Q. Has Hydro examined the impact of the proposed Valentine Gold Interconnection project on the reliability of the Island Interconnected system? If so, please provide the analysis. If not, please outline the rationale for not assessing any potential impact.

A. The potential areas of impact of the proposed Valentine Gold Interconnection project are the Star Lake Hydroelectric Generating Station and the Buchans 66kV bus. Newfoundland and Labrador Hydro examined the impact of the proposed interconnection on the voltage and angular stability of the Star Lake Hydroelectric Generating Station, and the voltage impact at the Buchans 66kV bus, for faults and loss of load conditions. As outlined in PUB-NLH-004, Attachment 1 , there were no impacts on the Island Interconnected System identified that resulted in planning criteria violations.

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**Doc #:** TP-TN-120
**Issue Date:** 2021/03/02
**Document Type:** Technical Note

# TP-TN-120

# Valentine Gold Project Interconnection - Facility Study

## Purpose

This document provides an update to the System Impact Study (TP-TN-099) as a result of updated technical design parameters.

# Table of Contents

# 1 Introduction

At the request of NL Hydro Customer Service, the Transmission Planning Department had undertaken a System Impact Study (SIS) to determine the impact of a request by Marathon Gold Corporation (MGC) (Valentine Gold Project) for Network Service. Since completion of the SIS, MGC has requested that a Facility Study be completed. To that end, this Technical Note provides a technical update as a result of an advanced design by both NLH and MGC with regard to the transmission line routing and configuration of MGC's proposed design for the Valentine Terminal Station (VTN TS) and load expectations.

The following technical details have been updated since the SIS:

1. NLH Transmission Line
   Appendix A outlines the 69kV H-Frame wood pole structure that will be used in this application. The line will have the following attributes:
   - 40km line length
   - 3.2m horizontal phase spacing for tangent structures
   - Estimate of 12.78m attachment height from ground level
   - Estimated sag of 2.50m
   - Calculated impedance (pu on 100MVA base) data as follows:
     - R = 0.11001, X = 0.42398, B = 0.00624
     - Ro = 0.27164, Xo = 1.84609, Bo = 0.00331

2. Valentine Terminal Station – Transformers
   Appendix B presents the proposed Valentine Terminal Station single line diagram. The original design has shifted from two to three power transformers with a rating of 66/6.9kV, 12/16MVA. The following are modeling details for these transformers:
   - Primary Off-Load Taps (+5% / +2.5% / Nominal / -2.5% / -5%)
   - Secondary On Load Tap Changer (+/- 10%, 33 steps of 0.625% each)
   - Impedance of 7%, +/- 7.5% , on 12 MVA base

3. Valentine Terminal Station – Capacitor Bank
   The reactive power compensation will now be located on the 6.9kV bus as opposed to the 66kV bus as per the original System Impact Study. The total reactive compensation will be distributed evenly across the three 6.9kV buses.

4. Valentine Terminal Station – Load Profile
   Table 1 below outlines the latest two staged load profile. Stage 1 has maximum load of 18.22 MW while Stage 2 the maximum demand is expected to be 20.87 MW.

**Table 1 – Valentine Gold Project Load Profile**

| | Power | Maximum Demand | | | Average Load | | |
|---|---|---|---|---|---|---|---|
| | Factor | MW | MVAR | MVA | MW | MVAR | MVA |
| **Phase 1** | 0.877 | 18.216 | 9.349 | 20.766 | 15.060 | 8.132 | 17.300 |
| **Phase 2** | 0.850 | 2.651 | 1.636 | 3.118 | 2.380 | 1.467 | 2.799 |
| **Total** | 0.874 | 20.867 | 10.985 | 23.884 | 17.441 | 9.599 | 20.099 |

This update to the System Impact Study looks at load flow, fault, dynamic and motor starting simulations of the proposed interconnection to determine any issues with connection to NLH's Interconnected System. These simulations were completed using Version 33 of PSS®E.

# 2 Load Flow Analysis

The following principles were applied in completing the analysis:

- Transmission Planning Criteria, as per NLSO Standard TP-S-007;
- The requirements outlined in NLSO Standard TP-S-005 *Technical Requirements for Connection to the Newfoundland and Labrador Transmission System*; and
- Necessary ancillary services (i.e. reserves, voltage control, etc.) for reliable operation of the network.

Load flow analysis was completed on several operating scenarios for the 2024 Peak Load flow case for Stage I and II mine loading forecast. The 2024 Light Load flow case was also investigated. Operating scenarios included the following:

a. Normal system operation;
b. N-1 contingency operation with Star Lake Generating Station out of service; and

## 2.1 Peak Load Flow Analysis – Stage 1

Peak load flows with a Stage 1 MGC load of 18.22 MW for the three scenarios outlined above were analyzed to ensure steady-state voltage criteria as outlined in TP-S-007. For all analysis the following assumptions were used:

- Buchans T1 operating to maintain Buchans 66kV bus voltage between 1.03 - 1.035pu.
- Star Lake generator operating to maintain the 13.8kV bus to 1.0pu.
- VTN TS transformers high side taps are set to 0.975pu boost position.

Figure 1 below outlines the normal system operations in which 4.5 MVARs of reactive compensation is required at VTN TS 6.9kV bus to maintain the 66kV bus voltage above 0.95pu and maintain Star Lake excitation capability to control the 13.8kV to 1.0pu as it is close to its reactive capability at 18MW.

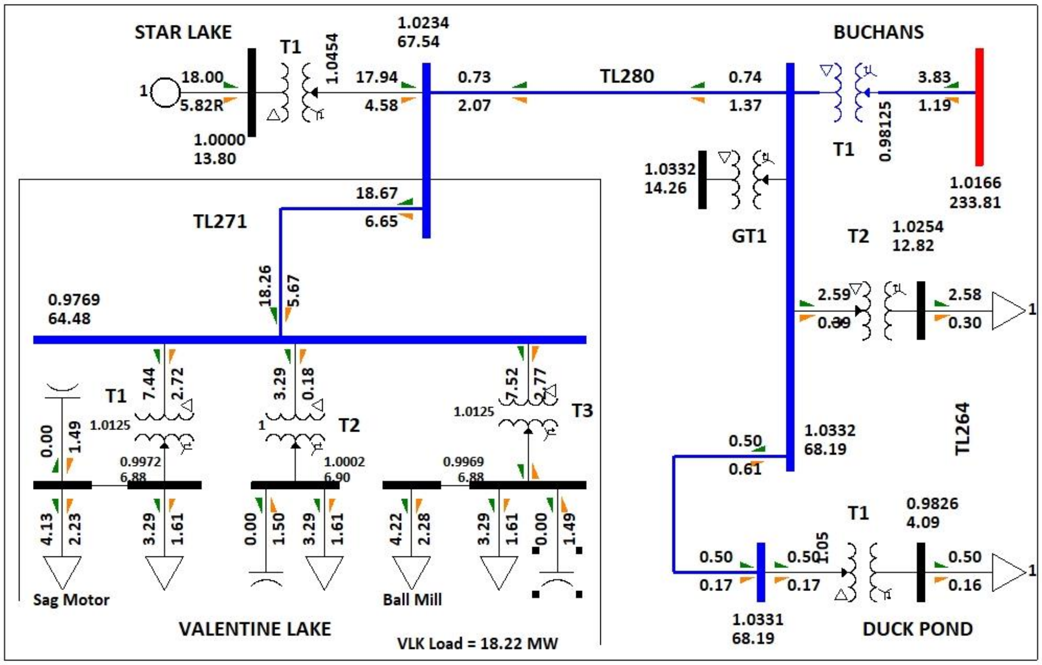



**Figure 1: Normal System Operation – 18.22 MW Loading to Meet Voltage Criteria**

Figure 2 below outlines the load flow of N-1 contingency with Star Lake Generating Station out of service in which 4.8 MVARs of reactive compensation is required at VTN TS 6.9kV bus to maintain the 66kV bus voltage above 0.90pu.

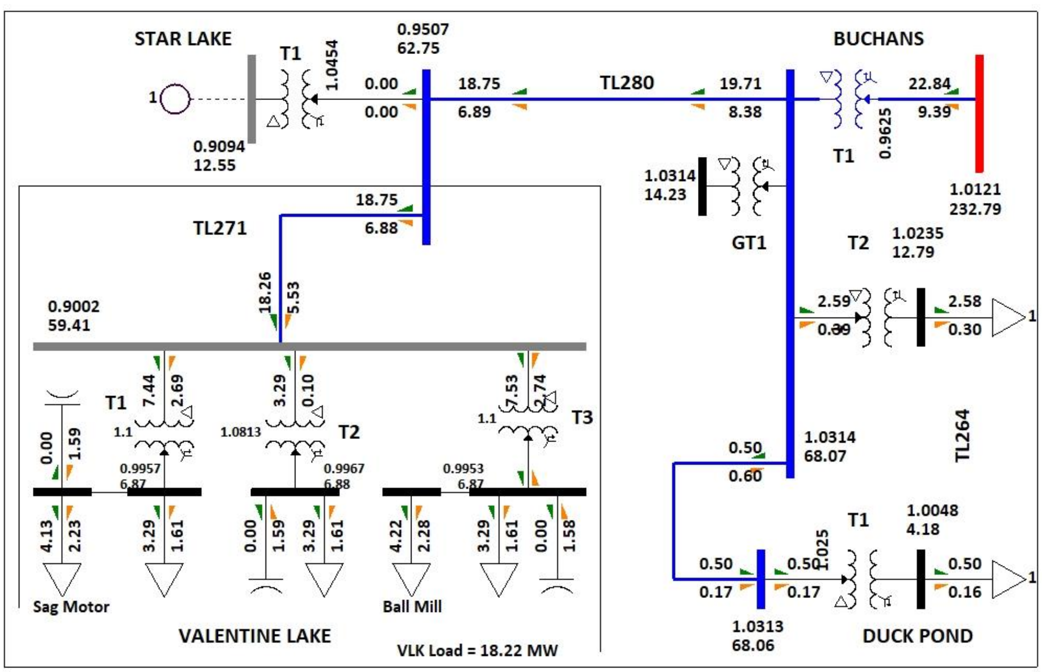



**Figure 2: N-1 Star Lake Generator Out of Service – 18.22 MW Loading to Meet Voltage Criteria**

## 2.2 Peak Load Flow Analysis – Stage 2

Peak load flows with a Stage 2 load increase of 2.65 MW to 20.87 MW for the three scenarios outlined above were analyzed to ensure steady-state voltage criteria as outlined in TP-S-007. For all analysis the following assumptions were used:

- Buchans T1 operating to maintain Buchans 66kV bus voltage between 1.03 - 1.035pu.
- Star Lake generator operating to maintain the 13.8kV bus to 1.00pu.
- VTN TS transformers high side taps are set to 0.975pu boost position.

Figure 3 below outlines the load flow of normal system operations in which 8.0 MVARs of reactive compensation is required at VTN TS 6.9kV bus to maintain the 66kV bus voltage above 0.95pu and maintain Star Lake excitation capability to control the 13.8kV to 1.0pu as it is close to its reactive capability at 18MW.

