

**Interconnection Study Report for 10 MW of Wind Generation
Interconnecting at Xcel Energy Averill Distribution Substation,
MISO Queue No G692**

Prepared For:
An independent power Producer

Submitted by:

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Overview:

This report summarizes the conclusions of an evaluation of interconnecting 10 MW of wind generation to the Xcel Energy Averill 23.9 kV distribution system. The objective of this study is to determine the transmission facilities necessary to add the 10 MW of generation at this location without violating MISO, MRO and Xcel Energy steady state transmission planning criteria.

Conclusions:

Based on this evaluation, the following can be concluded:

- There are no local thermal constraints associated with the interconnection of the generator.
- It is required that the generators be operated in constant voltage mode.

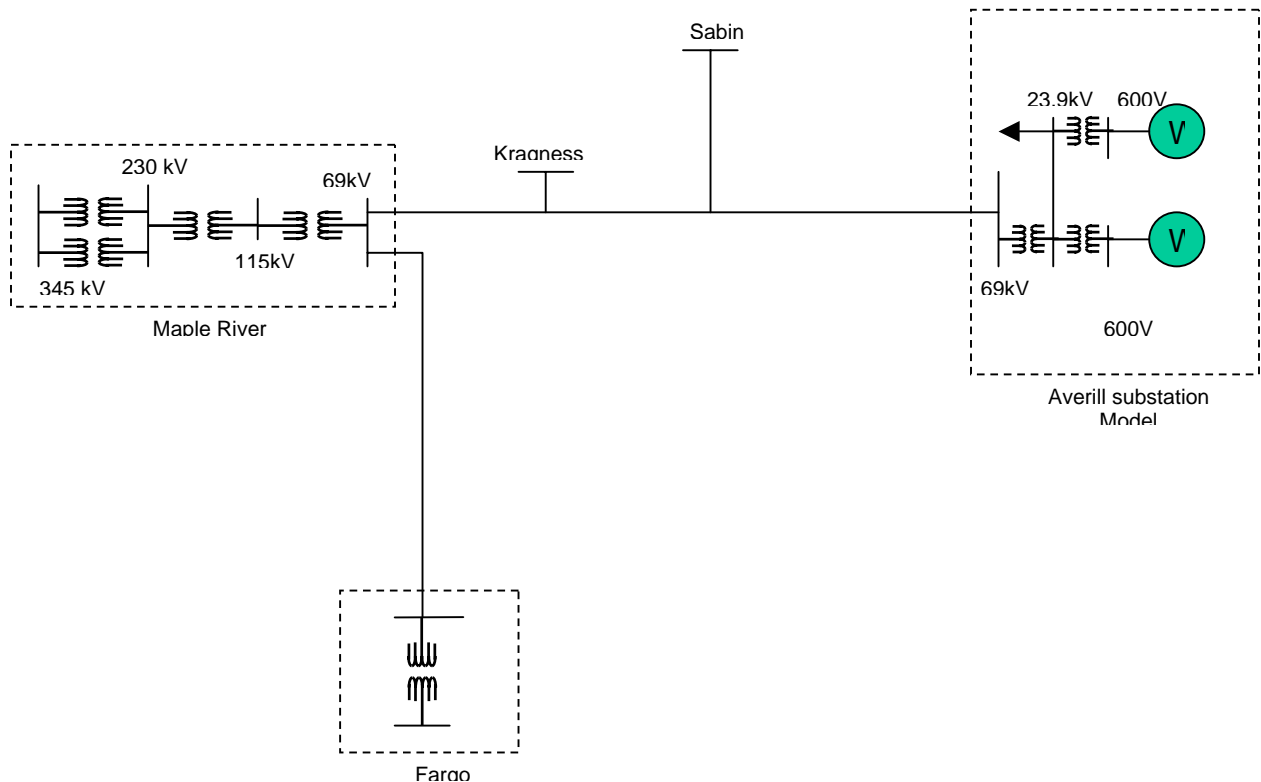
Study Scope

This study involves steady state analysis only, the study involves identifying the injection constrains associated with G692. Due to the location and nature of topology of the system at the point of interconnection, it is determined by the ad-hoc study group that the interconnection will have minimal or no impact on the voltages beyond Maple River 115 kV bus. Therefore the voltages beyond Maple River are not monitored. PV analysis is done to determine the effect of load on the voltages on the 69 kV system.

