



A Transmission Island Sustained by a Distribution Solar Farm

Documented Field Experience of an Unintended DER Island
Ontario, Canada

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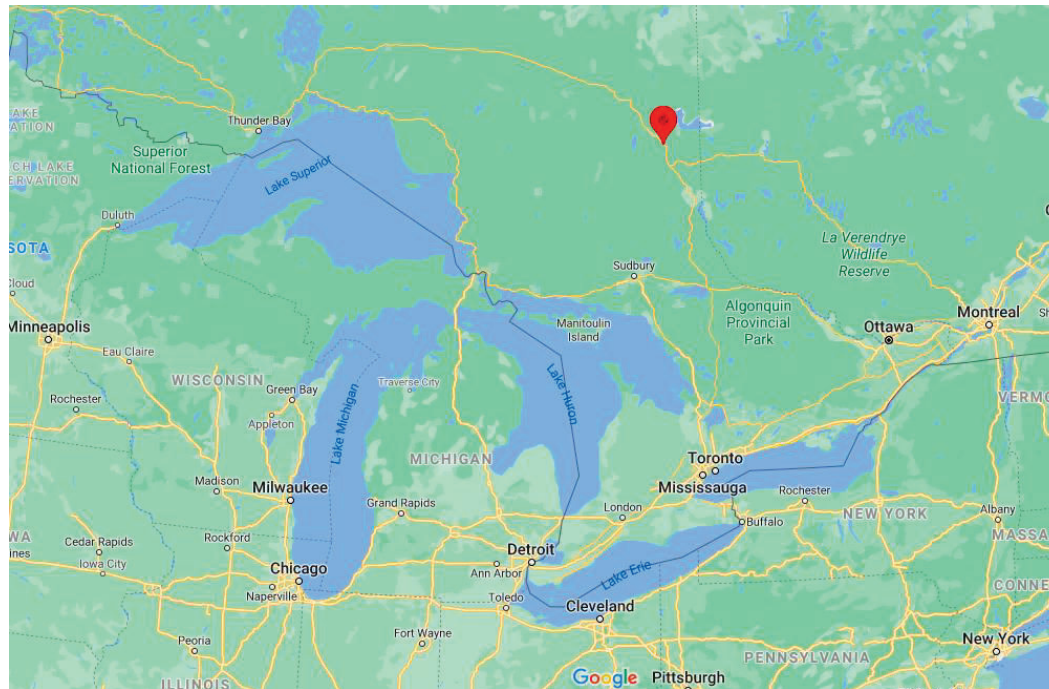
Scope of this presentation

- Lay of the land
- Accidental substation island
- 8-min island scenario/analysis
- Order of actions
- Telemetry
- Results
- Conclusion