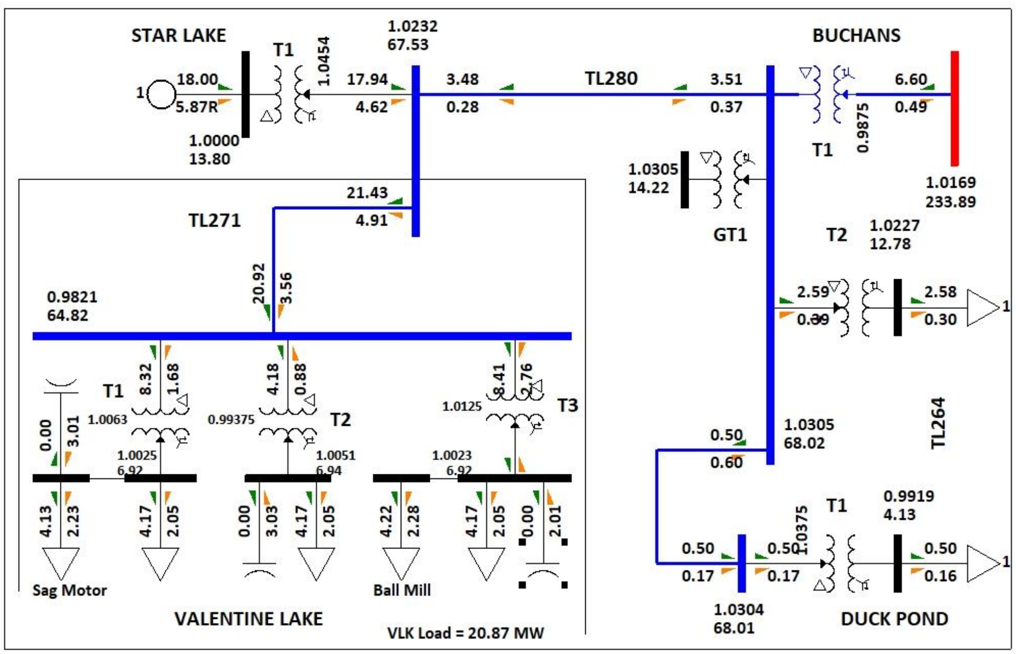



**Figure 3: Normal System Operation – 20.87 MW Loading to Meet Voltage Criteria**

Figure 4 below outlines the load flow of N-1 contingency with Star Lake Generating Station out of service in which 8.0 MVARs of reactive compensation is required at VTN TS 6.9kV bus to maintain the 66kV bus voltage above 0.90pu.

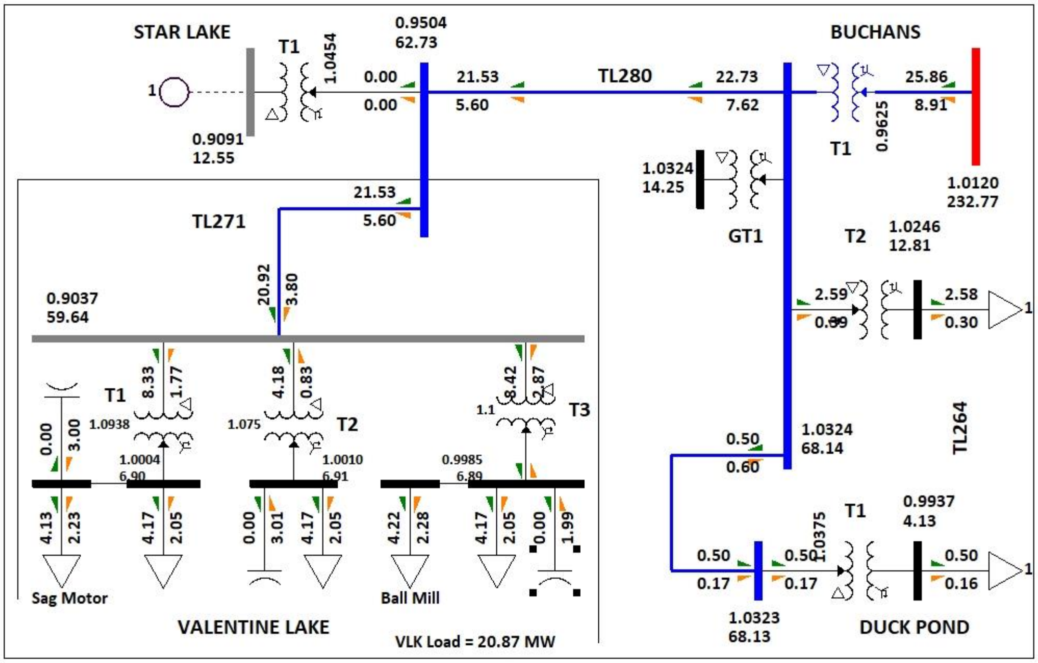



**Figure 4: N-1 Star Lake Generator Out of Service – 20.87 MW Loading to Meet Voltage Criteria**

The load flow analysis for the 66 kV interconnection of the Valentine Lake project to the system at Star Lake indicates that there is significant voltage drop, particularly when the Star Lake generator is out of service. To improve the voltage profile along the 66 kV transmission system and ensure voltage levels at the Valentine Terminal Station are within acceptable limits, Hydro requires the addition of 6.9 kV switch shunt capacitor banks.

## 2.3 Shunt Capacitor Bank Sizing Requirement

The standard requirement for shunt capacitor banks on the Newfoundland and Labrador Interconnected System is that the voltage change during switching does not exceed 2.5% at the customer level. The standard configuration is the ungrounded wye arrangement with a high resistance neutral device to measure unbalance. From an operational perspective, unless contamination dictates otherwise, the externally fused can is desired as it lends itself to ease of detection of failed units.

The prospective minimum short circuit level on the 66 kV bus at Valentine Terminal Station is estimated to equal 79.9 MVA. Given a 2.5% voltage change, the individual capacitor bank size should not exceed an estimated 2.0 MVAR. Under minimum short circuit levels the voltage change on switching a 2 MVAR bank on the 6.9kV bus at VTN TS will result in the following voltage changes:

- VTN TS 66kV bus = 2.5%, 6.9kV = 3.6%
- SLK TS 66kV bus = 1.6%
- BUC TS 66kV bus = 0.5%

The voltage change of 3.6% on the 6.9kV bus exceeds NLH's standard and the capacitor size would need to be reduced to 1.33MVAR to prevent the voltage from exceeding 2.5%. In consultation with MGC, they have determined the maximum bus voltage change on the 6.9kV bus should not exceed 2.0%, thus the maximum capacitor bank switching size should be less than 1.1MVARs.

Figure 4 above highlights the peak load flow simulation of maximum load of 20.87MW with Star Lake generation out of service, which would be the most onerous case for low voltage conditions. A minimum in-service reactive compensation of approximately 8.0 MVAR is required in order to meet steady-state voltage criteria for a 40km transmission line. This means that there is a need for four banks of 2.0 MVAR if it is decided to go with the maximum capacitor bank size for maximum voltage rise of 2.5% on the 66kV system, during switching events.

In the event Star Lake generation is not available for an extended period of time due to unplanned maintenance, then it would be prudent to plan for the loss of a 2.0 MVAR capacitor bank during the outage of the Star Lake generation. Therefore, it is recommended to provide a redundant 2.0 MVAR capacitor bank, thus making the total reactive power compensation to be installed at 10.0 MVAR.

Figure 5 provides the peak load flow plot for the scenario where there is a loss of 11.4 MW of load at Valentine Teminal Station, with transformer T1 out of service, while the capacitor banks on the 6.9kV bus are in service. The resulting overvoltages on the 6.9kV and 66kV buses at Valentine Terminal Station are outside the limits of Transmission Planning Criteria for contingency operations. Therefore, in the event of loss of load, the protection controls for the capacitor banks must be configured to trip in stages in order to alleviate the overvoltage conditions in an acceptable timeframe (within 3 seconds of the voltage exceeding 1.10pu[1]).

[1] *As per TP-S-005 NLSO Standard – Technical Requirements for Connection to the NL Transmission System.*

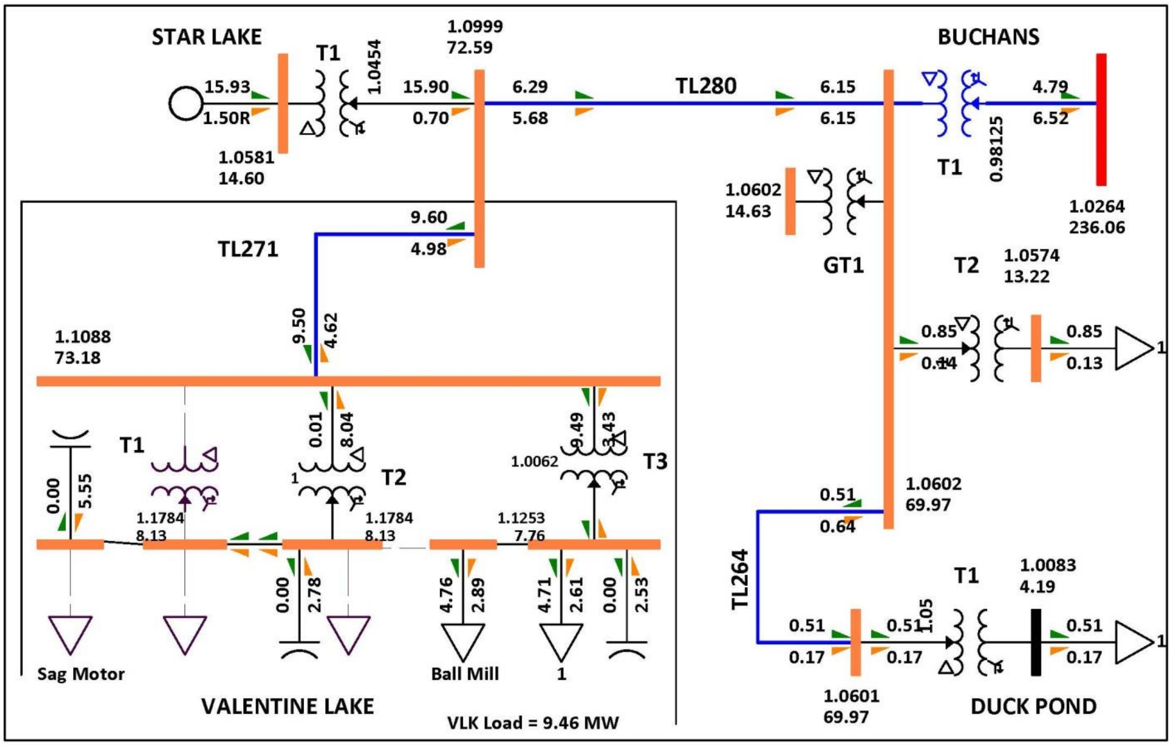



**Figure 5: Loss of 11.4 MW of Load at VTN TS**

In consultation with MGC, Before final design and installation, the customer will be required to provide a capacitor bank switching study for the cap bank design. This study should confirm the appropriate size of the banks for customer switching purposes and the current inrush limiting reactors and surge arresters. It should be noted that Hydro requires grounding switches on both the line and neutral side of each switched shunt capacitor bank for de-energization and maintenance.

## 2.4 Light Load Flow Analysis

Load flow analysis of light load conditions of the interconnected system was analyzed for the Valentine Gold project. The analysis looked at both peak and zero loading at Valentine Lake for two operating scenarios of normal operation and Star Lake Generating Unit out of service. For this analysis the following assumptions were used:

- Buchans T1 operating to maintain Buchans 66kV bus voltage close to 1.04pu.
- Star Lake generator operating to maintain the 13.8kV bus to 1.00pu.
- VTN TS transformers high side taps are set to 0.975pu boost position.

Appendix C shows the simulation of each case and the results indicate there are no issues with voltage from a steady state perspective. High voltage levels would be experienced for loss of load as documented in the Peak Load flow analysis, therefore a fast protection scheme is required for removing the capacitor banks from service on overvoltage conditions.

# 3 Short Circuit Analysis

A short circuit study was completed of the Valentine Lake 66 kV and 6.9 kV buses to determine the range of fault levels that may be experienced during a wide operating range. Two operating scenarios are as follows:

i) Minimum Short Circuit Level;
ii) Maximum Foreseeable Short Circuit Level.

Table 2 below presents the three phase and line to ground fault levels that can be expected at Valentine Lake.