Model details

MRO 2007 Series 2009 summer peak model was used to perform the analysis. The 69 kV system connected to Maple River is not part of the standard MRO models, information provided by MPC was used to model the 69 kV system in this region. The loads along the 69 kV line from Maple River to Averill were modeled at their minimum level to ensure maximum injection of power into the transmission system.

The generators at Lake Agassiz and Averill were modeled on 690 and 600 V buses respectively along with the generator step up transformers. The impedance used for the transformers is typical and it is assumed that it is sufficient for the study.



Transfer Limit Analysis

Using G692 as source and Sherco as sink, transfer limit analysis was performed to identify the thermal constraints. The following control areas were monitored to identify constraints.

AREA 600 (NSP)
AREA 626 (OTP)
AREA 608 (MP)
AREA 618 (GRE)
AREA 652 (WAPA)

All the overloaded branches with more than 3% distribution factor were assumed to be constraints. No constraints were identified for the 10 MW injection into Averill substation.

Voltage stability analysis

Based on Xcel Energy's planning criteria, the transmission voltages should not fall below 0.95 and 0.92 for generator and load buses respectively. The company's preferred upper limit for bus voltage is 1.05 for both generator and load buses. Finally, the instantaneous change in voltage (rise/drop) due to capacitors or generators during system intact conditions is limited to 0.03 PU.

Based on the PV curves shown below, there are no concerns associated with voltage instability or violations. This analysis is based on the assumption that the proposed wind farm exhibits the characteristics of a synchronous machine, and can regulate the voltage at the generator terminals. This is a valid assumption based on the specifications provided by the vendor.

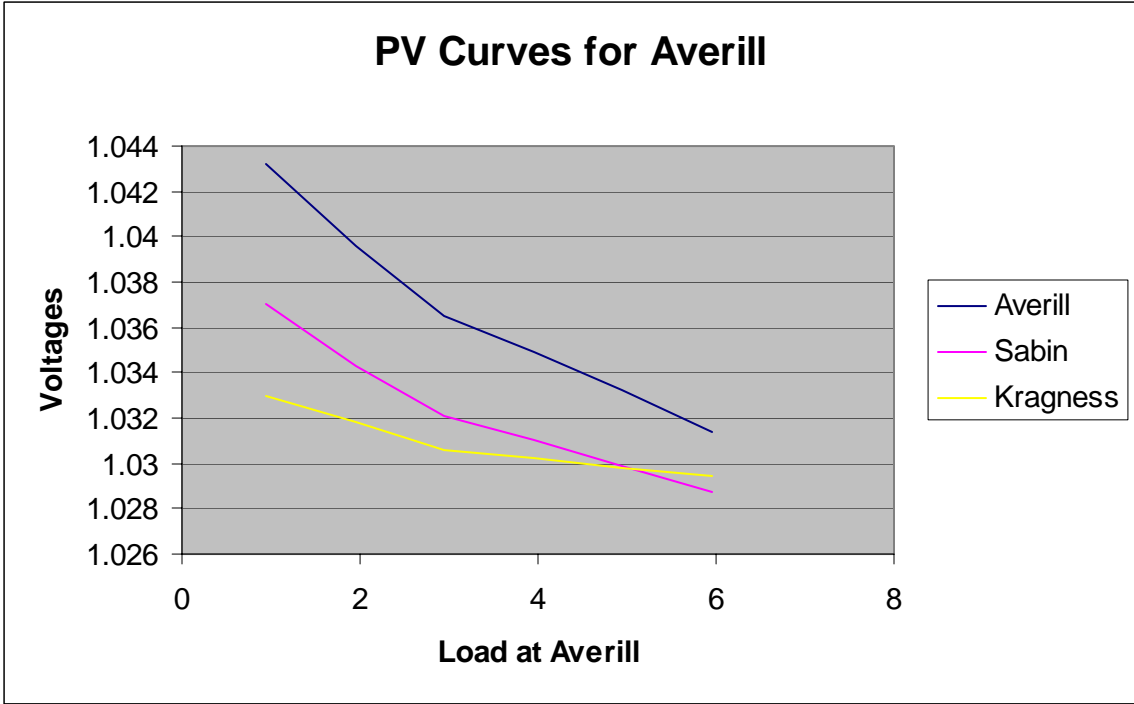


Figure 1

PV curves with prior outage of Maple River transformer.

