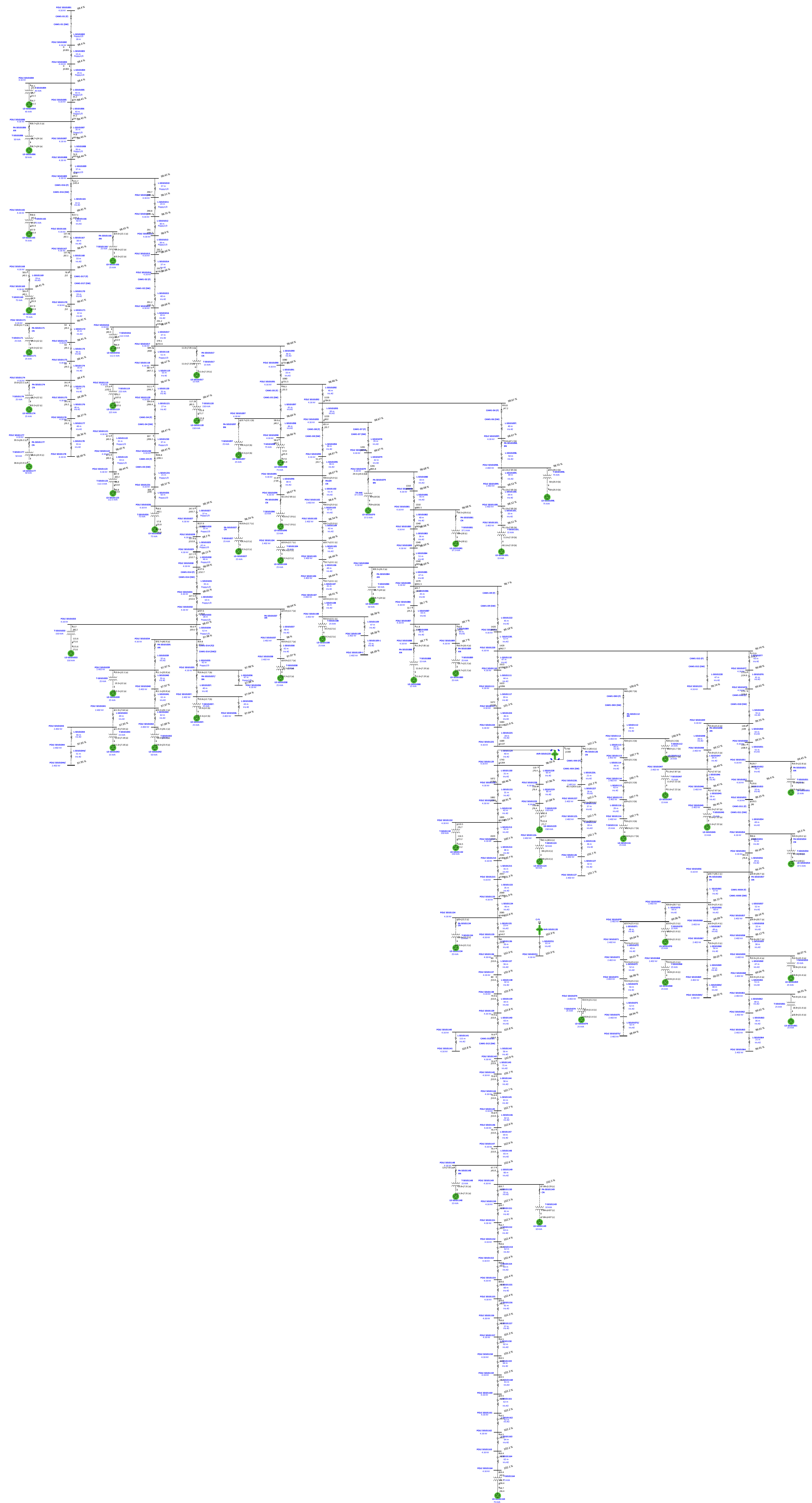
Appendix 1

Cambridge Bay Network ETAP Model and Results