**Table 2 – Valentine Terminal Station Fault Levels**

| Fault Level Case | Fault Level (MVA) | | | |
|---|---|---|---|---|
| | 66 kV Bus | | 6.9 kV Bus | |
| | 3 Phase | L-G | 3 Phase | L-G |
| Minimum | 79.90 | 64.70 | 54.80 | 0.30 |
| Maximum Foreseeable | 101.07 | 72.81 | 63.82 | 0.30 |

# 4 Dynamic Stability Analysis

Stability of the Newfoundland and Labrador Interconnected System shall be maintained in normal pre-contingency operation, during a contingency and post-contingency for all applicable contingencies. Stability of the system will be considered acceptable if all oscillations in voltage, current and angle are adequately damped so as not to cause unplanned equipment tripping or equipment damage.

Post fault recovery voltages on the AC system shall be as follows:

- Transient under voltages following fault clearing should not drop below 70%; and
- The duration of the voltage below 80% following fault clearing should not exceed 20 cycles.

To ensure that protection systems will not be triggered, it must be ensured that power frequency voltage variations are within the envelope defined in Table 10 of TP-S-005 - NLSO Standard – Technical Requirements for Connection to the NL Transmission System. These voltages are provided in Table 3 below.

**Table 3 - Power Frequency Voltage Variations During Transient Conditions – Island of Newfoundland**

| **Power Frequency Voltage Variations During Transient Conditions – Island of Newfoundland** | |
|---|---|
| *Voltage (pu)* | *Duration* |
| *V = 0.00* | *0.15 seconds* |
| *0. 0 ≤ V < 0.80* | *1 second* |
| *0.85 ≤ V < 0.90* | *300 seconds* |
| ***0.90 ≤ V < 1.10*** | ***Steady State*** |
| *1.10 ≤ V < 1.20* | *3 seconds* |
| *1.10 ≤ V < 1.30* | *0.5 seconds* |
| *1.30 ≤ V < 1.50* | *0.1 seconds* |

**Note:** There are no single pole reclosing on NLH's 66 kV interconnected system and there will be none associated with the new 66 kV line to Valentine Terminal Station.

The System Impact Study completed in 2020 identified there were no stability concerns of the Star Lake generator for faults at Valentine Terminal Station or on TL271. With minor changes to the loading profile and transmission line length, the following contingencies were studied to see the effect on NLH's interconnected system, in particular any effect on the stability of the Star Lake generating unit.

1. Three phase fault at Valentine Terminal Station 66kV bus followed by tripping of TL271 after 6 cycles.
2. Line to ground fault at Valentine Terminal Station 66kV bus followed by tripping of TL271 after 30 cycles.

For the dynamic simulations, the peak load case is used with Star Lake generation on at maximum power output. Appendix D contains the simulations of the above fault contingencies.

The results presented show no dynamic angular or voltage stability issues impacting Newfoundland & Labrador Hydro's Interconnected System, via the interconnection of the Marathon Gold mine operations under the present operating philosophy.

## 5 Motor Starting Analysis

The System Impact Study of 2020 recommended the use of variable frequency drive (VFD) starters for large motors to reduce the effect of voltage dips on motor startup and limiting the use of direct on line motor starters to below 700HP. Marathon Gold has provided a preliminary motor listing in which the largest direct on line starter is 200HP while the largest soft starter is less than 400HP which should pose no issues with regard to voltage sag during motor startup. The largest VFD will be the 6000HP, 6.9kV Ball and Mill Motor, each with a maximum full load demand of 4600kW.

Marathon Gold has provided typical speed / torque vs mill angle in Figures 6 and 7 below. Start-up speed using the VFD is approximately 10% of 15RPM or 1.5RPM or roughly 9° per second. Figure 7 shows that the start-up torque, which is directly proportional to current, increases from 0 to 150% full load in 10 seconds and tapers off to 100% after the next 5 seconds.

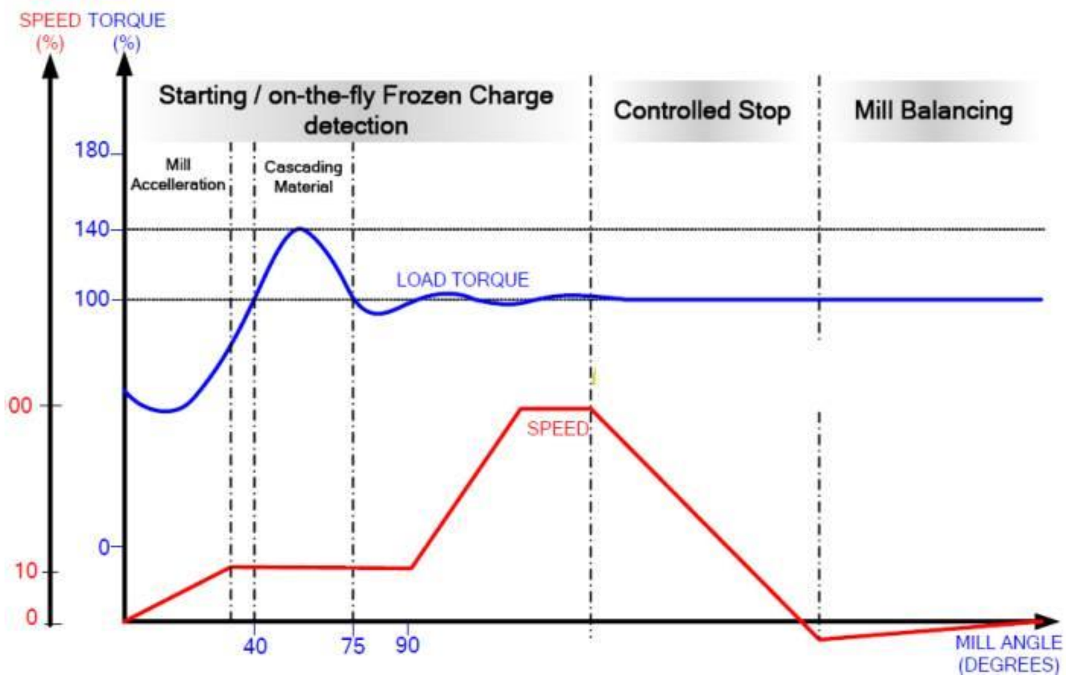



**Figure 6: Speed / Torque vs Mill Angle**

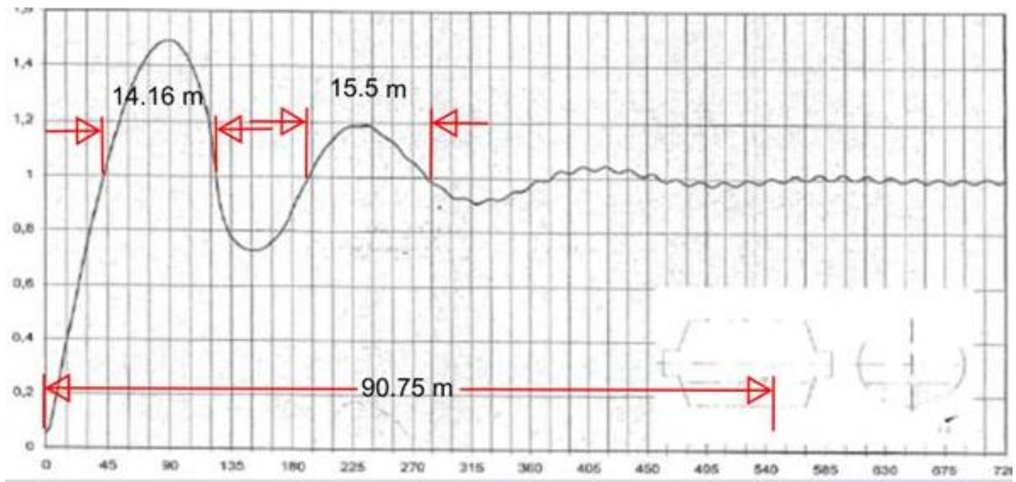



**Figure 7: Torque vs. Mill Angle**

Motor starting analysis was performed to simulate the starting of the 6000HP Ball Mill motor with the load increasing steadily from 0 to 6.9MW, which represents 150% full load, in 10 seconds to represent the linear load increase. Star Lake generator is loaded to its typical value of 18MW while maintaining the 13.8kV bus voltage to unity. Appendix E shows the reactive capability curve for Star Lake generator in which the maximum generator loading of 18MW has a reactive output restriction of approximately 5.8MVARs.

Appendix F shows the results of two cases in which the Valentine Terminal Station has a loading of approximately 14.00MW followed by the starting of the Ball Mill motor, this would be the maximum loading of Phase I with all load in-service with the exception of the Ball Motor. The first case shows the starting of the motor with an initial capacitor bank installation of 6MVARs on the 6.9kV bus. In this scenario, the Star Lake generator VAR output increases from 2.5MVARs to 7.2MVARs, which is outside the reactive capability of the generator. The second case increases the capacitor bank installation from 6 to 8MVARs, with the resulting Star Lake generator increasing from 1.2 to 5.8MVARs, which is at the limit of the reactive capability of the generator at 18MW output.

Appendix G shows the results of three cases in which the Valentine Terminal Station has a loading of approximately 16.65MW followed by the starting of the Ball Mill motor, this would be the maximum loading of Phase II with all load in-service with the exception of the Ball Motor. The first case shows the starting of the motor with an initial capacitor bank installation of 8MVARs on the 6.9kV bus. In this scenario, the Star Lake generator VAR output increases from 2.5MVARs to 7.4MVARs, which is outside the reactive capability of the generator. The second case increases the capacitor bank installation from 8 to 10MVARs, with the resulting Star Lake generator increasing from 1.1 to 6.0MVARs, again outside the reactive capability of the generator. Finally, the capacitor bank installation from 10 to 12VARs, with the resulting Star Lake generator increasing from 0.4 to 5.4MVARs, which is within the reactive capability of the generator.

In all cases, the VFD's slow and steady increase in VAR requirements can be mitigated by the Star Lake generator excitation system as long as the pre-motor starting reactive output of the generator is close to unity power factor.

It is recommended to increase the operating reactive compensation from 6 MVARs to 8 MVARs during Ball Mill or Sag motor operation during Stage I mine loading. For Stage II loading, it is recommended to increase the operating reactive compensation from 10 MVARs to 12 MVARs. As outlined previously, should one 2MVAR capacitor bank be out of service, it is further recommended to install an additional redundant 2MVAR capacitor bank to bring the total reactive compensation of the terminal station to 10MVARs for Stage I and 14MVARs for Stage II loading.

If Marathon Gold does not install redundant compensation then operation is acceptable as long as all capacitor banks are available. If one capacitor bank is unavailable due to maintenance, then load reductions will be required at site prior to the starting of the large Ball and Sag Mill motors by approximately 2MW.

# 6 Conclusions and Recommendations

Load flow analysis indicates the requirement of reactive compensation at the Valentine Gold facility in order to provide acceptable voltages at the 66 kV point of interconnection during both normal operation and outage of the Star Lake facility. Fault analysis during light load system conditions with the Star Lake generator out of service indicates a minimum fault level of approximately 80MVA at the 66 kV bus at Valentine Terminal Station which will have an impact on motor starting capability of large induction machines. From a dynamic point of view, there are no angular or voltage stability issues impacting Newfoundland & Labrador Hydro's Interconnected System with the interconnection of the Marathon Gold mine operations.

Based on the analysis undertaken as part of this System Impact Study, the interconnection of Marathon Gold Mine and its 20.87MW of interconnected load to the 66 kV Buchans system should not adversely impact the Newfoundland & Labrador Interconnected System if the recommendations outlined below are followed.