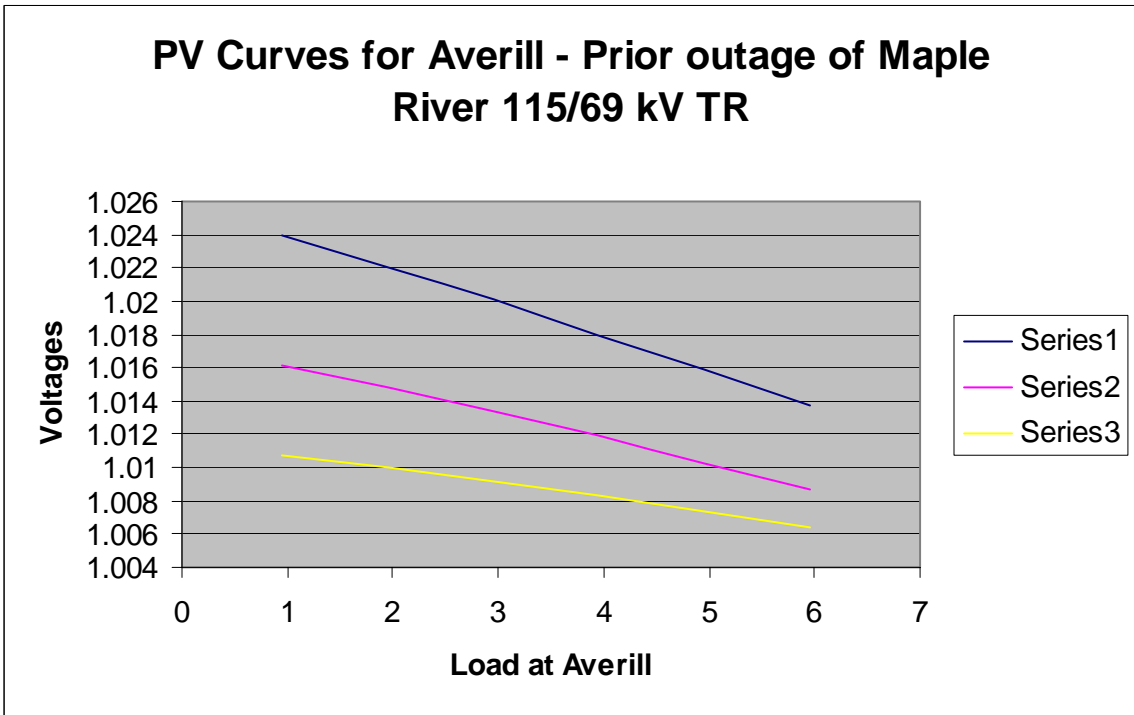


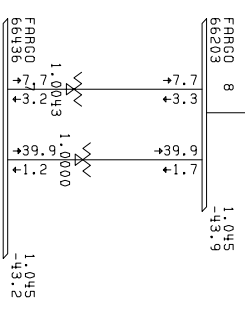
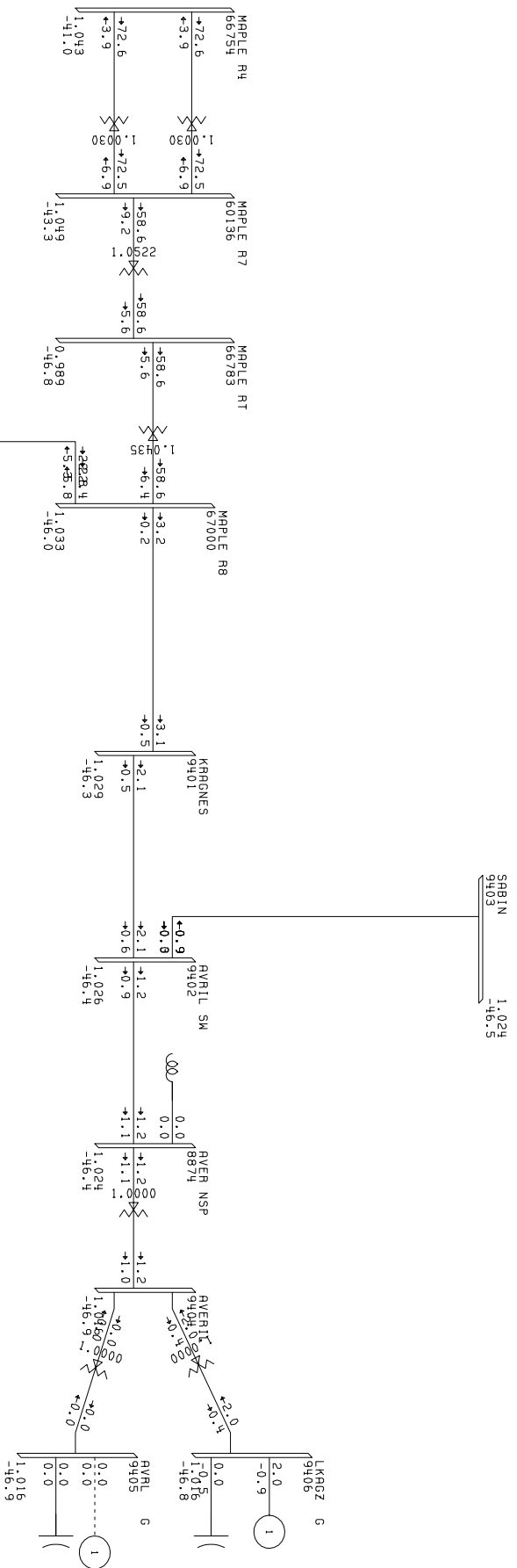
Figure 2

Based on the information provided by vendor, the generators can be operated in three modes

- Constant voltage mode.
- Constant reactive power mode.
- Constant power factor mode.