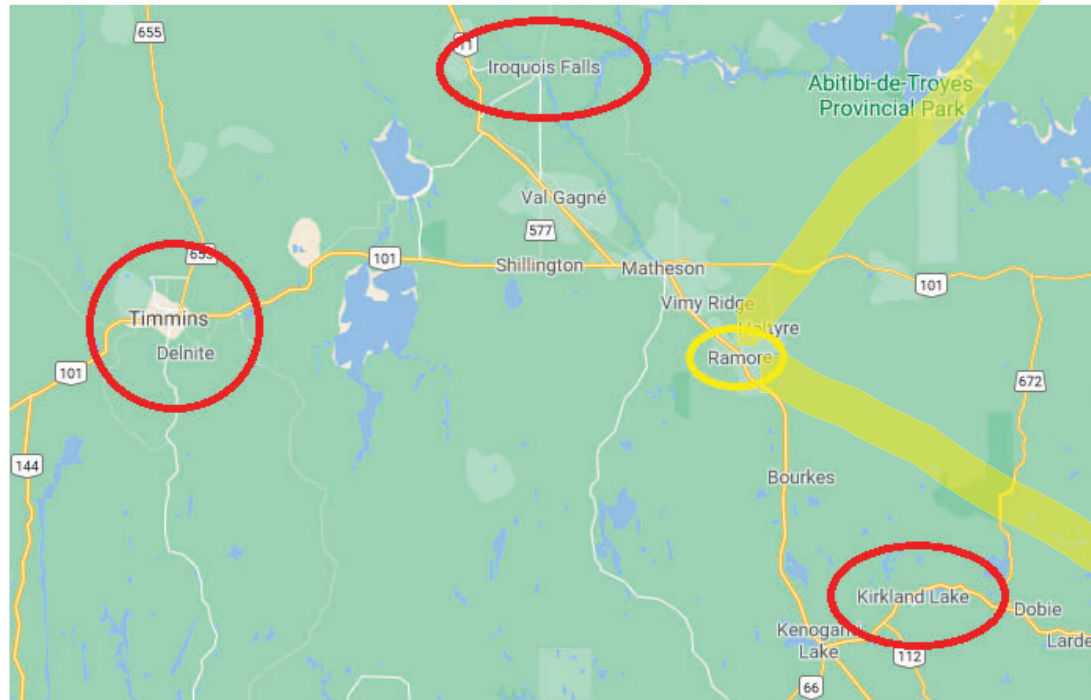
Ramore, Ontario

- Located approx. 600km (375mi) north of Toronto in the small hamlet of Ramore
- Boreal Forest- mining and forestry primary industries



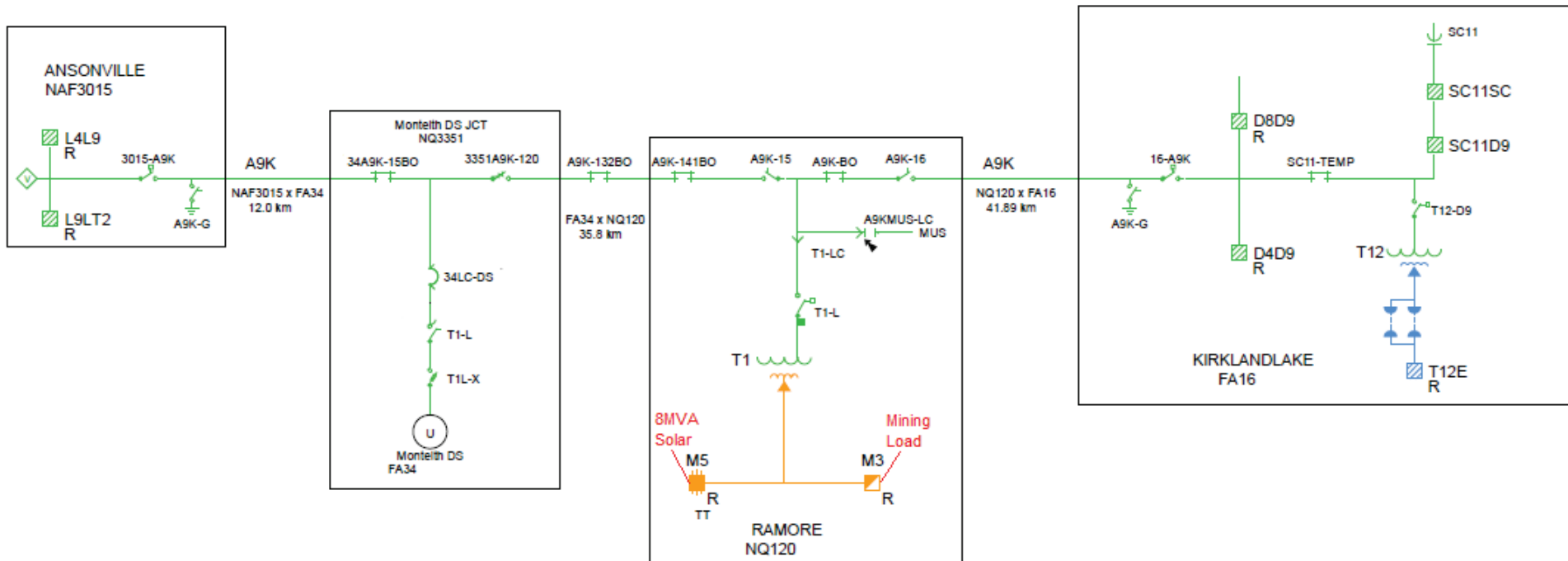
8 MW Solar Plant at Ramore

- Kirkland Lake: Pop. 8,000- 55km away
- Iroquois Falls (Ansonville): Pop. 4,500- 50km away
- Timmins: Pop. 40,000- 90km away