Based on the analysis, the following interconnection specifications are recommended:

1) Connection to the grid via a 66 kV transmission from Star Lake Generating Station to Valentine Terminal Station, approximately 40 km in length;

2) Utilization of 477 kcmil, ACSR, Hawk conductor to construct the transmission line connecting Valentine Terminal Station to the grid. This size of conductor is necessary to reduce the line impedance such that voltage drops are minimized and losses are minimized;

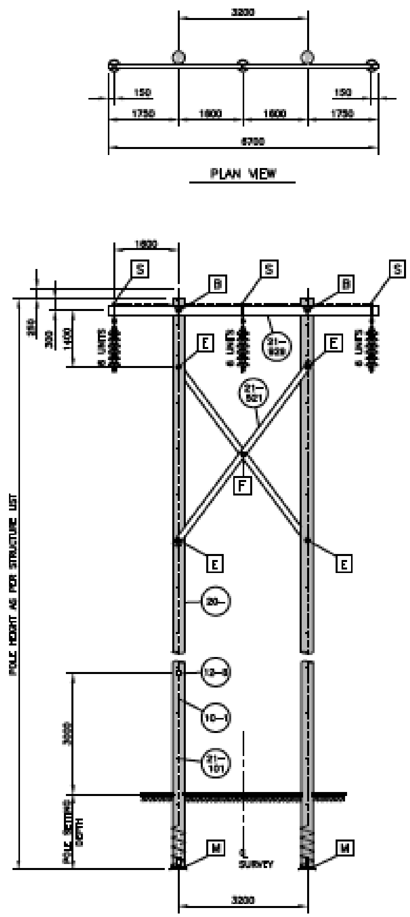
3) Installation of 6.9kV switch shunt capacitor banks to provide voltage support and ensure that voltage levels at the Valentine Terminal Station are within acceptable limits. Due to minimum short circuit levels and consultation with MGC on maximum acceptable voltage deviations, it is recommended that maximum step sizes of 1.1MVAR externally fused capacitor banks be used. The capacitor bank sizing will be based on expected loading and operating philosophy as follows:
   - Stage I Loading – No Redundant Capacitor Bank
     - i) 8 x 1 MVAR Capacitor for total of 8 MVARs
     - ii) No operational restrictions if all capacitor banks are in service
     - iii) Reduced plant loading prior to Ball or Sag Mill motor start-up if one stage of 1 MVAR capacitor banks are out of service
   - Stage I Loading with Redundant Capacitor Bank (Preferred)
     - i) 10 x 1 MVAR Capacitor for total of 10 MVARs
     - ii) No operational restrictions if one stage of 1 MVAR capacitor banks are out of service
   - Stage II Loading - No Redundant Capacitor Bank
     - i) 12 x 1 MVAR Capacitor for total of 12 MVARs
     - ii) No operational restrictions if all capacitor banks are in service
     - iii) Reduced plant loading prior to Ball or Sag Mill motor start-up if one stage of 1 MVAR capacitor banks are out of service
   - Stage II Loading with Redundant Capacitor Bank (Preferred)
     - i) 13 x 1 MVAR Capacitor for total of 13 MVARs
     - ii) No operational restrictions if one stage of 1 MVAR capacitor banks are out of service

4) Configuration of protection controls for the capacitor banks to permit staged tripping to alleviate overvoltage conditions in an acceptable timeframe;

5) As a result of consultation with Hatch and MGC related to capacitor bank installations and low risks of third harmonic resonances on the 6.9kV bus, it is recommended that MGC's capacitor bank supplier perform a detailed design and mitigation of any harmonics concerns.

# APPENDIX A

# 66kV TRANSMISSION TOWER CONSTRUCTION




| BM | JD Edwards | QTY | DESCRIPTION | DETAIL ITEM |
|---|---|---|---|---|
| 3-3 | - | 3 | O.H.G.W. DAMPER, AS PER STRUCTURE LIST | S |
| 4-1 | - | 3 | SUSPENSION CLAMP | S |
| 6-1 | 76100014 | 18 | SUSPENSION INSULATORS, 15,000 lbs. | S |
| 9-72 | 24000117 | 2 | GAIN, CROSSARM SHELF TYPE | B |
| 9-73 | 25100241 | 2 | BOLT, SHOULDER BALL LINK EYE, 3/4" x 12" (19x305mm) | S |
| 10-1 | 37100006 | AS REQ'D | No.5 STEEL POLE GROUNDING WIRE | M |
| 12-8 | 82200101 | 1 | SMALL NUMBER SIGN | – |
| 20- | - | 2 | WOOD POLES, CLASS & HEIGHT AS PER STRUCTURE LIST | – |
| 21-13 | 25100088 | 4 | BOLT, MACHINE, 1/2" x 8" (13x203mm) | E |
| 21-40 | 24000187 | 2 | WASHER, ROUND, 2" (51mm), for 3/4" (19mm #) BOLT | M |
| 21-44 | 24000182 | 6 | WASHER, CURVED, 3.5"x3.5"x3/8" (89x89x3/8mm) for 3/4" BOLT | B, E |
| 21-46 | 25100104 | 6 | BOLT, MACHINE, 3/4" x 18" (19x457mm) | B, E |
| 21-48 | 25100105 | 2 | BOLT, MACHINE, 3/4" x 20" (19x508mm) | M |
| 21-48 | 24000142 | 4 | PLATE, POLE BEARING, VERTICAL | M |
| 21-79 | 25300069 | 8 | WASHER, SQUARE FLAT, 2"x2"x3/16" (51x51x5mm) for 3/4" BOLT | B, E |
| 21-90 | 24000234 | 16 | SCREW, LAG, 5/8" x 5" (16x127mm) FOR BEARING PLATE | M |
| 21-101 | 24000039 | 200 | GALVANIZED STAPLES 1-1/4" (32mm) LONG | M |
| 21-108 | 24000119 | 4 | GRID GAIN, TEETH BOTH SIDES, 3/4" (19mm) | E |
| 21-154 | 24000196 | 11 | WASHER, SQ. FLAT, 4"x4"x1/4" (102x102x6mm) for 3/4" BOLT | B, E, F, S |
| 21-200 | 25100431 | 1 | BOLT, DOUBLE ARMING, 3/4" x 24" (19x610mm) | F |
| 21-521 | - | 2 | CROSSBRACE, WOOD, 4" x 6" x 18'-7" (102x152x5660mm) | – |
| 21-929 | - | 1 | CROSSARM, WOOD, 4" x 8" x 22'-0" (102x203x6700mm) | – |
| 38-4 | 14200007 | AS REQ'D | WOOD FILLER BLOCKS | F |
| – | 24000378 | 2 | CAP, POLE, 9" (229mm), PRO TOP | M |
| | | | | |
| | | | | |

NOTES :

1. FOR GENERAL NOTES, SEE A3-1-69TL (NOTES).DWG

Preliminary

NOTICE
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| NO | DATE | REVISION | BY | CKD | APD |
|---|---|---|---|---|---|
| 1 | 08-09-12 | Redrawn for WPLM from 2300-T-151 | K.B.R. | | |

ORIGINAL DRAWING SEALED BY A. HALDAR 1988

hydro

Newfoundland and Labrador Hydro

| | |
|---|---|
| DWN | G.W. |
| CKD | T.G. |
| APD | D.P. |

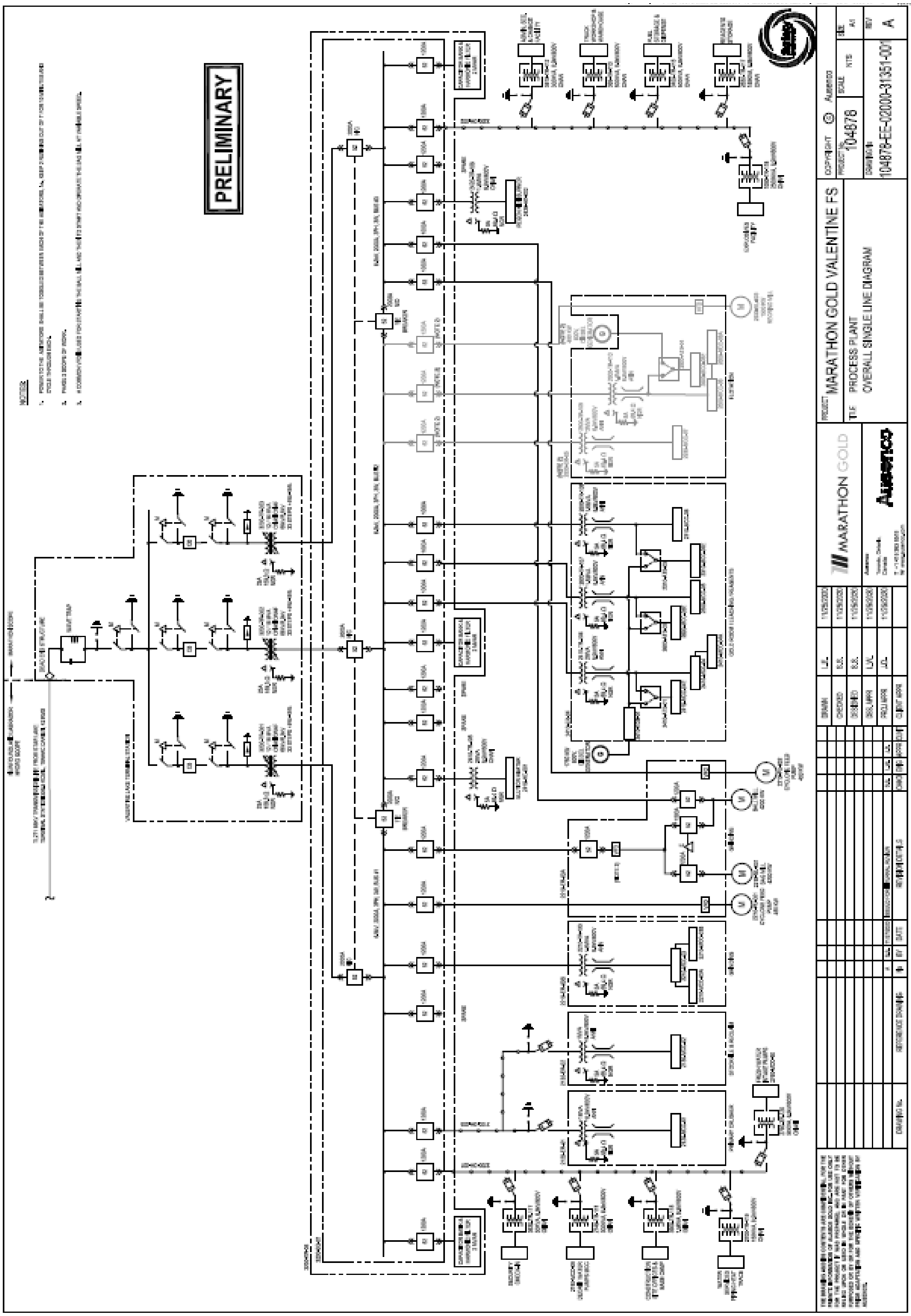
69kV WOOD POLE STRUCTURE
TYPE "A"
TANGENT SUSPENSION

Scale 1 : 100
Date 88-05-30
A3- 1-69TL (A)
REV. 1
CAD

# APPENDIX B

## Valentine Terminal Station

## Electrical Distribution System Single Line Diagram


PRELIMINARY
MARATHON GOLD VALENTINE FS
PROCESS PLANT
OVERALL SINGLE LINE DIAGRAM
MARATHON GOLD
104878
104878-EE-02000-31351-001
A

# APPENDIX C

## Light Load Flow Plots

1. **Light Load Case – Normal System Operation.**
2. **Light Load Case – Contingency Operation with Star Lake out of service.**
3. **Light Load Case – No Load at VTS TS – Normal System Operation**
4. **Light Load Case – No Load at VTS TS – Star Lake out of service.**

## 1. 2024 Light Load Case – Normal System Operation – 20.87MW Load at VTS TS

Figure 10 provides the light load flow plot for operation with a maximum load of 20.87 MW. There are no Transmission Planning Criteria violations in this scenario.