The study indicated that it is required to operate the generators in a constant voltage mode to ensure minimal impact on the system voltages.

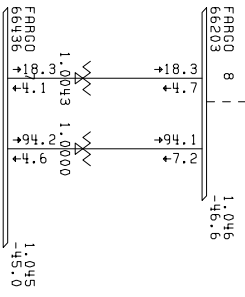
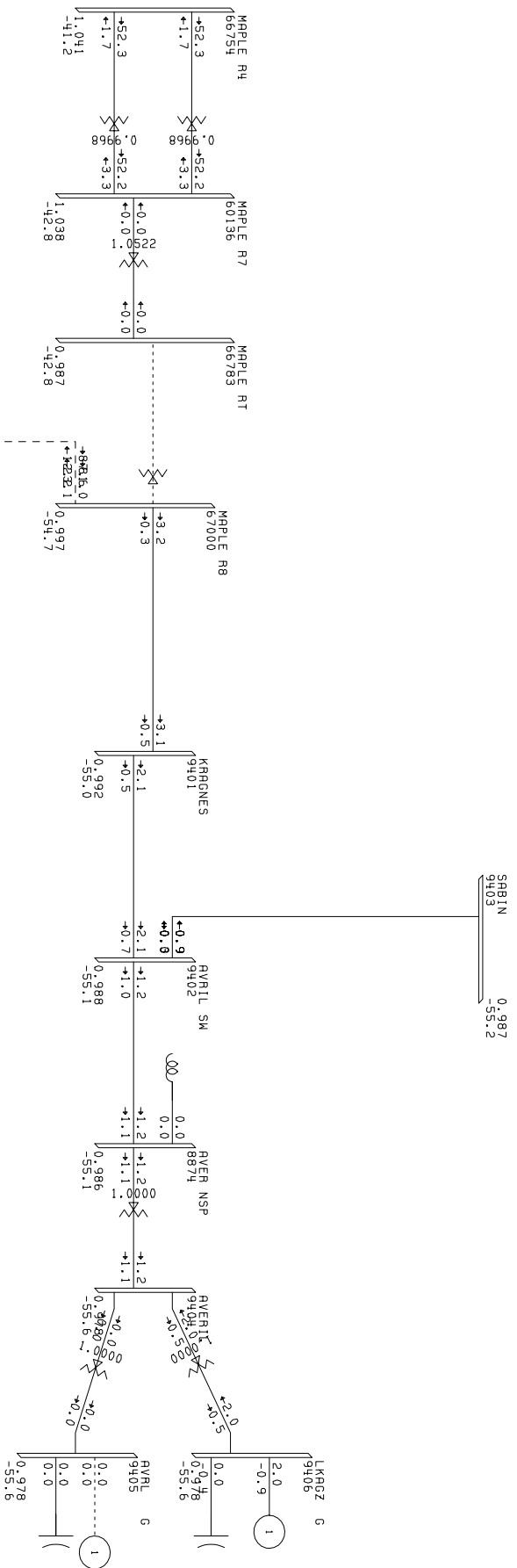
The powerflow maps for the 69 kV system for select contingencies and conditions are provided at the end.



