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Electrical - Instrumentation - System Integration
Solutions

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# RTMR - PMG RECOVERY PLANT

etap

# Index – RTMR LOAD FLOW ANALYSES

# Engineering Report

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# RTMR PGM Recovery Plant – Electrical Load Flow & PSCC Report

## 1. EXECUTIVE SUMMARY

A full electrical study was performed on the RTMR PGM Recovery Plant, including load flow analysis without PF correction, simulated PF correction analysis, and PSCC analysis. The existing system shows poor power factor (58–60%), low LV voltages, high transformer kvar flow, and increased losses. PF correction significantly improves voltage stability and system performance.

## 2. NETWORK DESCRIPTION

The plant receives 6.6 kV supply from a 3.2 MVA utility source. Three MV/LV substations distribute power to MCC1, MCC2, MCC3, and Ball Mill MCC. LV loads consist of motors, conveyors, milling equipment, and auxiliary electrical systems.

## 3. LOAD FLOW ANALYSIS – WITHOUT PF CORRECTION

Key results:
- MCC1 voltage: 95.17%
- MCC2 voltage: 96.37%
- Ball Mill MCC voltage: 94.95%
- Mini-Sub 1 loading: 52.05% (PF 58.67%)
- Mini-Sub 2 loading: 32.19% (PF 59.18%)
- Ball Mill Mini-Sub loading: 72.10% (PF 83.9%)
- MCC2 load cable loading: 87.62%
- System-wide PF extremely poor (58–60%)
- High transformer reactive flow and losses

## 4. LOAD FLOW ANALYSIS – WITH PF CORRECTION (SIMULATED)

Simulated PF equipment:
- CAP1 = 0.6 Mvar
- CAP2 = 0.3 Mvar
- CAP3 = 0.4 Mvar

Improvements:
- LV voltages rise to 97–99%
- Transformer reactive burden decreases
- Feeder currents reduce significantly
- Overall losses decrease

## 5. COMPARISON – WITH AND WITHOUT PF CORRECTION

Voltage Levels:
- Without PF: 94–96%
- With PF: 97–99%

Power Factor:
- Without PF: 58–60%
- With PF: >92%

Transformer Loading:
- Without PF: 50–72%
- With PF: 30–55%

Reactive Flow:
- Without PF: up to 632 kvar
- With PF: reduced to ~30 kvar (steps can be correctly simulated)

## 6. PSCC ANALYSIS – IEC 60909

Fault Levels:
- MCC1 Bus: 9.793 kA (3-phase)
- MCC2 Bus: 8.862 kA (3-phase)
- Ball Mill MCC: 8.248 kA (3-phase)
- LLG Fault MCC1: 11.916 kA
- LLG Fault MCC2: 11.056 kA
- LLG Fault Ball Mill MCC: 9.521 kA

All fault levels remain within breaker ratings.

## 7. FINAL FINDINGS

Without PF correction:

- Low LV voltages
- High reactive power burden
- Transformer heating
- Higher feeder currents

With PF correction:

- Voltage improves to safe levels
- Reduced transformer loading
- System losses decrease
- Higher system stability

PSCC:

- All buses remain within IEC 60909 compliance
- No protection issues found

## 8. RECOMMENDATIONS

- Install 1.3–1.8 Mvar distributed PF correction
- Validate LV protection settings after PF installation
- Perform annual ETAP upgrades
- Conduct monthly transformer thermal monitoring

## 9. ANNEXURES

Annexure A – Complete Report Current plant conditions

Annexure B – PSCC L-L-G Report

Annexure C – Load Flow Diagram Without PF

Annexure D – Load Flow Diagram With PF

Annexure E – PSCC Diagrams

# Annexure A

Complete report current plant

# Electrical Transient Analyzer Program

## Load Flow Analysis

Loading Category (1): Design

Generation Category (1): Design

Load Diversity Factor: None

| | Swing | V-Control | Load | Total |
|---|---|---|---|---|
| Number of Buses: | 1 | 0 | 12 | 13 |

| | XFMR2 | XFMR3 | Reactor | Line/Cable/ Busway | Impedance | Tie PD | Total |
|---|---|---|---|---|---|---|---|
| Number of Branches: | 3 | 0 | 0 | 8 | 0 | 1 | 12 |

| | |
|---|---|
| Method of Solution: | Adaptive Newton-Raphson Method |
| Maximum No. of Iteration: | 99 |
| Precision of Solution: | 0.0001000 |
| System Frequency: | 50.00 Hz |
| Unit System: | Metric |
| Project Filename: | EISI Loadflow Analyses |
| Output Filename: | C:\ETAP 2400\EISI Loadflow Analyses\RTMR Load Flow Study.lfr |

## Adjustments

| Tolerance | Apply Adjustments | Individual /Global | Percent |
|---|---|---|---|
| Transformer Impedance: | Yes | Individual | |
| Reactor Impedance: | Yes | Individual | |
| Overload Heater Resistance: | No | | |
| Transmission Line Length: | No | | |
| Cable / Busway Length: | No | | |

| Temperature Correction | Apply Adjustments | Individual /Global | Degree C |
|---|---|---|---|
| Transmission Line Resistance: | Yes | Individual | |
| Cable / Busway Resistance: | Yes | Individual | |

## Bus Input Data

| Bus | | | Initial Voltage | | Load | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Constant kVA | | Constant Z | | Constant I | | Generic | |
| ID | kV | Sub-sys | % Mag. | Ang. | MW | Mvar | MW | Mvar | MW | Mvar | MW | Mvar |
| Ball Mill Bus | 6.600 | 1 | 100.0 | 30.0 | | | | | | | | |
| Ball Mill MCC Bus | 0.400 | 1 | 100.0 | 0.0 | 0.031 | 0.034 | 0.004 | 0.004 | | | | |
| Ball Mill Mini-Sub Bus | 0.400 | 1 | 100.0 | 0.0 | | | | | | | | |
| Ball Motor Cable Bus | 0.400 | 1 | 100.0 | 0.0 | 0.257 | 0.146 | 0.001 | 0.001 | | | | |
| Bus1 | 6.600 | 1 | 100.0 | 0.0 | | | | | | | | |
| MCC 1 Bus | 0.550 | 1 | 100.0 | 0.0 | 0.412 | 0.549 | 0.046 | 0.061 | | | | |
| MCC 2 Bus | 0.550 | 1 | 100.0 | 0.0 | 0.257 | 0.343 | 0.029 | 0.038 | | | | |
| Mini Sub 1 Bus | 6.600 | 1 | 100.0 | 30.0 | | | | | | | | |
| Mini Sub 2 MV Bus | 6.600 | 1 | 100.0 | 0.0 | | | | | | | | |
| Mini-Sub 1 Bus | 0.550 | 1 | 100.0 | 0.0 | | | | | | | | |
| Mini-Sub-1 Supply | 6.600 | 1 | 100.0 | 0.0 | | | | | | | | |
| Mini-Sub 2 Bus | 0.550 | 1 | 100.0 | 0.0 | | | | | | | | |
| Transmission Line Bus | 6.600 | 1 | 100.0 | 0.0 | | | | | | | | |
| Total Number of Buses: 13 | | | | | 0.957 | 1.071 | 0.080 | 0.104 | 0.000 | 0.000 | 0.000 | 0.000 |

| Generation Bus | | | | Voltage | | Generation | | | Mvar Limits | |
|---|---|---|---|---|---|---|---|---|---|---|
| ID | kV | Type | Sub-sys | % Mag. | Angle | MW | Mvar | % PF | Max | Min |
| Bus1 | 6.600 | Swing | 1 | 100.0 | 0.0 | | | | | |
| | | | | | | 0.000 | 0.000 | | | |

## Line/Cable/Busway Input Data

| Line/Cable/Busway | | | ohms or siemens/1000 m per Conductor (Cable) or per Phase (Line/Busway) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Length | | | | | | |
| ID | Library | Size | Adj. (m) | % Tol. | #/Phase | T (°C) | R | X | Y |
| Ball Mill Supply Cable | 1,0NCUN3 | 95 | 17.0 | 0.0 | 2 | 75 | 0.235582 | 0.073000 | 0.0001433 |
| Main Supply Cable1 | 11NCUN3 | 70 | 35.0 | 0.0 | 1 | 75 | 0.326382 | 0.117000 | 0.0000900 |
| MCC3 Supply Cable | 1,0MCUN4 | 95 | 18.0 | 0.0 | 2 | 75 | 0.235582 | 0.073000 | 0.0001433 |
| Supply Cable MCC 1 | 1,0MCUN1 | 630 | 15.0 | 0.0 | 2 | 75 | 0.040059 | 0.086000 | 0.0002023 |
| Supply Cable MCC 2 | 1,0NCUN1 | 630 | 15.0 | 0.0 | 2 | 75 | 0.040059 | 0.086000 | 0.0002023 |
| Supply Cable Mini Sub-1/2 | 11NCUN3 | 95 | 100.0 | 0.0 | 1 | 75 | 0.235487 | 0.111000 | 0.0001010 |
| Supply Cable Mini-Sub 2 | 11NCUN3 | 50 | 100.0 | 0.0 | 1 | 75 | 0.470974 | 0.126000 | 0.0000800 |
| Line1 | | 122, | 1000.0 | 0.0 | 1 | 75 | 0.306324 | 0.265711 | 0.0000045 |