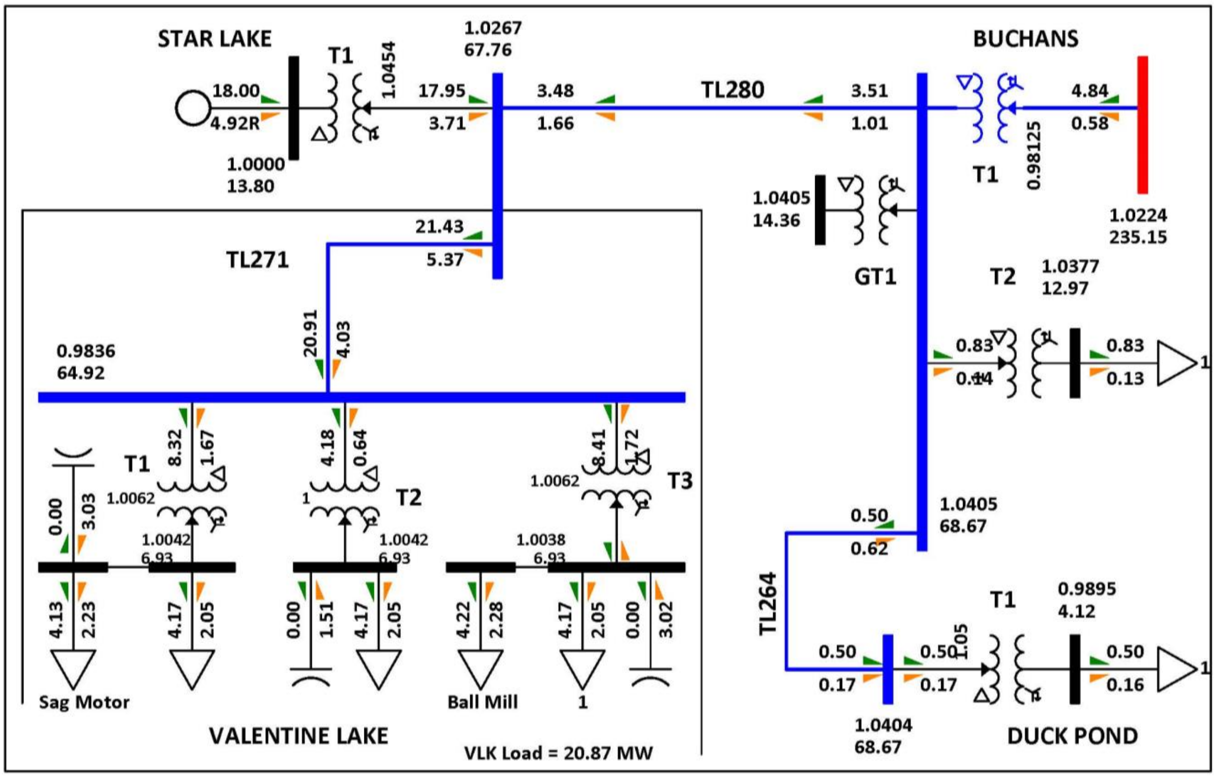



**Figure 10: 2024 Light Load Case – Normal System Operation**

## 2. 2024 Light Load Case – N-1 Star Lake out of service - 20.87MW Load at VTS TS

Figure 11 provides the light load flow plot for operation with a maximum load of 20.87 MW. In this scenario, the Star Lake generator is out of service for maintenance. There are no Transmission Planning Criteria violations in this scenario.

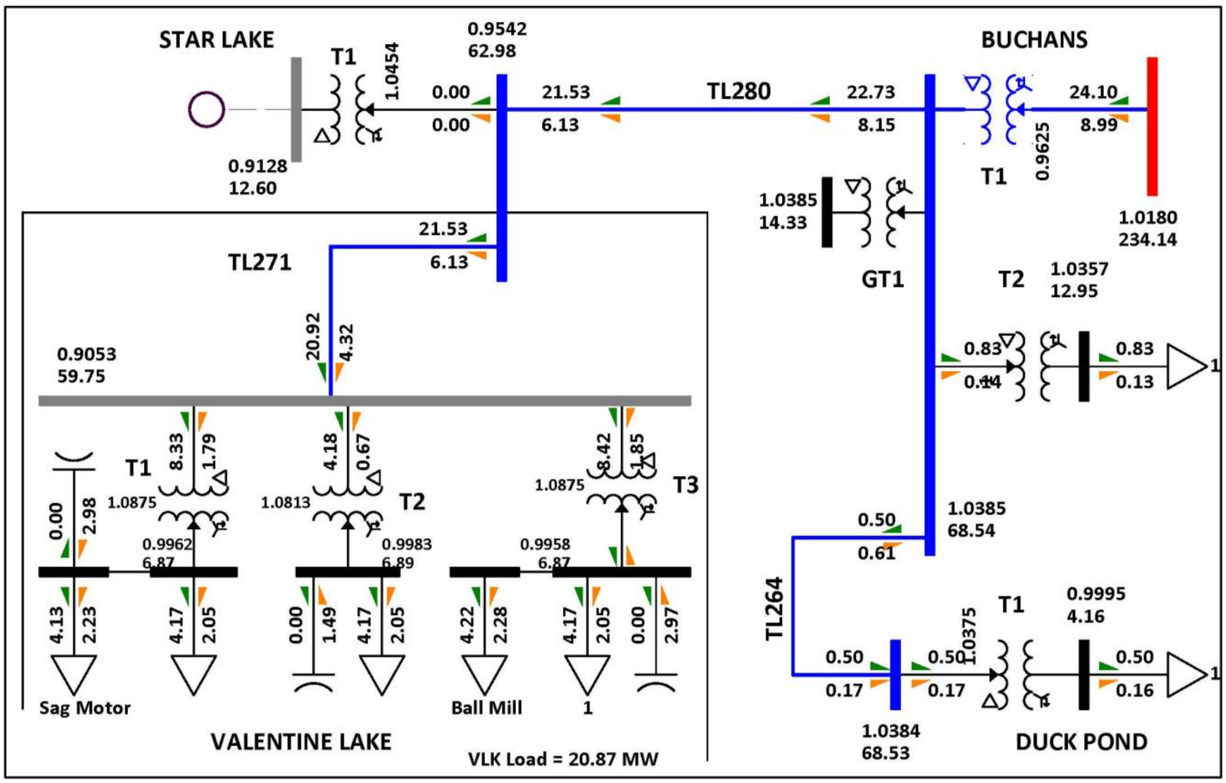



**Figure 11: 2024 Light Load Case – SLK out of service**

### 3. 2024 Light Load Case – Normal System Operation – No Load at VTN TS

Figure 12 provides the light load flow plot for operation with no load at VTN TS.. There are no Transmission Planning Criteria violations in this scenario.

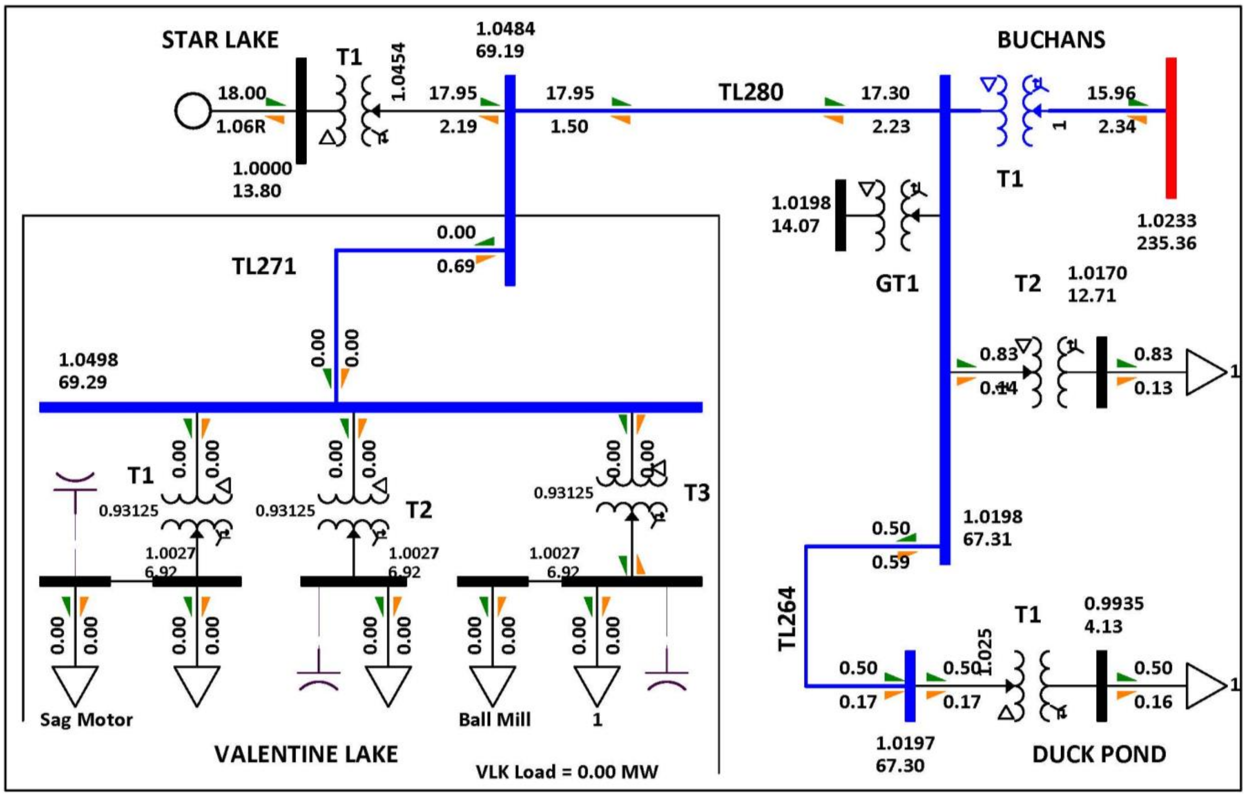



**Figure 12: 2024 Light Load Case – Normal Operation – No Load**

## 4. 2024 Light Load Case – N-1 Star Lake out of service – No Load at VTN TS

Figure 13 provides the light load flow plot with no load at Valentine Terminal Station and all capacitor banks out of service. There are no Transmission Planning Criteria violations in this scenario.