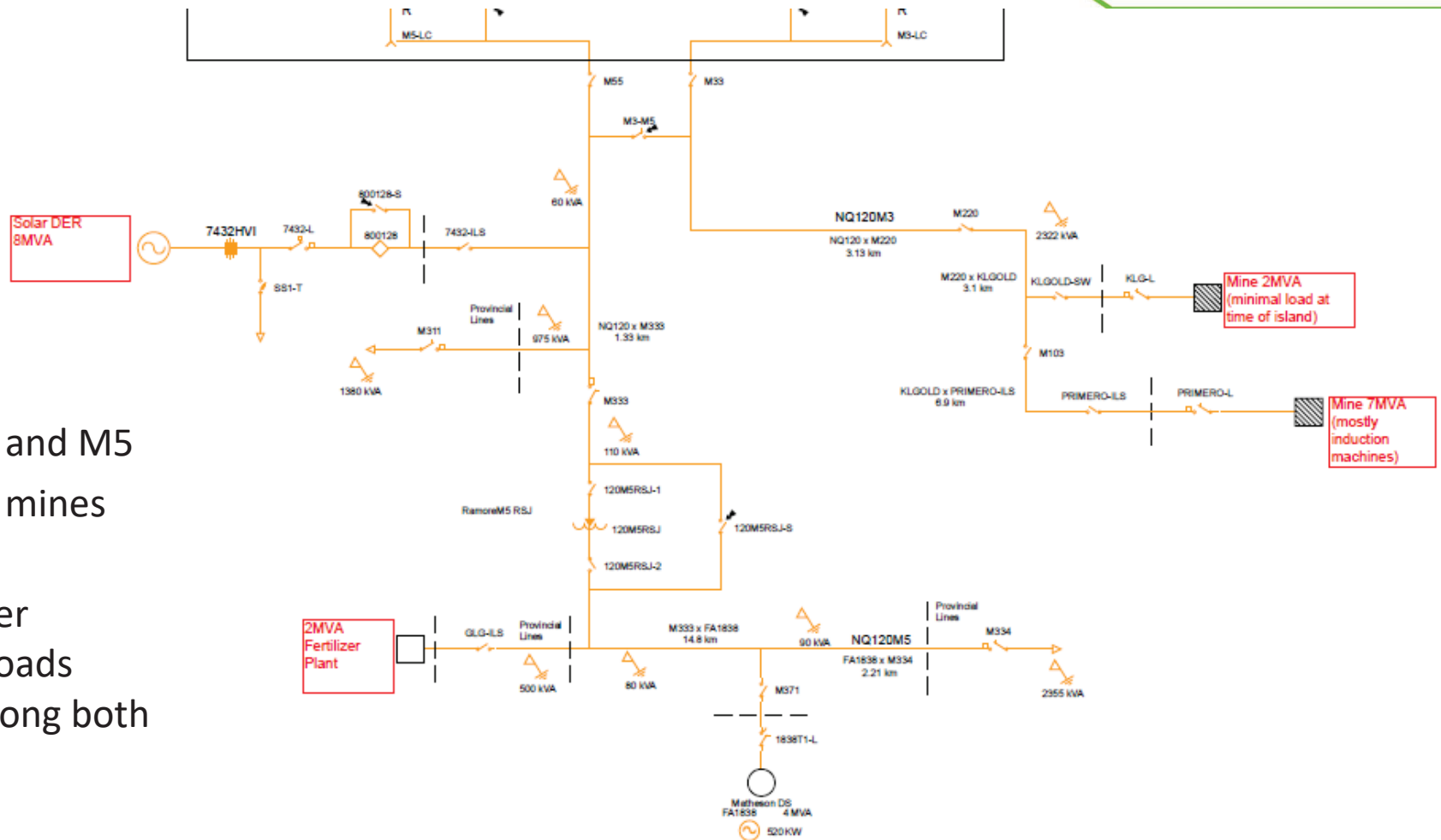


Transmission Circuit Overview (115kV)

- Circuit A9K is a ~90km 2-ended between Ansonville and Kirkland Lake Substations
- In between, the Ramore Trans Sub serves a 27kV distribution feeder with primarily mining load and PV generation.