2007 SERIES, MRD/MBS BASE CASE LIBRARY
 2009 SUMMER PEAK CASE, JULY 6, FINNL
 BASE CASE: SYSTEM INTACT MED, FEB 06 2008 22:35

100% RAIER
 0.950 UV 1.050 OV

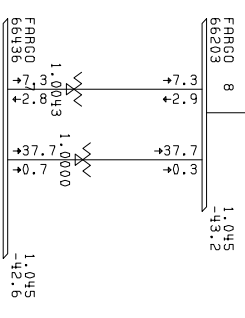
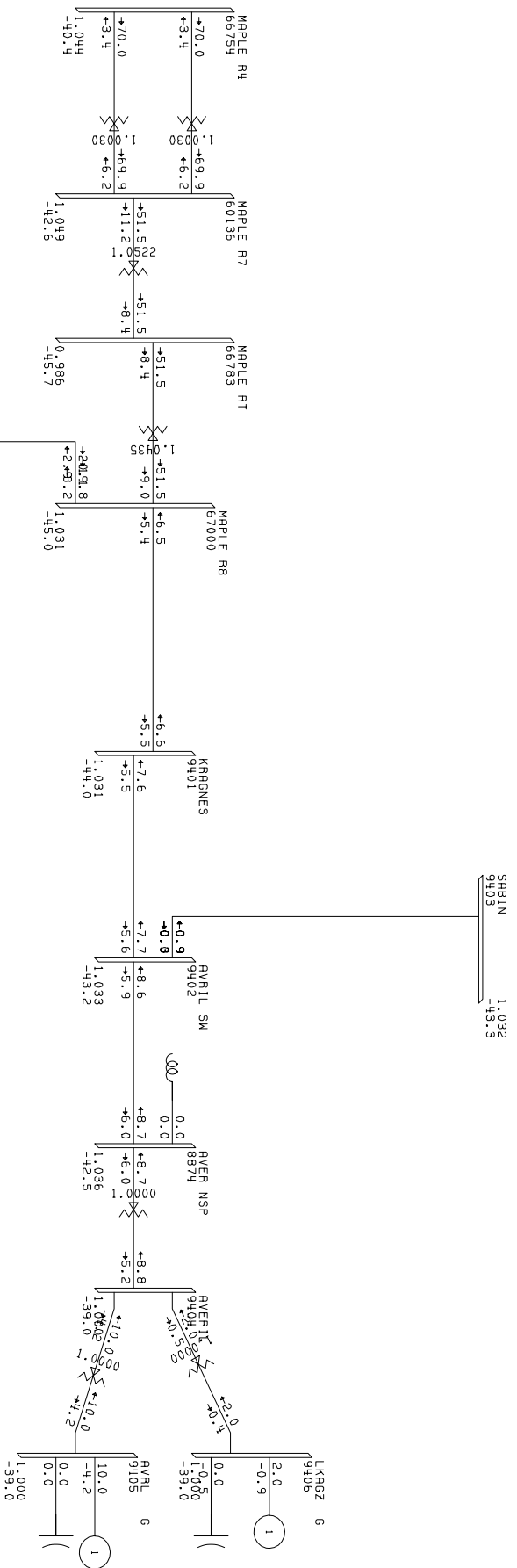
BUS - VOLTAGE (PU) / ANGLE
 BRANCH - MW/MVAR
 EQUIPMENT - MW/MVAR