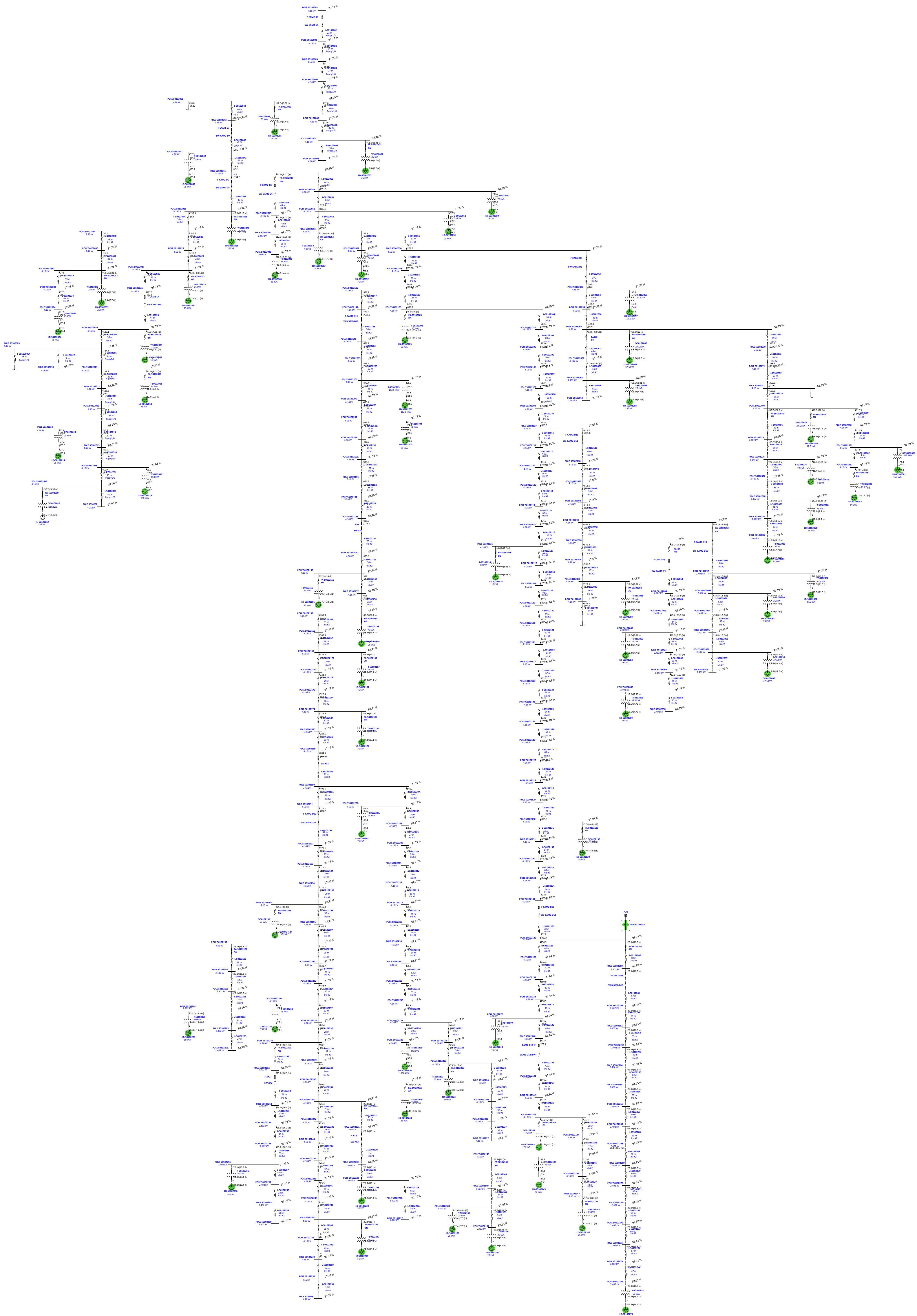
One-Line Diagram - OLV1 | Load Flow Analysis | LF