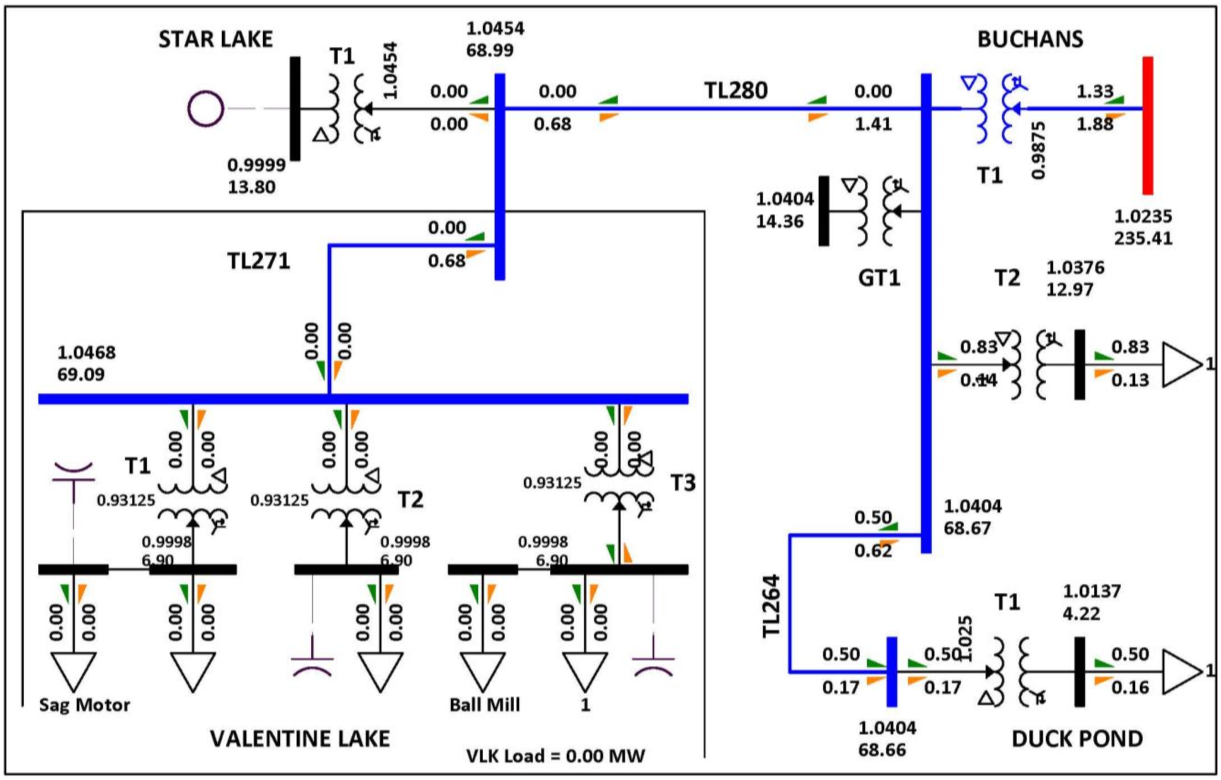



**Figure 13: 2024 Light Load Case – N-1 Star Lake Out of Service with No Load at VTN TS**

# APPENDIX D

## Dynamic Simulation Results

1. **Three Phase Fault for 6 Cycles at 66 kV at VTN TS – Trip of TL271 and full 20.87 MW load**

2. **Line to ground Fault for 30 Cycles at 66 kV at VTN TS – Trip of TL271 and full 20.87 MW load**

**1. Three Phase Fault for 6 Cycles at 66 kV at VTN TS – Trip of TL271 and full 20.87 MW load**

Figure 14 provides the dynamic simulation results of a three phase fault on the 66 kV line TL271 near Valentine Terminal Station and subsequent tripping of that line after 6 cycles, along with the loss of 20.87MW. These results indicate a stable system as Star Lake generator's angular swing is stable and is damped very quickly. High voltages may be experienced at Star Lake's 66 and 13.8kV buses but AVR operation and on load tap changer operation of Buchans transformer T1 should bring voltages back to a normal operating range.

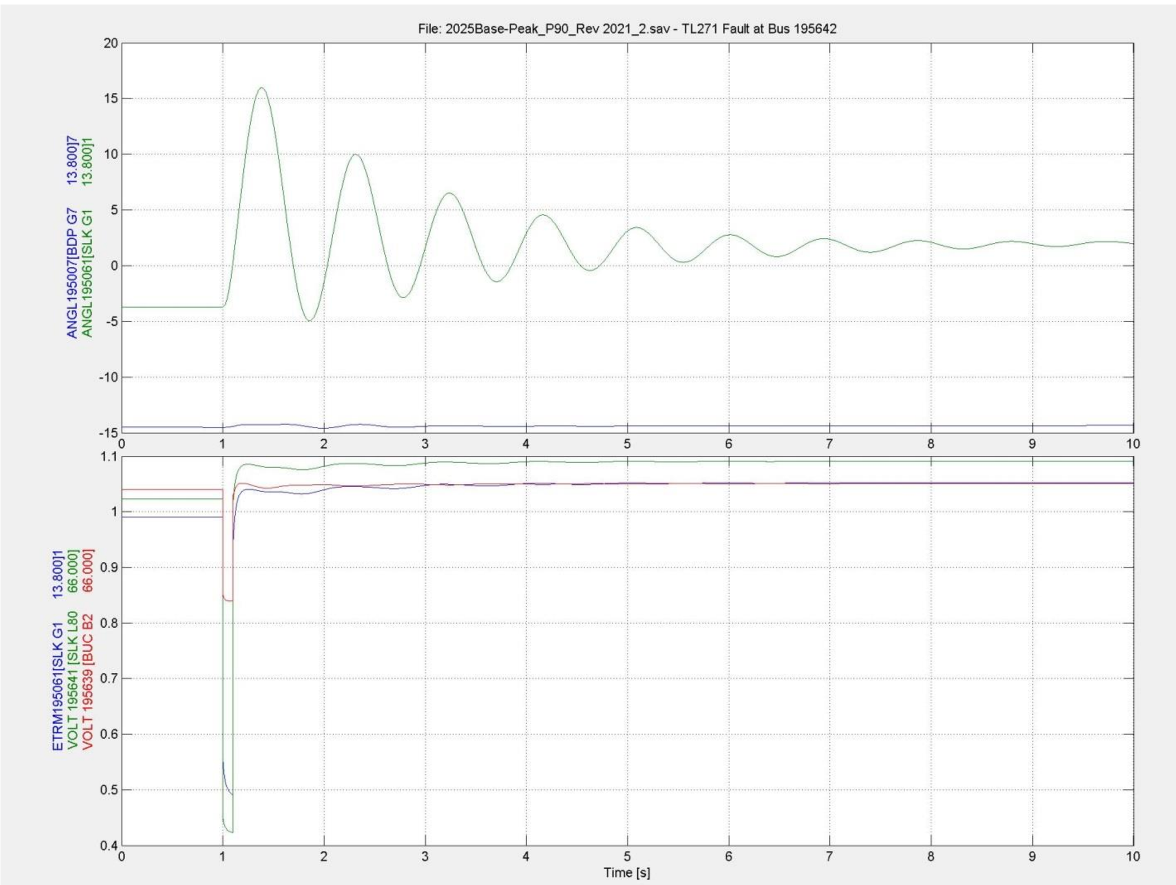



**Figure 14: Dynamic Results of 3 Phase Fault at VTN66 and Trip of TL271 after 6 Cycles**

## 2. Line to ground Fault for 30 Cycles at 66 kV at VTN TS – Trip of TL271 and full 20.87MW load

Figure 15 provides the dynamic simulation results of a single line to ground fault on the 66 kV line TL271 near Valentine Terminal Station and subsequent tripping of that line after 30 cycles, along with the loss of 20.87MW. These results indicate a stable system as Star Lake generator's angular swing is stable and is damped very quickly. Low voltages will be experienced at Star Lake's 66 and 13.8kV buses approaching 0.85pu which should not cause operational problems for the unit at SLK. Consultation required with NLH Protection and Control to confirm timing of fault clearing.

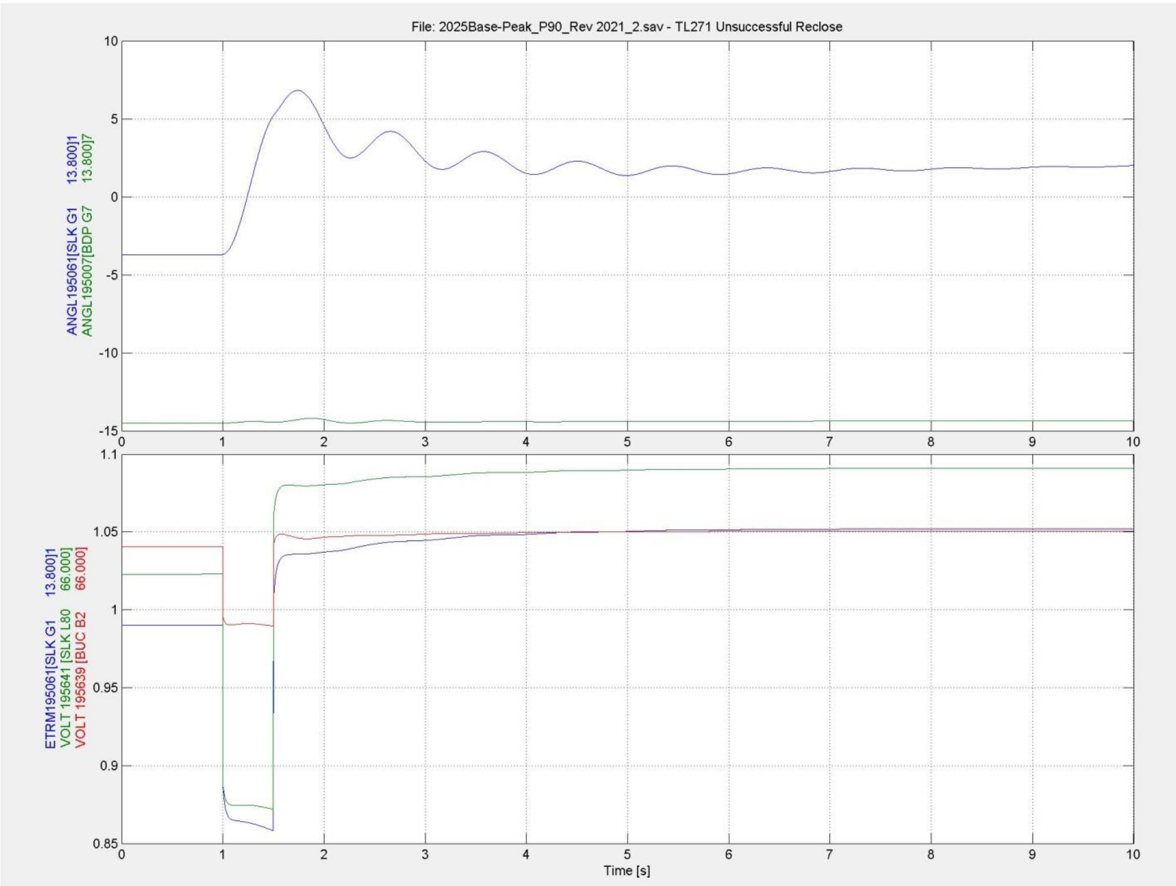
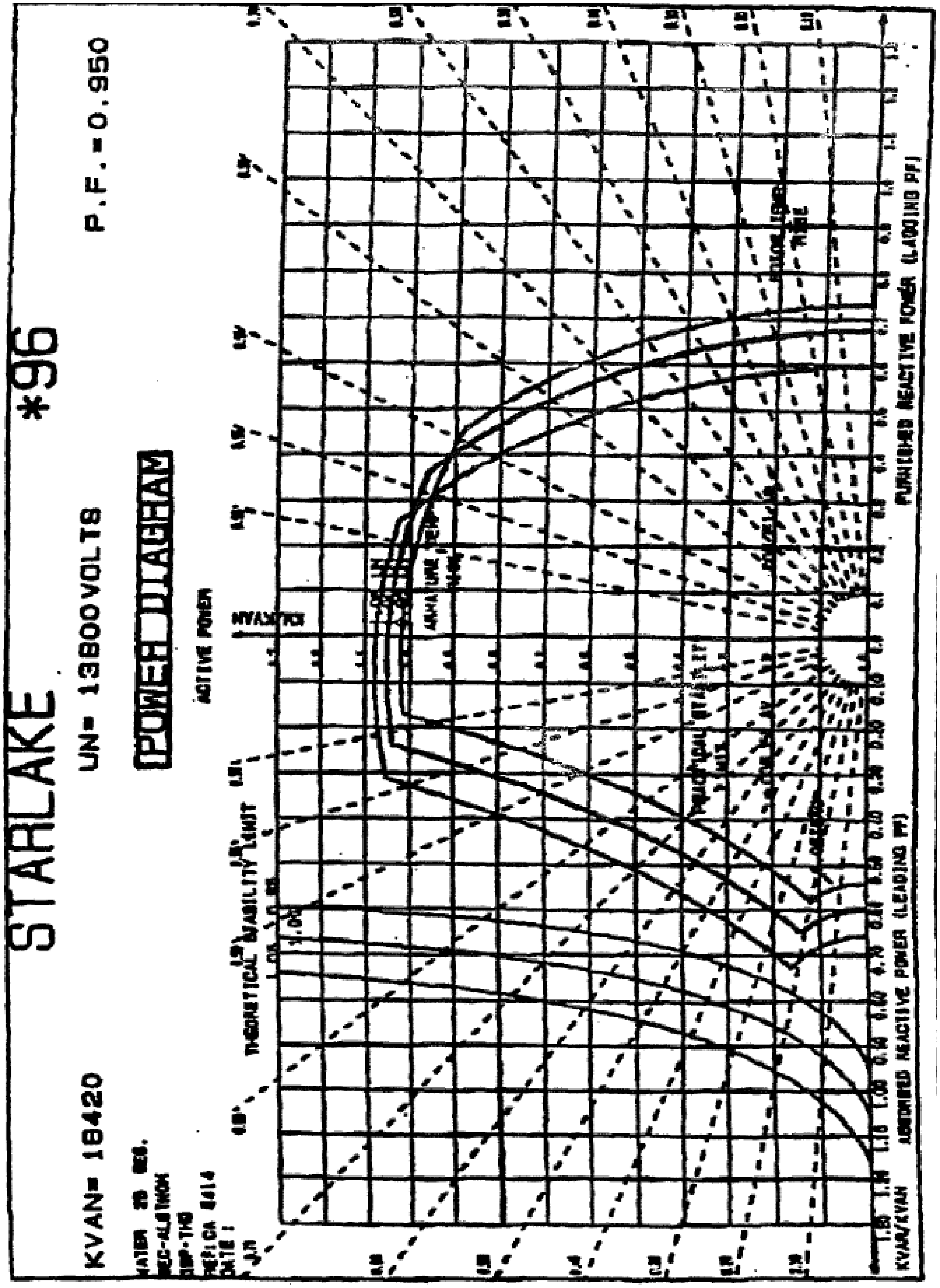