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

## 2-Winding Transformer Input Data

| Transformer | | Rating | | | | | Z Variation | | | % Tap Setting | | Adjusted | Phase Shift | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | Phase | MVA | Prim. kV | Sec. kV | % Z1 | X1/R1 | + 5% | - 5% | % Tol. | Prim. | Sec. | % Z | Type | Angle |
| Ballmill Mini-Sub | 3-Phase | 0.500 | 6.600 | 0.400 | 5.19 | 1.50 | 0 | 0 | 0 | 0 | 0 | 5.1900 | Dyn | 0.000 |
| Minisub-1 | 3-Phase | 1.500 | 6.600 | 0.550 | 6.53 | 6.00 | 0 | 0 | 0 | 0 | 0 | 6.5300 | Dyn | 0.000 |
| Minisub-2 | 3-Phase | 1.500 | 6.600 | 0.550 | 6.53 | 6.00 | 0 | 0 | 0 | 0 | 0 | 6.5300 | Dyn | 0.000 |

## Branch Connections

| CKT/Branch | | Connected Bus ID | | % Impedance, Pos. Seq., 100 MVA Base | | | |
|---|---|---|---|---|---|---|---|
| ID | Type | From Bus | To Bus | R | X | Z | Y |
| Ballmill Mini-Sub | 2W XFMR | Ball Mill Bus | Ball Mill Mini-Sub Bus | 575.78 | 863.67 | 1038.00 | |
| Minisub-1 | 2W XFMR | Mini Sub 1 Bus | Mini-Sub 1 Bus | 71.57 | 429.41 | 435.33 | |
| Minisub-2 | 2W XFMR | Mini Sub 2 MV Bus | Mini-Sub 2 Bus | 71.57 | 429.41 | 435.33 | |
| Ball Mill Supply Cable | Cable | Ball Mill Mini-Sub Bus | Ball Motor Cable Bus | 125.15 | 38.78 | 131.02 | 0.0000008 |
| Main Supply Cable1 | Cable | Transmission Line Bus | Ball Mill Bus | 2.62 | 0.94 | 2.79 | 0.0001372 |
| MCC3 Supply Cable | Cable | Ball Mill Mini-Sub Bus | Ball Mill MCC Bus | 132.52 | 41.06 | 138.73 | 0.0000008 |
| Supply Cable MCC 1 | Cable | Mini-Sub 1 Bus | MCC 1 Bus | 9.93 | 21.32 | 23.52 | 0.0000018 |
| Supply Cable MCC 2 | Cable | Mini-Sub 2 Bus | MCC 2 Bus | 9.93 | 21.32 | 23.52 | 0.0000018 |
| Supply Cable Mini Sub-1/2 | Cable | Mini-Sub-1 Supply | Mini Sub 1 Bus | 5.41 | 2.55 | 5.98 | 0.0004400 |
| Supply Cable Mini-Sub 2 | Cable | Mini Sub 1 Bus | Mini Sub 2 MV Bus | 10.81 | 2.89 | 11.19 | 0.0003485 |
| Line1 | Line | Bus1 | Transmission Line Bus | 70.32 | 61.00 | 93.09 | 0.0001941 |
| Blade Fuse 1 | Tie Fuse | Transmission Line Bus | Mini-Sub-1 Supply | | | | |

## LOAD_FLOW_REPORT

| Bus | | Voltage | | Generation | | Load | | Load Flow | | | | | XFMR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | kV | % Mag. | Ang. | MW | Mvar | MW | Mvar | ID | MW | Mvar | Amp | %PF | %Tap |
| Ball Mill Bus | 6.600 | 98.488 | 0.1 | 0.000 | 0.000 | 0.000 | 0.000 | Transmission Line Bus | -0.302 | -0.196 | 32.0 | 83.9 | |
| | | | | | | | | Ball Mill Mini-Sub Bus | 0.302 | 0.196 | 32.0 | 83.9 | |
| Ball Mill MCC Bus | 0.400 | 94.947 | -0.8 | 0.000 | 0.000 | 0.035 | 0.037 | Ball Mill Mini-Sub Bus | -0.035 | -0.037 | 77.8 | 68.1 | |
| Ball Mill Mini-Sub Bus | 0.400 | 95.012 | -0.8 | 0.000 | 0.000 | 0.000 | 0.000 | Ball Motor Cable Bus | 0.260 | 0.147 | 453.6 | 87.0 | |
| | | | | | | | | Ball Mill MCC Bus | 0.035 | 0.038 | 77.8 | 68.1 | |
| | | | | | | | | Ball Mill Bus | -0.295 | -0.185 | 528.3 | 84.7 | |
| Ball Motor Cable Bus | 0.400 | 94.609 | -0.7 | 0.000 | 0.000 | 0.259 | 0.147 | Ball Mill Mini-Sub Bus | -0.259 | -0.147 | 453.6 | 87.0 | |
| *Bus1 | 6.600 | 100.000 | 0.0 | 1.066 | 1.233 | 0.000 | 0.000 | Transmission Line Bus | 1.066 | 1.233 | 142.6 | 65.4 | |
| MCC 1 Bus | 0.550 | 95.169 | -0.8 | 0.000 | 0.000 | 0.453 | 0.604 | Mini-Sub 1 Bus | -0.453 | -0.604 | 832.7 | 60.0 | |
| MCC 2 Bus | 0.550 | 96.373 | -0.4 | 0.000 | 0.000 | 0.284 | 0.378 | Mini-Sub 2 Bus | -0.284 | -0.378 | 515.1 | 60.0 | |
| Mini Sub 1 Bus | 6.600 | 98.431 | 0.1 | 0.000 | 0.000 | 0.000 | 0.000 | Mini-Sub-1 Supply | -0.744 | -1.021 | 112.3 | 58.9 | |
| | | | | | | | | Mini Sub 2 MV Bus | 0.286 | 0.389 | 42.9 | 59.2 | |
| | | | | | | | | Mini-Sub 1 Bus | 0.458 | 0.632 | 69.4 | 58.7 | |
| Mini Sub 2 MV Bus | 6.600 | 98.388 | 0.2 | 0.000 | 0.000 | 0.000 | 0.000 | Mini Sub 1 Bus | -0.286 | -0.389 | 42.9 | 59.2 | |
| | | | | | | | | Mini-Sub 2 Bus | 0.286 | 0.389 | 42.9 | 59.2 | |
| Mini-Sub 1 Bus | 0.550 | 95.352 | -0.8 | 0.000 | 0.000 | 0.000 | 0.000 | MCC 1 Bus | 0.454 | 0.605 | 832.7 | 60.0 | |
| | | | | | | | | Mini Sub 1 Bus | -0.454 | -0.605 | 832.7 | 60.0 | |
| Mini-Sub-1 Supply | 6.600 | 98.498 | 0.1 | 0.000 | 0.000 | 0.000 | 0.000 | Mini Sub 1 Bus | 0.745 | 1.021 | 112.3 | 58.9 | |
| | | | | | | | | Transmission Line Bus | -0.745 | -1.021 | 112.3 | 58.9 | |
| Mini-Sub 2 Bus | 0.550 | 96.486 | -0.4 | 0.000 | 0.000 | 0.000 | 0.000 | MCC 2 Bus | 0.284 | 0.379 | 515.1 | 60.0 | |
| | | | | | | | | Mini Sub 2 MV Bus | -0.284 | -0.379 | 515.1 | 60.0 | |
| Transmission Line Bus | 6.600 | 98.498 | 0.1 | 0.000 | 0.000 | 0.000 | 0.000 | Ball Mill Bus | 0.302 | 0.196 | 32.0 | 83.9 | |
| | | | | | | | | Bus1 | -1.047 | -1.217 | 142.6 | 65.2 | |
| | | | | | | | | Mini-Sub-1 Supply | 0.745 | 1.021 | 112.3 | 58.9 | |

* Indicates a voltage regulated bus ( voltage controlled or swing type machine connected to it)