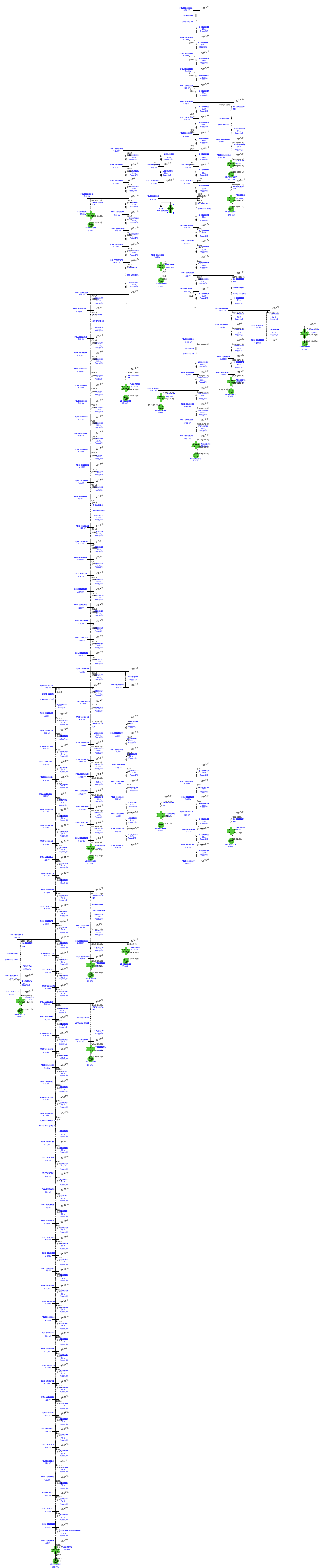


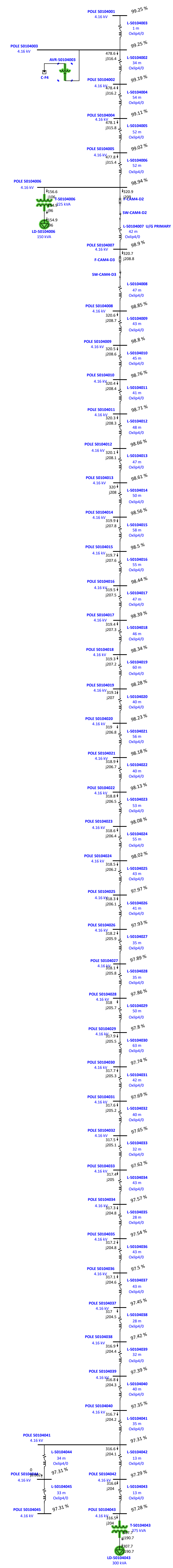
One-Line Diagram - OLV1->F1 | Load Flow Analysis | LF



One-Line Diagram - OLV1->F2 | Load Flow Analysis | LF







Appendix 2

Cambridge Bay – Estimated Electricity Production

Appendix C: Calculated power plant electricity generation after 2026

Estimated yearly electricity production for the new Cambridge Bay power plant

Year	Population	Population change	Estimated electricity produced (kWh/year)
2026	2,451	+55	15,407,427
2027	2,507	+57	15,763,605
2028	2,565	+58	16,128,017
2029	2,625	+59	16,500,853
2030	2,685	+61	16,882,308
2031	2,747	+62	17,272,581
2032	2,811	+64	17,671,877
2033	2,876	+65	18,080,403
2034	2,942	+66	18,498,373
2035	3,010	+68	18,926,005
2036	3,080	+70	19,363,523
2037	3,151	+71	19,811,155
2038	3,224	+73	20,269,136
2039	3,298	+75	20,737,703
2040	3,375	+76	21,217,103
2041	3,453	+78	21,707,585
2042	3,532	+80	22,209,405
2043	3,614	+82	22,722,827
2044	3,698	+84	23,248,117
2045	3,783	+85	23,785,550
2046	3,871	+87	24,335,408
2047	3,960	+89	24,897,977
2048	4,052	+92	25,473,551
2049	4,145	+94	26,062,430
2050	4,241	+96	26,664,923
2051	4,339	+98	27,281,344
2052	4,439	+100	27,912,015
2053	4,542	+103	28,557,265
2054	4,647	+105	29,217,432
2055	4,755	+107	29,892,860
2056	4,864	+110	30,583,902
2057	4,977	+112	31,290,919
2058	5,092	+115	32,014,280
2059	5,210	+118	32,754,364
2060	5,330	+120	33,511,556
2061	5,453	+123	34,286,252
2062	5,579	+126	35,078,858
2063	5,708	+129	35,889,786
2064	5,840	+132	36,719,461
2065	5,975	+135	37,568,315
2066	6,113	+138	38,436,793