**Figure 15: Dynamic Results of SLG Phase Fault on TL271 near VTN and Trip after 30 Cycles**

# APPENDIX E

## STAR LAKE GENERATOR

## CAPABILITY CURVE


STARLAKE
*96
KVAN= 18420
UN= 13800VOLTS
P.F. = 0.950
POWER DIAGRAM
ACTIVE POWER
THEORETICAL STABILITY LIMIT
ABSORBED REACTIVE POWER (LEADING PF)
FURNISHED REACTIVE POWER (LAGGING PF)
KVAR/KVAN

# APPENDIX F

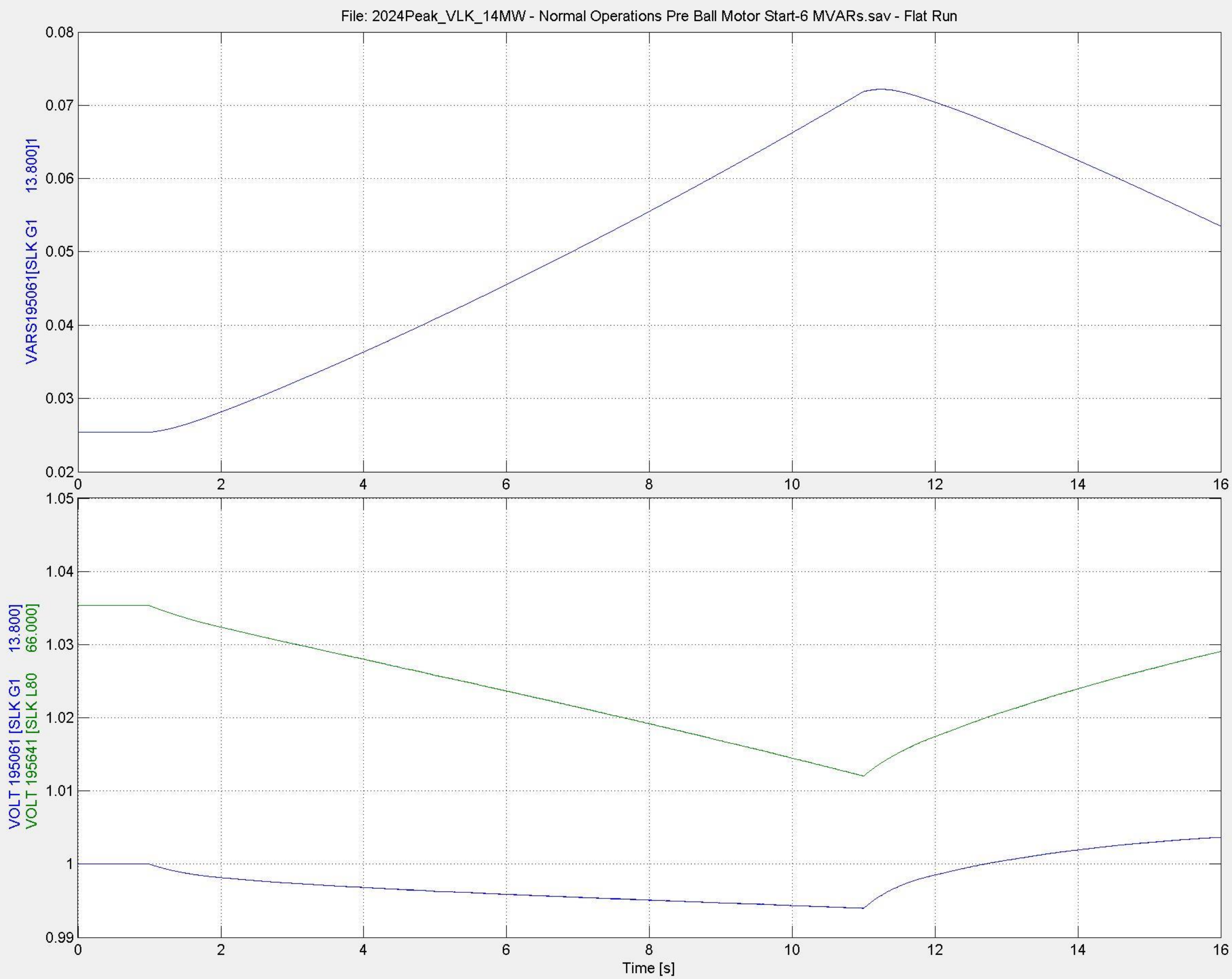
## Stage I Load Profile

## Ball Motor VFD Starting Simulation Results

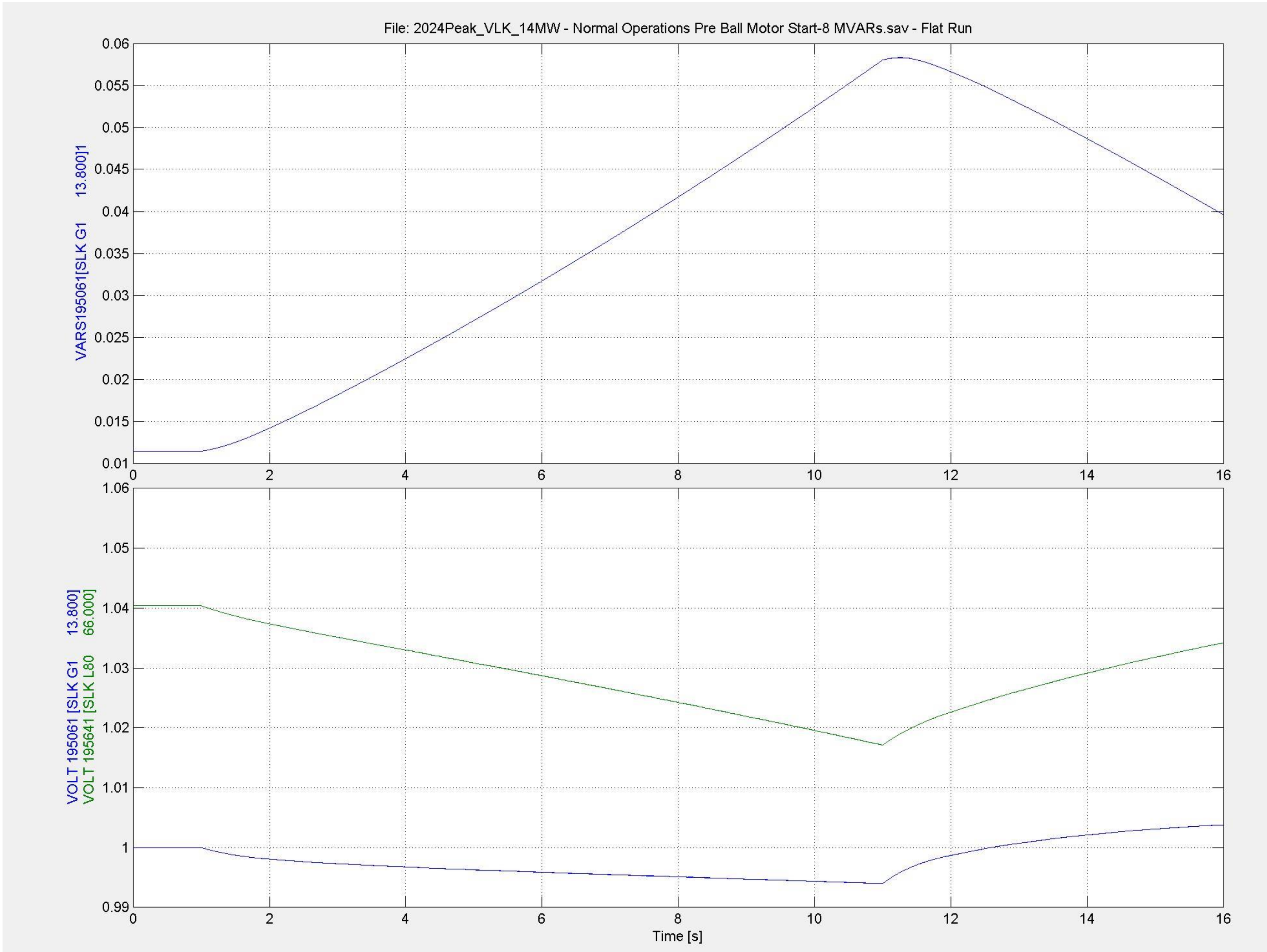
## with Starting Load of 14.00 MW

1. **Peak Load with 6 MVARs of Capacitors on 6.9kV Bus**
2. **Peak Load with 8 MVARs of Capacitors on 6.9kV Bus**

**Ball Motor Start-up – 150% Load Increase in 10 Sec , Reduced to 100% after 15 Sec**
**Star Lake Unit On at 18MW – Stage I Load – 14MW Pre-Ball Motor Startup – 6 MVAR Caps in at VTN**



**Ball Motor Start-up – 150% Load Increase in 10 Sec , Reduced to 100% after 15 Sec**
**Star Lake Unit On at 18MW – Stage I Load – 14MW Pre-Ball Motor Startup – 8 MVAR Caps in at VTN**