\# Indicates a bus with a load mismatch of more than 0.1 MVA

## Bus Loading Summary Report

| Bus | | | Directly Connected Load | | | | | | | | Total Bus Load | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Constant kVA | | Constant Z | | Constant I | | Generic | | | | | |
| ID | kV | Rated Amp | MW | Mvar | MW | Mvar | MW | Mvar | MW | Mvar | MVA | % PF | Amp | Percent Loading |
| Ball Mill Bus | 6.600 | 600.0 | | | | | | | | | 0.361 | 83.9 | 32.0 | 5.3 |
| Ball Mill MCC Bus | 0.400 | 1600.0 | 0.031 | 0.034 | 0.004 | 0.004 | | | | | 0.051 | 68.1 | 77.8 | 4.9 |
| Ball Mill Mini-Sub Bus | 0.400 | 2000.0 | | | | | | | | | 0.348 | 84.7 | 528.3 | 26.4 |
| Ball Motor Cable Bus | 0.400 | | 0.257 | 0.146 | 0.001 | 0.001 | | | | | 0.297 | 87.0 | 453.6 | |
| Bus1 | 6.600 | | | | | | | | | | 1.630 | 65.4 | 142.6 | |
| MCC 1 Bus | 0.550 | 2000.0 | 0.412 | 0.549 | 0.041 | 0.055 | | | | | 0.755 | 60.0 | 832.7 | 41.6 |
| MCC 2 Bus | 0.550 | 2000.0 | 0.257 | 0.343 | 0.027 | 0.035 | | | | | 0.473 | 60.0 | 515.1 | 25.8 |
| Mini Sub 1 Bus | 6.600 | 600.0 | | | | | | | | | 1.264 | 58.9 | 112.3 | 18.7 |
| Mini Sub 2 MV Bus | 6.600 | 600.0 | | | | | | | | | 0.483 | 59.2 | 42.9 | 7.2 |
| Mini-Sub 1 Bus | 0.550 | | | | | | | | | | 0.756 | 60.0 | 832.7 | |
| Mini-Sub-1 Supply | 6.600 | | | | | | | | | | 1.264 | 58.9 | 112.3 | |
| Mini-Sub 2 Bus | 0.550 | | | | | | | | | | 0.473 | 60.0 | 515.1 | |
| Transmission Line Bus | 6.600 | 600.0 | | | | | | | | | 1.606 | 65.2 | 142.6 | 23.8 |

* Indicates operating load of a bus exceeds the bus critical limit (100.0% of the Continuous Ampere rating).
\# Indicates operating load of a bus exceeds the bus marginal limit (95.0% of the Continuous Ampere rating).

## Branch Loading Summary Report

| CKT / Branch | | Busway / Cable & Reactor | | | Transformer | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Loading (input) | | Loading (output) | |
| ID | Type | Ampacity (Amp) | Loading Amp | % | Capability (MVA) | MVA | % | MVA | % |
| Ball Mill Supply Cable | Cable | 517.75 | 453.64 | 87.62 | | | | | |
| Main Supply Cable1 | Cable | 198.35 | 32.02 | 16.14 | | | | | |
| MCC3 Supply Cable | Cable | 517.75 | 77.80 | 15.03 | | | | | |
| Supply Cable Mini Sub-1/2 | Cable | 235.72 | 112.29 | 47.64 | | | | | |
| Supply Cable Mini-Sub 2 | Cable | 161.21 | 42.93 | 26.63 | | | | | |
| Ballmill Mini-Sub | Transformer | | | | 0.500 | 0.361 | 72.1 | 0.348 | 69.6 |
| Minisub-1 | Transformer | | | | 1.500 | 0.781 | 52.1 | 0.756 | 50.4 |
| Minisub-2 | Transformer | | | | 1.500 | 0.483 | 32.2 | 0.473 | 31.6 |

* Indicates a branch with operating load exceeding the branch capability.

## Branch Losses Summary Report

| Branch ID | From-To Bus Flow | | To-From Bus Flow | | Losses | | % Bus Voltage | | Vd % Drop in Vmag |
|---|---|---|---|---|---|---|---|---|---|
| | MW | Mvar | MW | Mvar | kW | kvar | From | To | |
| Ball Mill Supply Cable | 0.260 | 0.147 | -0.259 | -0.147 | 1.2 | 0.4 | 95.0 | 94.6 | 0.40 |
| Ballmill Mini-Sub | 0.302 | 0.196 | -0.295 | -0.185 | 7.7 | 11.6 | 98.5 | 95.0 | 3.48 |
| Line1 | 1.066 | 1.233 | -1.047 | -1.217 | 18.7 | 16.0 | 100.0 | 98.5 | 1.50 |
| Main Supply Cable1 | -0.302 | -0.196 | 0.302 | 0.196 | 0.0 | -0.1 | 98.5 | 98.5 | 0.01 |
| MCC3 Supply Cable | -0.035 | -0.037 | 0.035 | 0.038 | 0.0 | 0.0 | 94.9 | 95.0 | 0.06 |
| Minisub-1 | 0.458 | 0.632 | -0.454 | -0.605 | 4.5 | 27.0 | 98.4 | 95.4 | 3.08 |
| Minisub-2 | 0.286 | 0.389 | -0.284 | -0.379 | 1.7 | 10.3 | 98.4 | 96.5 | 1.90 |
| Supply Cable MCC 1 | -0.453 | -0.604 | 0.454 | 0.605 | 0.6 | 1.3 | 95.2 | 95.4 | 0.18 |
| Supply Cable MCC 2 | -0.284 | -0.378 | 0.284 | 0.379 | 0.2 | 0.5 | 96.4 | 96.5 | 0.11 |
| Supply Cable Mini Sub-1/2 | -0.744 | -1.021 | 0.745 | 1.021 | 0.9 | 0.0 | 98.4 | 98.5 | 0.07 |
| Supply Cable Mini-Sub 2 | 0.286 | 0.389 | -0.286 | -0.389 | 0.3 | -0.3 | 98.4 | 98.4 | 0.04 |
| | | | | | 36.0 | 66.8 | | | |

* This Transmission Line includes Series Capacitor.

## Alert Summary Report

| | % Alert Settings | |
|---|---|---|
| | Critical | Marginal |
| **Loading** | | |
| Bus | 100.0 | 95.0 |
| Cable / Busway | 100.0 | 95.0 |
| Reactor | 100.0 | 95.0 |
| Line | 100.0 | 95.0 |
| Transformer | 100.0 | 95.0 |
| Panel | 100.0 | 95.0 |
| Protective Device | 100.0 | 95.0 |
| Generator | 100.0 | 95.0 |
| Inverter/Charger | 100.0 | 95.0 |
| **Bus Voltage** | | |
| OverVoltage | 105.0 | 102.0 |
| UnderVoltage | 95.0 | 98.0 |
| **Generator Excitation** | | |
| OverExcited (Q Max.) | 100.0 | 95.0 |
| UnderExcited (Q Min.) | 100.0 | |

## Critical Report

| Device ID | Type | Condition | Rating/Limit | Unit | Operating | % Operating | Phase Type |
|---|---|---|---|---|---|---|---|
| Ball Mill MCC Bus | Bus | Under Voltage | 0.400 | kV | 0.380 | 94.9 | 3-Phase |
| Ball Motor Cable Bus | Bus | Under Voltage | 0.400 | kV | 0.378 | 94.6 | 3-Phase |

## Marginal Report

| Device ID | Type | Condition | Rating/Limit | Unit | Operating | % Operating | Phase Type |
|---|---|---|---|---|---|---|---|
| Ball Mill Mini-Sub Bus | Bus | Under Voltage | 0.400 | kV | 0.380 | 95.0 | 3-Phase |
| MCC 1 Bus | Bus | Under Voltage | 0.550 | kV | 0.523 | 95.2 | 3-Phase |
| MCC 2 Bus | Bus | Under Voltage | 0.550 | kV | 0.530 | 96.4 | 3-Phase |
| Mini-Sub 1 Bus | Bus | Under Voltage | 0.550 | kV | 0.524 | 95.4 | 3-Phase |
| Mini-Sub 2 Bus | Bus | Under Voltage | 0.550 | kV | 0.531 | 96.5 | 3-Phase |