2007 SERIES, MRD/MBS BASE CASE LIBRARY
 2009 SUMMER PEAK CASE, JULY 6, FINNL
 BASECASE: LOSS OF MAPLE RIVER T MED, FEB 06 2008 22:44

100% RATED
 0.950 UV 1.050 OV

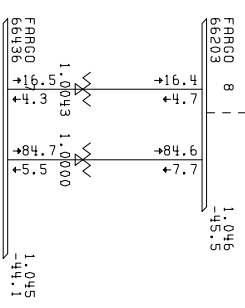
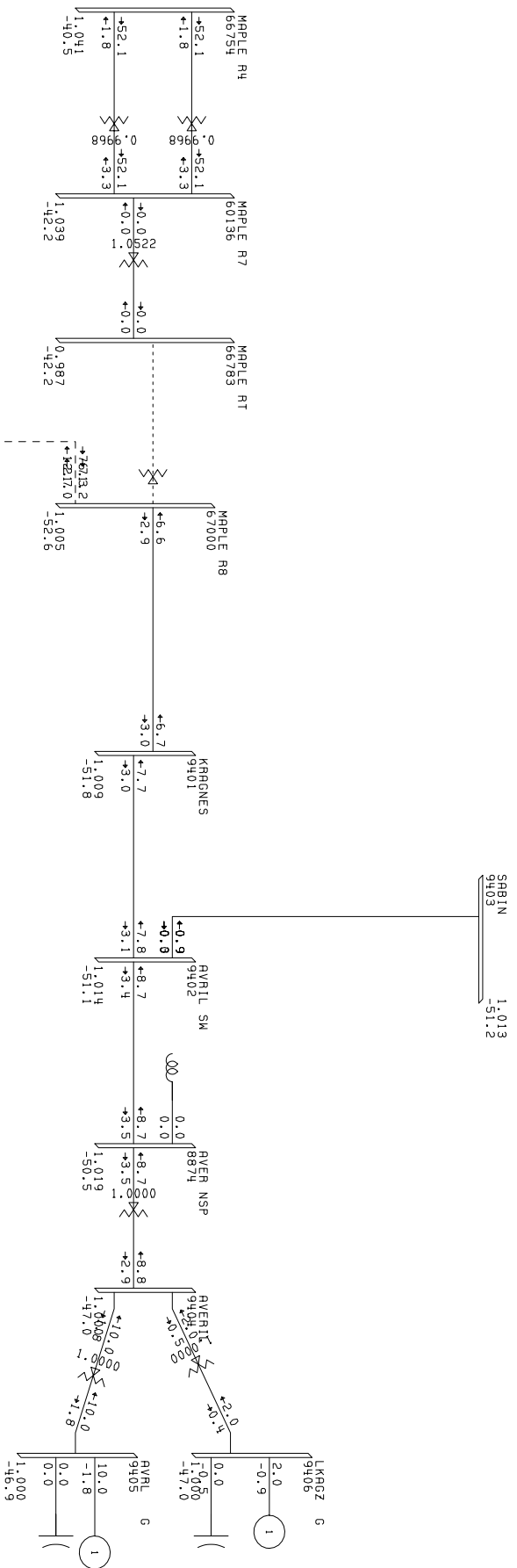
BUS - VOLTAGE (PU) / ANGLE
 BRANCH - MW/MVAR
 EQUIPMENT - MW/MVAR



2007 SERIES, MRD/MBS BASE CASE LIBRARY
 2009 SUMMER PEAK CASE, JULY 6, FINNL
 G692: SYSTEM INTACT, MED, FEB 06 2008 22:36

100% RAIER
 0.950UV 1.050UV

BUS - VOLTAGE (PU) / ANGLE
 BRANCH - MW/MVAR
 EQUIPMENT - MW/MVAR



2007 SERIES, MRD/MBS BASE CASE LIBRARY
 2009 SUMMER PEAK CASE, JULY 6, FINNL
 G692: LOSS OF MAPLE RIVER TR, MED, FEB 06 2008 22:46

100% FAIRER
 0.950 UV 1.050 OV

BUS - VOLTAGE (PU) / ANGLE
 BRANCH - MW/MVAR
 EQUIPMENT - MW/MVAR