# APPENDIX G

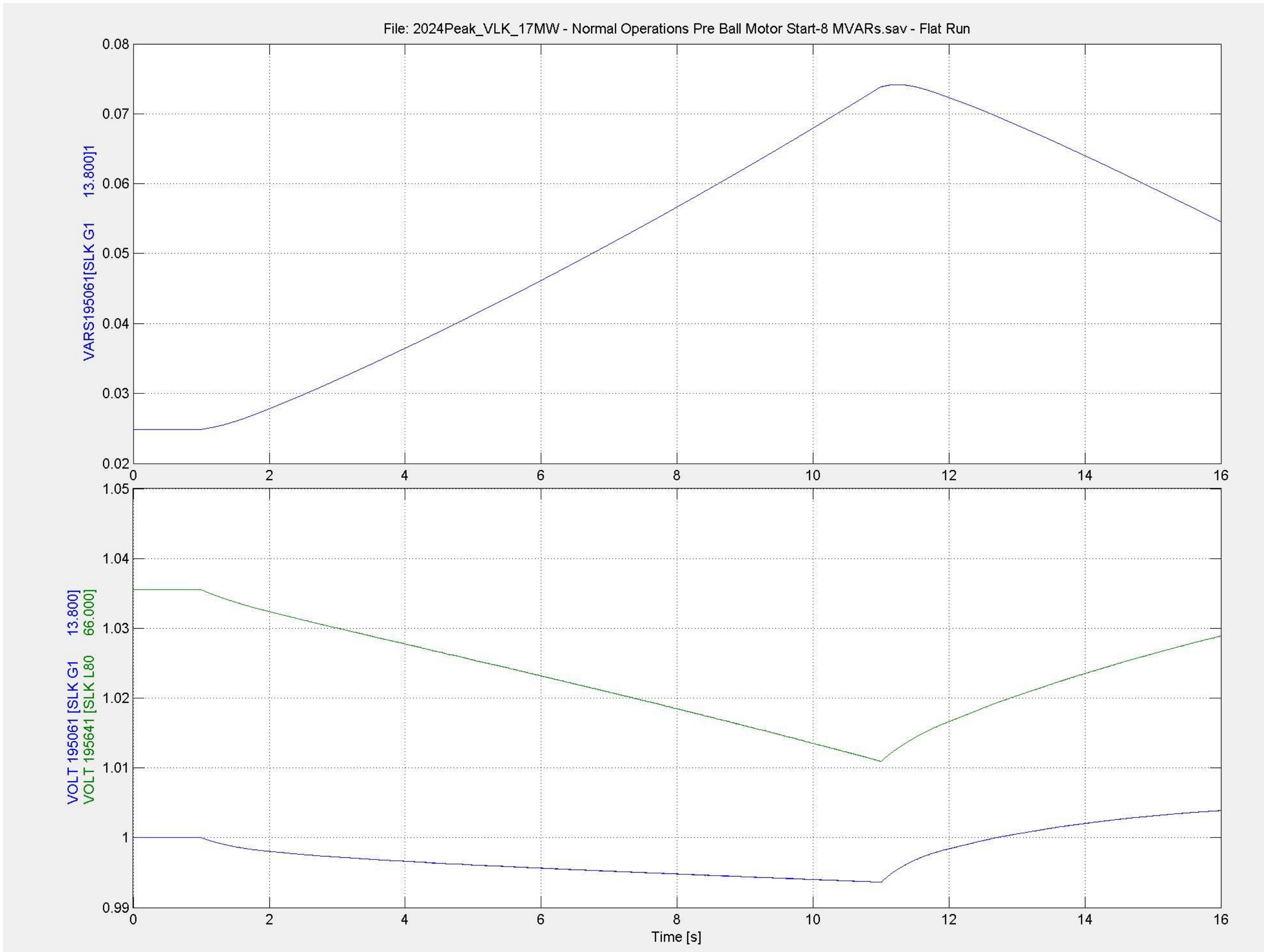
## Stage II Load Profile

## Ball Motor VFD Starting Simulation Results

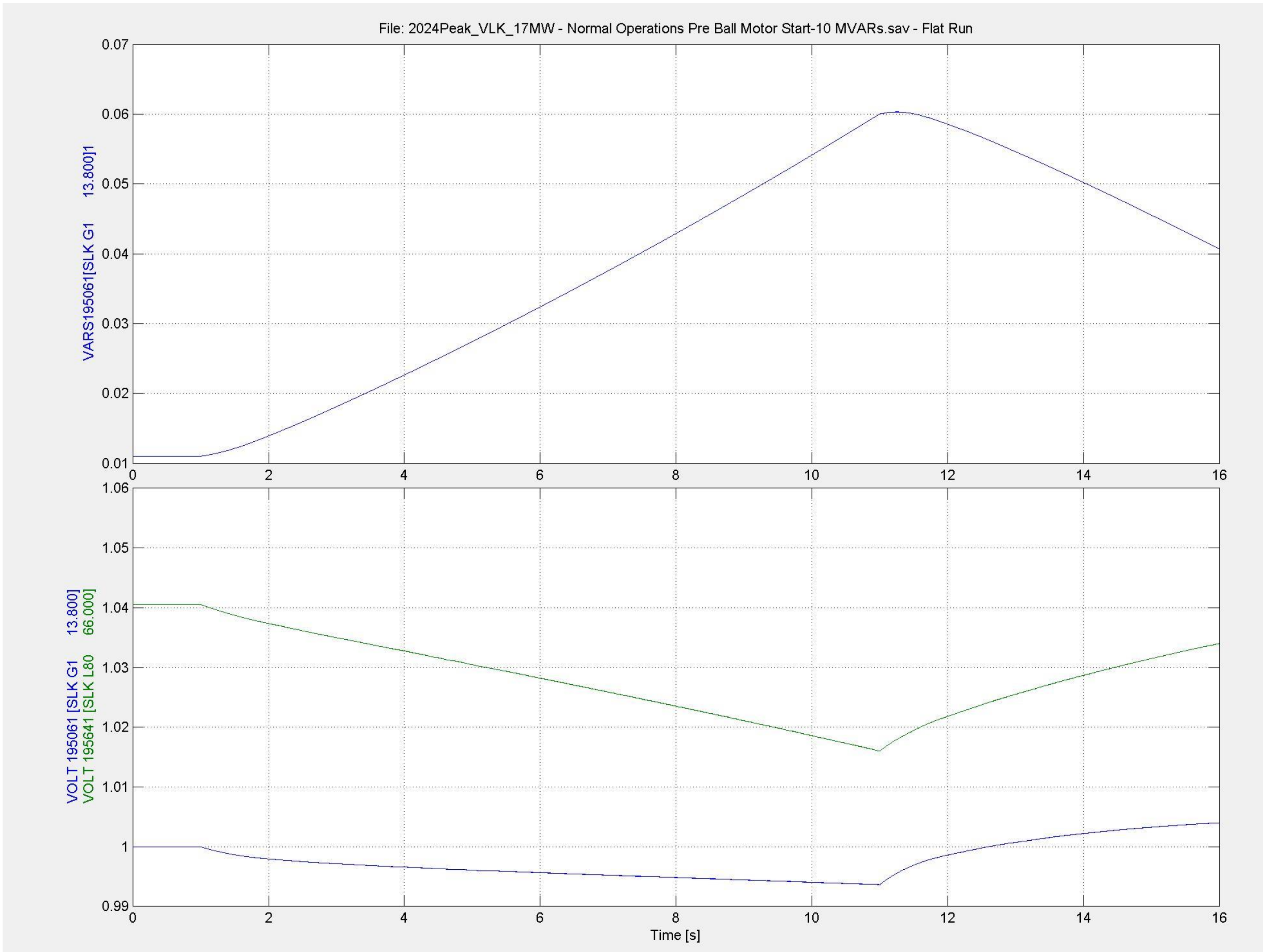
## with Starting Load of 16.65 MW

1. **Peak Load with 8 MVARs of Capacitors on 6.9kV Bus**
2. **Peak Load with 10 MVARs of Capacitors on 6.9kV Bus**
3. **Peak Load with 12 MVARs of Capacitors on 6.9kV Bus**

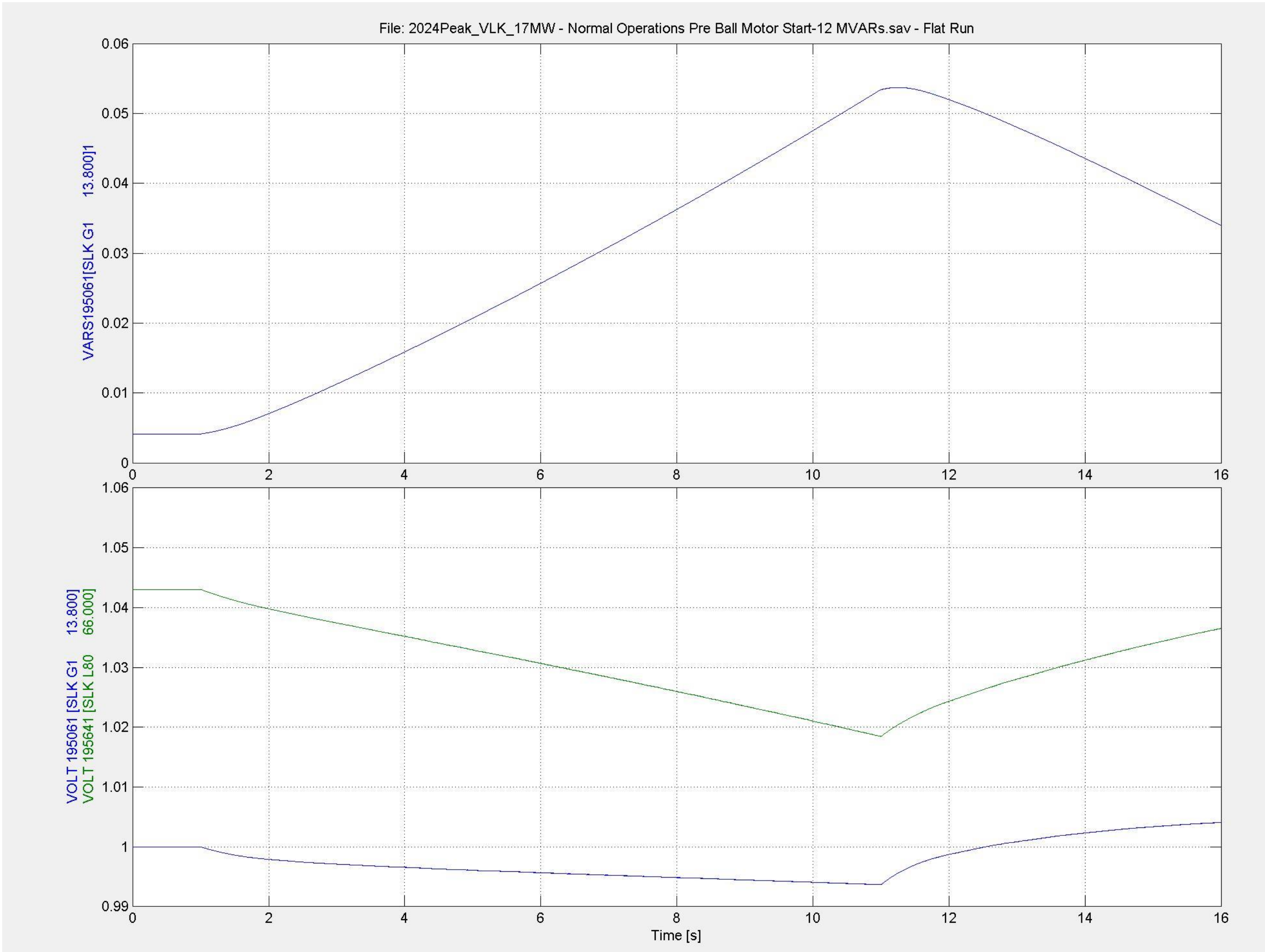
**Ball Motor Start-up – 150% Load Increase in 10 Sec , Reduced to 100% after 15 Sec**
**Star Lake Unit On at 18MW – Peak Case – 8 MVAR Caps in at VTN**



**Ball Motor Start-up – 150% Load Increase in 10 Sec , Reduced to 100% after 15 Sec**
**Star Lake Unit On at 18MW – Peak Case – 10 MVAR Caps in at VTN**



**Ball Motor Start-up – 150% Load Increase in 10 Sec , Reduced to 100% after 15 Sec
Star Lake Unit On at 18MW – Peak Case – 12 MVAR Caps in at VTN**



## Document Summary

| | |
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| **Document Owner:** | J. Flynn |
| **Document Distribution:** | R. Coish, R. Collett |

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| Revision | Prepared by | Reason for change | Effective Date |
|---|---|---|---|
| 1 | J. Flynn | Approved for Release | 2021/03/10 |
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