## SUMMARY OF TOTAL GENERATION, LOADING & DEMAND

| | MW | Mvar | MVA | % PF |
|---|---|---|---|---|
| Source (Swing Buses): | 1.066 | 1.233 | 1.630 | 65.40 Lagging |
| Source (Non-Swing Buses): | 0.000 | 0.000 | 0.000 | |
| Total Demand: | 1.066 | 1.233 | 1.630 | 65.40 Lagging |
| Total Motor Load: | 0.957 | 1.071 | 1.437 | 66.63 Lagging |
| Total Static Load: | 0.073 | 0.095 | 0.120 | 60.76 Lagging |
| Total Constant I Load: | 0.000 | 0.000 | 0.000 | |
| Total Generic Load: | 0.000 | 0.000 | 0.000 | |
| Apparent Losses: | 0.036 | 0.067 | | |
| System Mismatch: | 0.000 | 0.000 | | |

Number of Iterations: 5

# Annexure B

PSCC L-L-G Report

# Electrical Transient Analyzer Program

## Short-Circuit Analysis

### IEC 60909 Standard

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

| | Swing | V-Control | Load | Total |
|---|---|---|---|---|
| Number of Buses: | 1 | 0 | 12 | 13 |

| | XFMR2 | XFMR3 | Reactor | Line/Cable/ Busway | Impedance | Tie PD | Total |
|---|---|---|---|---|---|---|---|
| Number of Branches: | 3 | 0 | 0 | 8 | 0 | 1 | 12 |

| | Synchronous Generator | Power Grid | Synchronous Motor | Induction Machines | Lumped Load | Inverter | Total |
|---|---|---|---|---|---|---|---|
| Number of Machines: | 0 | 1 | 0 | 0 | 4 | 0 | 5 |

| | |
|---|---|
| System Frequency: | 50.00 |
| Unit System: | Metric |
| Project Filename: | EISI Loadflow Analyses |
| Output Filename: | C:\ETAP 2400\EISI Loadflow Analyses\RTMR PGm Recovery Plant.SI2S |

## Adjustments

| Tolerance | Apply Adjustments | Individual /Global | Percent |
|---|---|---|---|
| Transformer Impedance: | Yes | Individual | |
| Reactor Impedance: | Yes | Individual | |
| Overload Heater Resistance: | No | | |
| Transmission Line Length: | No | | |
| Cable / Busway Length: | No | | |

| Temperature Correction | Apply Adjustments | Individual /Global | Degree C |
|---|---|---|---|
| Transmission Line Resistance: | Yes | Individual | |
| Cable / Busway Resistance: | Yes | Individual | |

## Bus Input Data

| Bus | | | | | Initial Voltage | |
|---|---|---|---|---|---|---|
| ID | Type | Nom. kV | Base kV | Sub-sys | %Mag. | Ang. |
| Ball Mill Bus | Load | 6.600 | 6.600 | 1 | 100.00 | 0.00 |
| Ball Mill MCC Bus | Load | 0.400 | 0.400 | 1 | 100.00 | -30.00 |
| Ball Mill Mini-Sub Bus | Load | 0.400 | 0.400 | 1 | 100.00 | -30.00 |
| Ball Motor Cable Bus | Load | 0.400 | 0.400 | 1 | 100.00 | -30.00 |
| Bus1 | SWNG | 6.600 | 6.600 | 1 | 100.00 | 0.00 |
| MCC 1 Bus | Load | 0.550 | 0.550 | 1 | 100.00 | -30.00 |
| MCC 2 Bus | Load | 0.550 | 0.550 | 1 | 100.00 | -30.00 |
| Mini Sub 1 Bus | Load | 6.600 | 6.600 | 1 | 100.00 | 0.00 |
| Mini Sub 2 MV Bus | Load | 6.600 | 6.600 | 1 | 100.00 | 0.00 |
| Mini-Sub 1 Bus | Load | 0.550 | 0.550 | 1 | 100.00 | -30.00 |
| Mini-Sub-1 Supply | Load | 6.600 | 6.600 | 1 | 100.00 | 0.00 |
| Mini-Sub 2 Bus | Load | 0.550 | 0.550 | 1 | 100.00 | -30.00 |
| Transmission Line Bus | Load | 6.600 | 6.600 | 1 | 100.00 | 0.00 |

13 Buses Total

All voltages reported by ETAP are in % of bus Nominal kV.
Base kV values of buses are calculated and used internally by ETAP.

## Line/Cable/Busway Input Data

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

| Line/Cable/Busway | | | Length | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | Library | Size | Adj. (m) | % Tol. | #/Phase | T (°C) | R1 | X1 | Y1 | R0 | X0 | Y0 |
| Ball Mill Supply Cable | 1,0NCUN3 | 95 | 17.0 | 0.0 | 2 | 75 | 0.2355824 | 0.0730000 | 0.0001433 | 0.3745761 | 0.1854200 | |
| Main Supply Cable1 | 11NCUN3 | 70 | 35.0 | 0.0 | 1 | 75 | 0.3263818 | 0.1170000 | 0.0000900 | 2.1659279 | 0.0751000 | 0.0000900 |
| MCC3 Supply Cable | 1,0MCUN4 | 95 | 18.0 | 0.0 | 2 | 75 | 0.2355824 | 0.0730000 | 0.0001433 | 0.7420847 | 0.1795800 | |
| Supply Cable MCC 1 | 1,0MCUN1 | 630 | 15.0 | 0.0 | 2 | 75 | 0.0400585 | 0.0860000 | 0.0002023 | 0.1261844 | 0.2115600 | |
| Supply Cable MCC 2 | 1,0NCUN1 | 630 | 15.0 | 0.0 | 2 | 75 | 0.0400585 | 0.0860000 | 0.0002023 | 0.0636931 | 0.2184400 | |
| Supply Cable Mini Sub-1/2 | 11NCUN3 | 95 | 100.0 | 0.0 | 1 | 75 | 0.2354871 | 0.1110000 | 0.0001010 | 1.9426490 | 0.0705000 | 0.0001010 |
| Supply Cable Mini-Sub 2 | 11NCUN3 | 50 | 100.0 | 0.0 | 1 | 75 | 0.4709741 | 0.1260000 | 0.0000800 | 2.4631240 | 0.0817000 | 0.0000800 |
| Line1 | | 122, | 1000.0 | 0.0 | 1 | 75 | 0.3063243 | 0.2657114 | 0.0000045 | 0.4507264 | 1.7395618 | 0.0000011 |

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

## 2-Winding Transformer Input Data

| Transformer | Rating | | | | | Z Variation | | | % Tap Setting | | Adjusted | Phase Shift | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | MVA | Prim. kV | Sec. kV | % Z | X/R | + 5% | - 5% | % Tol. | Prim. | Sec. | % Z | Type | Angle |
| Ballmill Mini-Sub | 0.500 | 6.600 | 0.400 | 5.19 | 1.50 | 0 | 0 | 0 | 0 | 0 | 5.19 | Dyn | 30.00 |
| Minisub-1 | 1.500 | 6.600 | 0.550 | 6.53 | 6.00 | 0 | 0 | 0 | 0 | 0 | 6.53 | Dyn | 30.00 |
| Minisub-2 | 1.500 | 6.600 | 0.550 | 6.53 | 6.00 | 0 | 0 | 0 | 0 | 0 | 6.53 | Dyn | 30.00 |

## 2-Winding Transformer Grounding Input Data

| Transformer | Rating | | | Grounding | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Conn. | Primary | | | | Secondary | | | |
| ID | MVA | Prim. kV | Sec. kV | Type | Type | kV | Amp | ohm | Type | kV | Amp | ohm |
| Ballmill Mini-Sub | 0.500 | 6.600 | 0.400 | D/Y | | | | | Solid | | | |
| Minisub-1 | 1.500 | 6.600 | 0.550 | D/Y | | | | | Solid | | | |
| Minisub-2 | 1.500 | 6.600 | 0.550 | D/Y | | | | | Solid | | | |

## Branch Connections

| CKT/Branch | | Connected Bus ID | | % Impedance, Pos. Seq., 100 MVAb | | | |
|---|---|---|---|---|---|---|---|
| ID | Type | From Bus | To Bus | R | X | Z | Y |
| Ballmill Mini-Sub | 2W XFMR | Ball Mill Bus | Ball Mill Mini-Sub Bus | 559.83 | 839.75 | 1009.26 | |
| Minisub-1 | 2W XFMR | Mini Sub 1 Bus | Mini-Sub 1 Bus | 68.73 | 412.40 | 418.09 | |
| Minisub-2 | 2W XFMR | Mini Sub 2 MV Bus | Mini-Sub 2 Bus | 68.73 | 412.40 | 418.09 | |
| Ball Mill Supply Cable | Cable | Ball Mill Mini-Sub Bus | Ball Motor Cable Bus | 125.15 | 38.78 | 131.02 | 0.0000008 |
| Main Supply Cable1 | Cable | Transmission Line Bus | Ball Mill Bus | 2.62 | 0.94 | 2.79 | 0.0001372 |
| MCC3 Supply Cable | Cable | Ball Mill Mini-Sub Bus | Ball Mill MCC Bus | 132.52 | 41.06 | 138.73 | 0.0000008 |
| Supply Cable MCC 1 | Cable | Mini-Sub 1 Bus | MCC 1 Bus | 9.93 | 21.32 | 23.52 | 0.0000018 |
| Supply Cable MCC 2 | Cable | Mini-Sub 2 Bus | MCC 2 Bus | 9.93 | 21.32 | 23.52 | 0.0000018 |
| Supply Cable Mini Sub-1/2 | Cable | Mini-Sub-1 Supply | Mini Sub 1 Bus | 5.41 | 2.55 | 5.98 | 0.0004400 |
| Supply Cable Mini-Sub 2 | Cable | Mini Sub 1 Bus | Mini Sub 2 MV Bus | 10.81 | 2.89 | 11.19 | 0.0003485 |
| Line1 | Line | Bus1 | Transmission Line Bus | 70.32 | 61.00 | 93.09 | 0.0001941 |
| Blade Fuse 1 | Tie Fuse | Transmission Line Bus | Mini-Sub-1 Supply | | | | |

## Power Grid Input Data

| Power Grid ID | Connected Bus ID | Rating MVASC | Rating kV | % Impedance 100 MVA Base R | % Impedance 100 MVA Base X" | % Impedance 100 MVA Base R/X" | Grounding Type |
|---|---|---|---|---|---|---|---|
| Utility | Bus1 | 3.200 | 6.600 | 310.94910 | 3109.49072 | 0.10 | Delta |

Total Connected Power Grids ( = 1 ): 3.200 MVA

## Lumped Load Input Data

| | Lumped Load | | | | | | Motor Loads | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Rating | | | | % Load | | Loading | | % Impedance (Machine Base) | | | Grounding | | | mFact. |
| Lumped Load ID | kVA | kV | Amp | % PF | MTR | STAT | kW | kvar | R | X" | R/X" | Conn. | Type | Amp | MW/PP |
| Ball Mill Lumped Load | 298.9 | 0.550 | 313.79 | 86.98 | 99 | 1 | 257.40 | 146.02 | 6.46 | 15.37 | 0.42 | Delta | | | 0.26 |
| MCC1 Lumped Load | 762.1 | 0.550 | 800.00 | 60.00 | 90 | 10 | 411.54 | 548.71 | 6.46 | 15.37 | 0.42 | Delta | | | 0.41 |
| MCC 2 Lumped Load | 476.3 | 0.550 | 500.00 | 60.00 | 90 | 10 | 257.21 | 342.95 | 6.46 | 15.37 | 0.42 | Delta | | | 0.26 |
| MCC 3 Lumped Load | 57.2 | 0.550 | 60.00 | 68.05 | 80 | 20 | 31.12 | 33.50 | 6.46 | 15.37 | 0.42 | Delta | | | 0.03 |

Total Connected Lumped Loads ( = 4 ): 1594.5 kVA

## SHORT- CIRCUIT REPORT

Fault at bus : **Ball Mill Bus**

Nominal kV = 6.600 Voltage c Factor = 1.10 (User-Defined)

**Line-To-Line-To-Ground Fault**

| Contribution | | % Voltage at From Bus | | | | | | Current at From Bus (kA) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From Bus | To Bus | Va | | Vb | | Vc | | Ia | | Ib | | Ic | | Sequence Current (kA) | | |
| ID | ID | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | I1 | I2 | I0 |
| Ball Mill Bus | Total | 165.00 | 0.0 | 0.00 | 0.0 | 0.00 | 0.0 | 0.000 | 0.0 | 0.795 | -162.6 | 0.795 | 17.4 | 0.459 | 0.459 | 0.000 |
| Transmission Line Bus | Ball Mill Bus | 165.00 | 0.0 | 0.23 | -143.6 | 0.23 | 36.4 | 0.000 | 0.0 | 0.714 | -163.4 | 0.714 | 16.6 | 0.412 | 0.412 | 0.000 |
| Ball Mill Mini-Sub Bus | Ball Mill Bus | 94.53 | -3.2 | 96.29 | -176.8 | 10.80 | 80.6 | 0.000 | 0.0 | 0.081 | -155.7 | 0.081 | 24.3 | 0.047 | 0.047 | 0.000 |
| Bus1 | Transmission Line Bus | 165.00 | 0.0 | 2.75 | -133.1 | 2.75 | 46.9 | 0.000 | 0.0 | 0.237 | -173.1 | 0.237 | 6.9 | 0.137 | 0.137 | 0.000 |
| Mini Sub 1 Bus | Mini-Sub-1 Supply | 165.00 | 0.0 | 0.55 | -137.5 | 0.55 | 42.5 | 0.000 | 0.0 | 0.482 | -158.6 | 0.482 | 21.4 | 0.278 | 0.278 | 0.000 |
| Ball Motor Cable Bus | Ball Mill Mini-Sub Bus | 94.10 | -3.5 | 96.77 | -176.6 | 11.76 | 76.9 | 0.668 | -155.7 | 0.668 | -155.7 | 1.336 | 24.3 | 0.668 | 0.668 | 0.000 |
| Ball Mill MCC Bus | Ball Mill Mini-Sub Bus | 94.46 | -3.3 | 96.37 | -176.8 | 10.95 | 79.9 | 0.104 | -156.1 | 0.104 | -156.1 | 0.208 | 23.9 | 0.104 | 0.104 | 0.000 |

\# Indicates fault current contribution is from three-winding transformers

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

Fault at bus : **Ball Mill MCC Bus**

Nominal kV = 0.400 Voltage c Factor = 1.05 (User-Defined)

**Line-To-Line-To-Ground Fault**

| Contribution | | % Voltage at From Bus | | | | | | Current at From Bus (kA) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From Bus ID | To Bus ID | Va | | Vb | | Vc | | Ia | | Ib | | Ic | | Sequence Current (kA) | | |
| | | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | I1 | I2 | I0 |
| Ball Mill MCC Bus | Total | 95.12 | -7.5 | 0.00 | 0.0 | 0.00 | 0.0 | 0.000 | 0.0 | 9.521 | 175.9 | 7.913 | 66.2 | 5.788 | 2.491 | 3.374 |
| Ball Mill Mini-Sub Bus | Ball Mill MCC Bus | 89.35 | -5.2 | 14.18 | 170.5 | 12.57 | 110.9 | 0.090 | 124.0 | 9.323 | 175.6 | 7.751 | 66.9 | 5.634 | 2.424 | 3.374 |
| MCC 3 Lumped Load | Ball Mill MCC Bus | 76.36 | 0.0 | 76.36 | -120.0 | 76.36 | 120.0 | 0.090 | -56.0 | 0.204 | -169.7 | 0.187 | 36.4 | 0.154 | 0.066 | 0.000 |
| Ball Motor Cable Bus | Ball Mill Mini-Sub Bus | 89.78 | -5.4 | 15.05 | 173.3 | 13.21 | 107.3 | 0.549 | -52.3 | 1.244 | -166.0 | 1.140 | 40.1 | 0.941 | 0.405 | 0.000 |
| Ball Mill Bus | Ball Mill Mini-Sub Bus | 80.59 | 13.4 | 52.96 | -101.3 | 75.70 | 154.0 | 0.638 | 127.1 | 8.152 | 172.9 | 6.753 | 71.3 | 4.693 | 2.020 | 3.374 |

\# Indicates fault current contribution is from three-winding transformers

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

Fault at bus : **Ball Mill Mini-Sub Bus**

Nominal kV = 0.400 Voltage c Factor = 1.05 (User-Defined)

**Line-To-Line-To-Ground Fault**

| Contribution | | % Voltage at From Bus | | | | | | Current at From Bus (kA) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From Bus | To Bus | Va | | Vb | | Vc | | Ia | | Ib | | Ic | | Sequence Current (kA) | | |
| ID | ID | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | I1 | I2 | I0 |
| Ball Mill Mini-Sub Bus | Total | 84.70 | -4.4 | 0.00 | 0.0 | 0.00 | 0.0 | 0.000 | 0.0 | 10.054 | 167.4 | 9.226 | 65.1 | 6.350 | 2.332 | 4.038 |
| Ball Motor Cable Bus | Ball Mill Mini-Sub Bus | 85.16 | -4.6 | 1.17 | -154.1 | 1.12 | 55.9 | 0.657 | -61.6 | 1.294 | -171.3 | 1.238 | 38.7 | 1.034 | 0.380 | 0.000 |
| Ball Mill MCC Bus | Ball Mill Mini-Sub Bus | 84.78 | -4.4 | 0.19 | -154.6 | 0.19 | 55.4 | 0.102 | -62.1 | 0.201 | -171.8 | 0.193 | 38.2 | 0.161 | 0.059 | 0.000 |
| Ball Mill Bus | Ball Mill Mini-Sub Bus | 74.97 | 14.8 | 49.24 | -99.1 | 71.04 | 155.5 | 0.760 | 118.3 | 8.677 | 163.9 | 7.972 | 69.7 | 5.156 | 1.894 | 4.038 |
| Ball Mill Lumped Load | Ball Motor Cable Bus | 76.36 | 0.0 | 76.36 | -120.0 | 76.36 | 120.0 | 0.657 | -61.6 | 1.294 | -171.3 | 1.238 | 38.7 | 1.034 | 0.380 | 0.000 |
| MCC 3 Lumped Load | Ball Mill MCC Bus | 76.36 | 0.0 | 76.36 | -120.0 | 76.36 | 120.0 | 0.102 | -62.1 | 0.201 | -171.8 | 0.193 | 38.2 | 0.161 | 0.059 | 0.000 |
| Transmission Line Bus | Ball Mill Bus | 75.06 | 14.8 | 49.35 | -99.2 | 71.07 | 155.4 | 0.286 | -12.3 | 0.427 | -155.5 | 0.262 | 65.4 | 0.312 | 0.115 | 0.000 |

\# Indicates fault current contribution is from three-winding transformers

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

Fault at bus : **MCC 1 Bus**

Nominal kV = 0.550 Voltage c Factor = 1.05 (User-Defined)

**Line-To-Line-To-Ground Fault**

| Contribution | | % Voltage at From Bus | | | | | | Current at From Bus (kA) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From Bus ID | To Bus ID | Va | | Vb | | Vc | | Ia | | Ib | | Ic | | Sequence Current (kA) | | |
| | | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | I1 | I2 | I0 |
| MCC 1 Bus | Total | 72.23 | 3.3 | 0.00 | 0.0 | 0.00 | 0.0 | 0.000 | 0.0 | 11.358 | 153.6 | 11.916 | 60.1 | 7.552 | 2.245 | 5.315 |
| Mini-Sub 1 Bus | MCC 1 Bus | 69.92 | 3.9 | 3.49 | -178.2 | 3.64 | 148.4 | 2.462 | 110.0 | 8.177 | 138.6 | 8.127 | 70.3 | 4.075 | 1.212 | 5.315 |
| MCC1 Lumped Load | MCC 1 Bus | 105.00 | 0.0 | 105.00 | -120.0 | 105.00 | 120.0 | 2.462 | -70.0 | 4.060 | -174.8 | 4.173 | 39.9 | 3.498 | 1.040 | 0.000 |
| Mini Sub 1 Bus | Mini-Sub 1 Bus | 53.09 | 14.9 | 22.19 | -86.1 | 53.49 | 170.9 | 2.462 | 110.0 | 8.177 | 138.6 | 8.127 | 70.3 | 4.075 | 1.212 | 5.315 |

\# Indicates fault current contribution is from three-winding transformers

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

Fault at bus : **MCC 2 Bus**

Nominal kV = 0.550 Voltage c Factor = 1.05 (User-Defined)

**Line-To-Line-To-Ground Fault**

| Contribution | | % Voltage at From Bus | | | | | | Current at From Bus (kA) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From Bus | To Bus | Va | | Vb | | Vc | | Ia | | Ib | | Ic | | Sequence Current (kA) | | |
| ID | ID | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | I1 | I2 | I0 |
| MCC 2 Bus | Total | 68.27 | 4.0 | 0.00 | 0.0 | 0.00 | 0.0 | 0.000 | 0.0 | 10.478 | 151.3 | 11.056 | 60.4 | 6.948 | 1.921 | 5.038 |
| Mini-Sub 2 Bus | MCC 2 Bus | 66.31 | 4.1 | 3.43 | -163.5 | 3.17 | 155.1 | 1.612 | 109.7 | 8.460 | 141.9 | 8.631 | 66.3 | 4.740 | 1.310 | 5.038 |
| MCC 2 Lumped Load | MCC 2 Bus | 105.00 | 0.0 | 105.00 | -120.0 | 105.00 | 120.0 | 1.612 | -70.3 | 2.543 | -175.7 | 2.625 | 40.6 | 2.223 | 0.614 | 0.000 |
| Mini Sub 2 MV Bus | Mini-Sub 2 Bus | 53.19 | 17.2 | 25.39 | -85.4 | 53.68 | 169.7 | 1.612 | 109.7 | 8.460 | 141.9 | 8.631 | 66.3 | 4.740 | 1.310 | 5.038 |

\# Indicates fault current contribution is from three-winding transformers

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

Fault at bus : **Mini Sub 1 Bus**

Nominal kV = 6.600 Voltage c Factor = 1.10 (User-Defined)

**Line-To-Line-To-Ground Fault**

| Contribution | | % Voltage at From Bus | | | | | | Current at From Bus (kA) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From Bus | To Bus | Va | | Vb | | Vc | | Ia | | Ib | | Ic | | Sequence Current (kA) | | |
| ID | ID | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | I1 | I2 | I0 |
| Mini Sub 1 Bus | Total | 165.00 | 0.0 | 0.00 | 0.0 | 0.00 | 0.0 | 0.000 | 0.0 | 0.796 | -162.7 | 0.796 | 17.3 | 0.460 | 0.460 | 0.000 |
| Mini-Sub-1 Supply | Mini Sub 1 Bus | 165.00 | 0.0 | 0.22 | -143.5 | 0.22 | 36.5 | 0.000 | 0.0 | 0.315 | -168.7 | 0.315 | 11.3 | 0.182 | 0.182 | 0.000 |
| Mini Sub 2 MV Bus | Mini Sub 1 Bus | 165.00 | 0.0 | 0.25 | -143.4 | 0.25 | 36.6 | 0.000 | 0.0 | 0.193 | -158.4 | 0.193 | 21.6 | 0.111 | 0.111 | 0.000 |
| Mini-Sub 1 Bus | Mini Sub 1 Bus | 97.17 | -4.6 | 94.00 | -175.2 | 16.07 | 101.4 | 0.000 | 0.0 | 0.291 | -159.1 | 0.291 | 20.9 | 0.168 | 0.168 | 0.000 |
| Ball Mill Bus | Transmission Line Bus | 165.00 | 0.0 | 0.24 | -142.7 | 0.24 | 37.3 | 0.000 | 0.0 | 0.081 | -155.6 | 0.081 | 24.4 | 0.047 | 0.047 | 0.000 |
| Bus1 | Transmission Line Bus | 165.00 | 0.0 | 2.74 | -133.1 | 2.74 | 46.9 | 0.000 | 0.0 | 0.237 | -173.1 | 0.237 | 6.9 | 0.137 | 0.137 | 0.000 |
| Mini-Sub 2 Bus | Mini Sub 2 MV Bus | 96.41 | -3.1 | 94.40 | -176.8 | 10.75 | 100.8 | 0.000 | 0.0 | 0.193 | -158.4 | 0.193 | 21.6 | 0.111 | 0.111 | 0.000 |
| MCC 1 Bus | Mini-Sub 1 Bus | 97.18 | -4.9 | 94.07 | -174.9 | 16.94 | 100.6 | 2.017 | -159.1 | 2.017 | -159.1 | 4.035 | 20.9 | 2.017 | 2.017 | 0.000 |

\# Indicates fault current contribution is from three-winding transformers

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

Fault at bus : **Mini Sub 2 MV Bus**

Nominal kV = 6.600 Voltage c Factor = 1.10 (User-Defined)

**Line-To-Line-To-Ground Fault**

| Contribution | | % Voltage at From Bus | | | | | | Current at From Bus (kA) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From Bus | To Bus | Va | | Vb | | Vc | | Ia | | Ib | | Ic | | Sequence Current (kA) | | |
| ID | ID | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | I1 | I2 | I0 |
| Mini Sub 2 MV Bus | Total | 165.00 | 0.0 | 0.00 | 0.0 | 0.00 | 0.0 | 0.000 | 0.0 | 0.794 | -162.4 | 0.794 | 17.6 | 0.459 | 0.459 | 0.000 |
| Mini Sub 1 Bus | Mini Sub 2 MV Bus | 165.00 | 0.0 | 0.77 | -148.7 | 0.77 | 31.3 | 0.000 | 0.0 | 0.602 | -163.7 | 0.602 | 16.3 | 0.348 | 0.348 | 0.000 |
| Mini-Sub 2 Bus | Mini Sub 2 MV Bus | 96.52 | -3.1 | 94.29 | -176.8 | 10.65 | 102.1 | 0.000 | 0.0 | 0.193 | -158.5 | 0.193 | 21.5 | 0.111 | 0.111 | 0.000 |
| Mini-Sub-1 Supply | Mini Sub 1 Bus | 165.00 | 0.0 | 0.98 | -147.5 | 0.98 | 32.5 | 0.000 | 0.0 | 0.314 | -168.3 | 0.314 | 11.7 | 0.181 | 0.181 | 0.000 |
| Mini-Sub 1 Bus | Mini Sub 1 Bus | 96.86 | -4.8 | 94.35 | -175.1 | 16.32 | 98.9 | 0.000 | 0.0 | 0.290 | -158.7 | 0.290 | 21.3 | 0.167 | 0.167 | 0.000 |
| MCC 2 Bus | Mini-Sub 2 Bus | 96.51 | -3.3 | 94.33 | -176.7 | 11.23 | 101.2 | 1.337 | -158.5 | 1.337 | -158.5 | 2.673 | 21.5 | 1.337 | 1.337 | 0.000 |

\# Indicates fault current contribution is from three-winding transformers

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

Fault at bus : **Mini-Sub 1 Bus**

Nominal kV = 0.550 Voltage c Factor = 1.05 (User-Defined)

**Line-To-Line-To-Ground Fault**

| Contribution | | % Voltage at From Bus | | | | | | Current at From Bus (kA) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From Bus ID | To Bus ID | Va | | Vb | | Vc | | Ia | | Ib | | Ic | | Sequence Current (kA) | | |
| | | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | Mag. | Ang. | I1 | I2 | I0 |
| Mini-Sub 1 Bus | Total | 67.38 | 4.9 | 0.00 | 0.0 | 0.00 | 0.0 | 0.000 | 0.0 | 11.598 | 151.3 | 12.364 | 61.1 | 7.720 | 2.098 | 5.639 |
| MCC 1 Bus | Mini-Sub 1 Bus | 67.95 | 4.8 | 0.90 | -110.9 | 0.94 | 105.8 | 2.583 | -70.9 | 4.020 | -175.9 | 4.177 | 40.8 | 3.536 | 0.961 | 0.000 |
| Mini Sub 1 Bus | Mini-Sub 1 Bus | 50.51 | 16.2 | 21.28 | -85.4 | 50.70 | 172.0 | 2.583 | 109.1 | 8.500 | 136.5 | 8.571 | 70.9 | 4.206 | 1.143 | 5.639 |
| MCC1 Lumped Load | MCC 1 Bus | 105.00 | 0.0 | 105.00 | -120.0 | 105.00 | 120.0 | 2.583 | -70.9 | 4.020 | -175.9 | 4.177 | 40.8 | 3.536 | 0.961 | 0.000 |
| Mini-Sub-1 Supply | Mini Sub 1 Bus | 50.63 | 16.2 | 21.38 | -85.8 | 50.69 | 171.8 | 0.189 | -36.6 | 0.278 | -169.9 | 0.202 | 53.2 | 0.218 | 0.059 | 0.000 |
| Mini Sub 2 MV Bus | Mini Sub 1 Bus | 50.65 | 16.2 | 21.39 | -85.9 | 50.69 | 171.8 | 0.116 | -26.2 | 0.169 | -159.5 | 0.123 | 63.5 | 0.133 | 0.036 | 0.000 |

\# Indicates fault current contribution is from three-winding transformers

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

## Short-Circuit Summary Report

3-Phase, LG, LL, LLG Fault Currents

| Bus | | 3-Phase Fault | | | Line-to-Ground Fault | | | | Line-to-Line Fault | | | | *Line-to-Line-to-Ground | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | kV | I"k | ip | Ik | I"k | ip | Ib | Ik | I"k | ip | Ib | Ik | I"k | ip | Ib | Ik |
| Ball Mill Bus | 6.600 | 0.917 | 1.868 | 0.274 | 0.000 | 0.000 | 0.000 | 0.000 | 0.795 | 1.618 | 0.795 | 0.795 | 0.795 | 1.618 | 0.795 | 0.795 |
| Ball Mill MCC Bus | 0.400 | 8.248 | 14.469 | 3.367 | 9.132 | 16.020 | 9.132 | 9.132 | 7.143 | 12.531 | 7.143 | 7.143 | 9.521 | 16.702 | 9.521 | 9.521 |
| Ball Mill Mini-Sub Bus | 0.400 | 8.673 | 15.791 | 3.421 | 10.118 | 18.422 | 10.118 | 10.118 | 7.511 | 13.675 | 7.511 | 7.511 | 10.054 | 18.305 | 10.054 | 10.054 |
| MCC 1 Bus | 0.550 | 9.793 | 19.680 | 2.791 | 12.137 | 24.392 | 12.137 | 12.137 | 8.481 | 17.044 | 8.481 | 8.481 | 11.916 | 23.947 | 11.916 | 11.916 |
| MCC 2 Bus | 0.550 | 8.862 | 17.991 | 2.788 | 11.176 | 22.690 | 11.176 | 11.176 | 7.675 | 15.581 | 7.675 | 7.675 | 11.056 | 22.444 | 11.056 | 11.056 |
| Mini Sub 1 Bus | 6.600 | 0.920 | 1.875 | 0.274 | 0.000 | 0.000 | 0.000 | 0.000 | 0.796 | 1.624 | 0.796 | 0.796 | 0.796 | 1.624 | 0.796 | 0.796 |
| Mini Sub 2 MV Bus | 6.600 | 0.917 | 1.861 | 0.274 | 0.000 | 0.000 | 0.000 | 0.000 | 0.794 | 1.612 | 0.794 | 0.794 | 0.794 | 1.612 | 0.794 | 0.794 |
| Mini-Sub 1 Bus | 0.550 | 9.807 | 19.753 | 2.807 | 12.422 | 25.019 | 12.422 | 12.422 | 8.494 | 17.106 | 8.494 | 8.494 | 12.364 | 24.901 | 12.364 | 12.364 |

All fault currents are in rms kA. Current ip is calculated using Method C.

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

## Sequence Impedance Summary Report

| Bus | | Positive Seq. Imp. (ohm) | | | Negative Seq. Imp. (ohm) | | | Zero Seq. Imp. (ohm) | | | Fault Zf (ohm) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | kV | Resistance | Reactance | Impedance | Resistance | Reactance | Impedance | Resistance | Reactance | Impedance | Resistance | Reactance | Impedance |
| Ball Mill Bus | 6.600 | 1.36721 | 4.35922 | 4.56860 | 1.36721 | 4.35922 | 4.56860 | | | | 0.00000 | 0.00000 | 0.00000 |
| Ball Mill MCC Bus | 0.400 | 0.01351 | 0.02611 | 0.02940 | 0.01351 | 0.02611 | 0.02940 | 0.01564 | 0.01505 | 0.02170 | 0.00000 | 0.00000 | 0.00000 |
| Ball Mill Mini-Sub Bus | 0.400 | 0.01151 | 0.02548 | 0.02796 | 0.01151 | 0.02548 | 0.02796 | 0.00896 | 0.01344 | 0.01615 | 0.00000 | 0.00000 | 0.00000 |
| MCC 1 Bus | 0.550 | 0.01061 | 0.03235 | 0.03405 | 0.01061 | 0.03235 | 0.03405 | 0.00303 | 0.01406 | 0.01438 | 0.00000 | 0.00000 | 0.00000 |
| MCC 2 Bus | 0.550 | 0.01124 | 0.03591 | 0.03762 | 0.01124 | 0.03591 | 0.03762 | 0.00256 | 0.01411 | 0.01434 | 0.00000 | 0.00000 | 0.00000 |
| Mini Sub 1 Bus | 6.600 | 1.35395 | 4.35192 | 4.55768 | 1.35395 | 4.35192 | 4.55768 | | | | 0.00000 | 0.00000 | 0.00000 |
| Mini Sub 2 MV Bus | 6.600 | 1.37872 | 4.35677 | 4.56972 | 1.37872 | 4.35677 | 4.56972 | | | | 0.00000 | 0.00000 | 0.00000 |
| Mini-Sub 1 Bus | 0.550 | 0.01053 | 0.03232 | 0.03400 | 0.01053 | 0.03232 | 0.03400 | 0.00208 | 0.01248 | 0.01265 | 0.00000 | 0.00000 | 0.00000 |

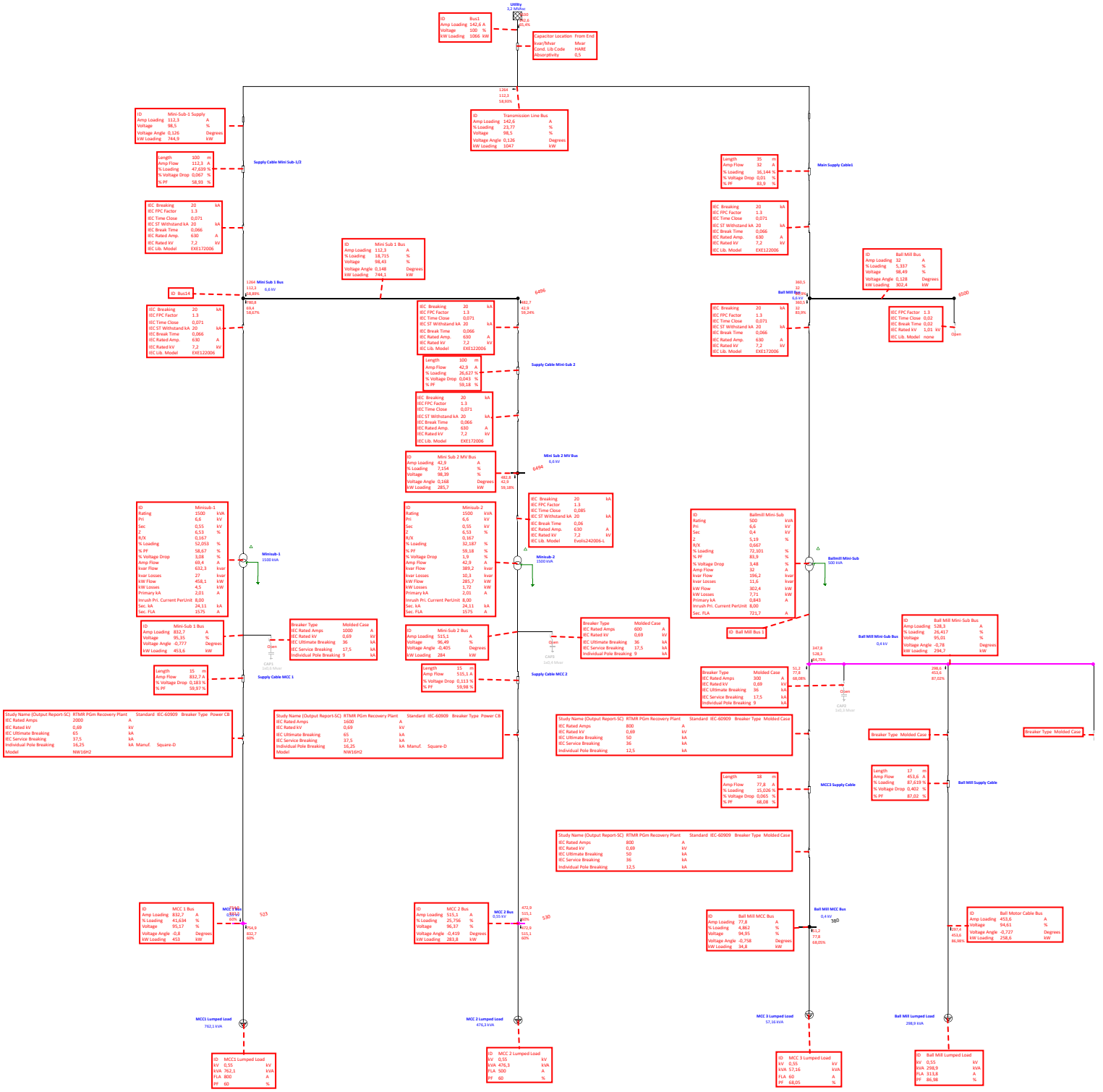
## Branch (earth-fault factor) Summary Report

| Bus | | EFF/Ke (LG) | EFF/Ke (LLG) |
|---|---|---|---|
| ID | kV | | |
| Ball Mill Bus | 6.600 | 1.91 | 1.65 |
| Ball Mill MCC Bus | 0.400 | 1.09 | 0.95 |
| Ball Mill Mini-Sub Bus | 0.400 | 1.02 | 0.85 |
| MCC 1 Bus | 0.550 | 0.97 | 0.72 |
| MCC 2 Bus | 0.550 | 0.97 | 0.68 |
| Mini Sub 1 Bus | 6.600 | 1.91 | 1.65 |
| Mini Sub 2 MV Bus | 6.600 | 1.91 | 1.65 |
| Mini-Sub 1 Bus | 0.550 | 0.97 | 0.67 |

# Annexure C

Load Flow diagram without PF

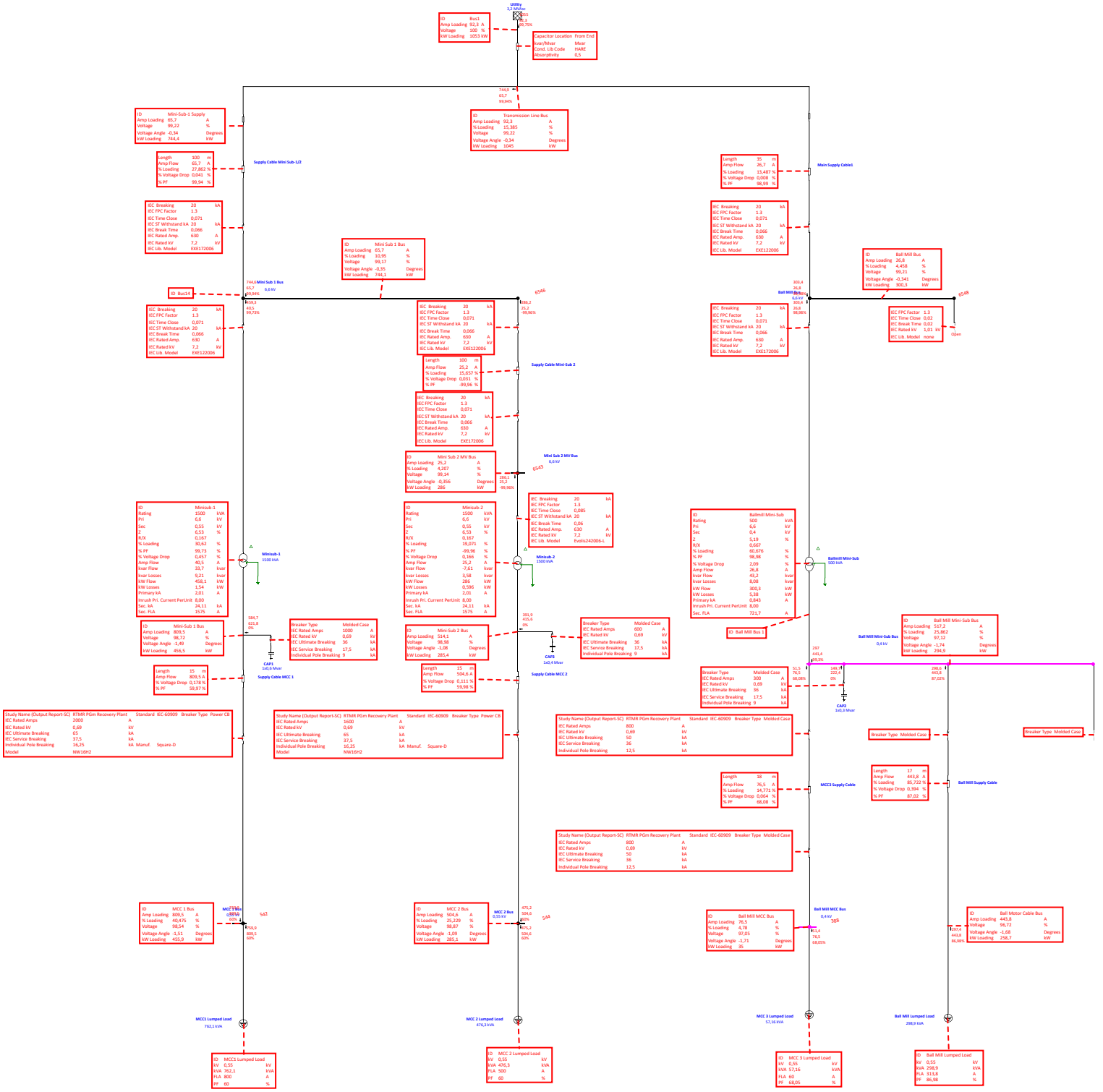
# One-Line Diagram - OLV1 | Load Flow Analysis | LF



# Annexure D

Load Flow diagram with PF

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



# Annexure E

PSCC Diagrams

# One-Line Diagram - OLV1 | Short-Circuit Analysis | SC