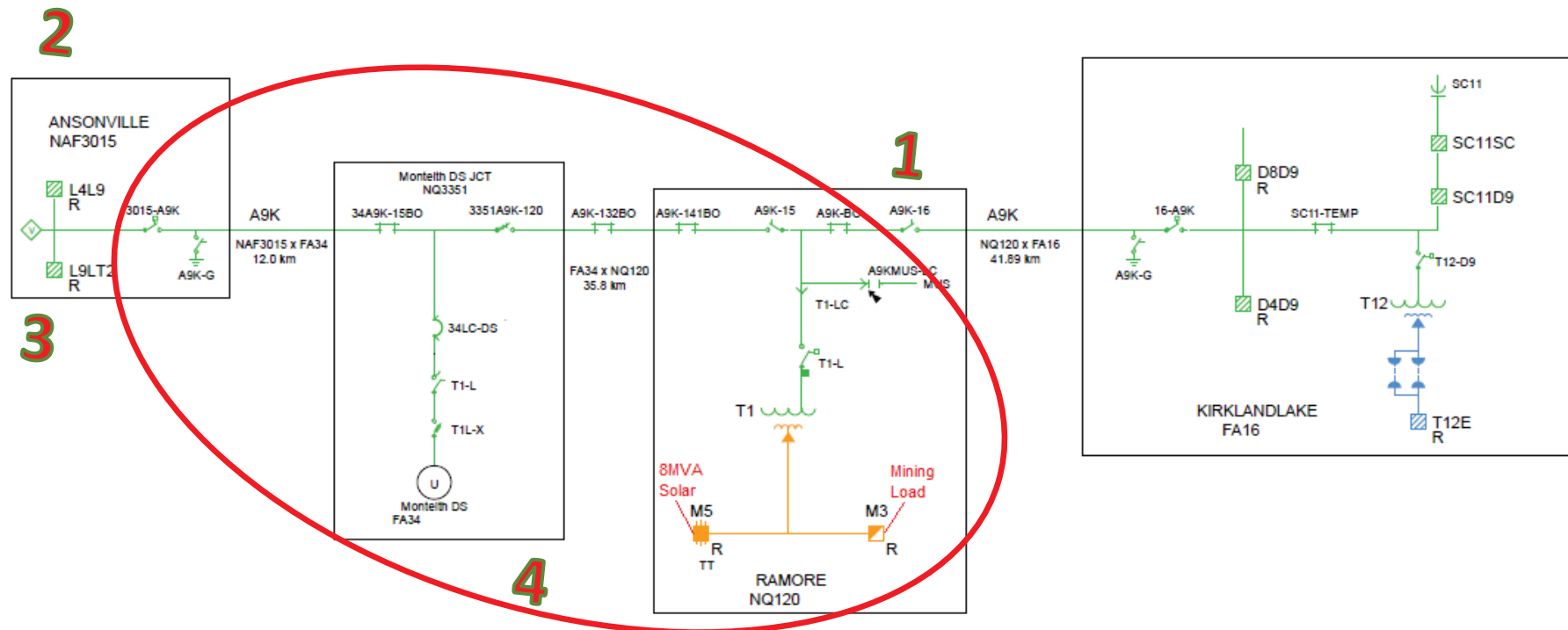
Ramore Substation 27kV feeders



- Feeders M3 and M5
- M3 has two mines
~7MVA
- Other smaller residential loads dispersed along both feeders

Island Scenario and Timing

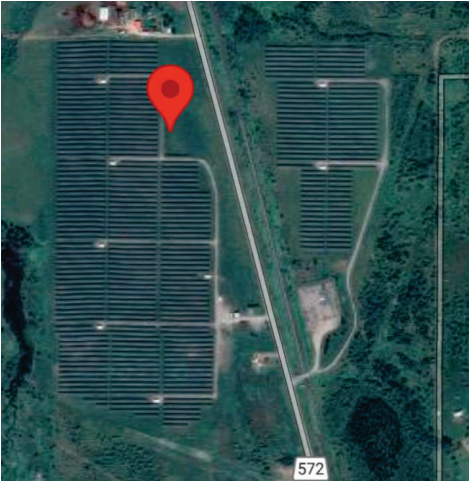
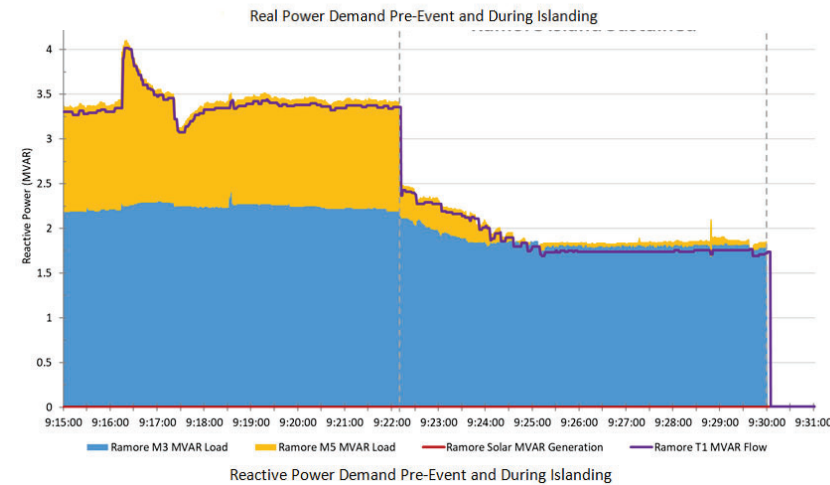
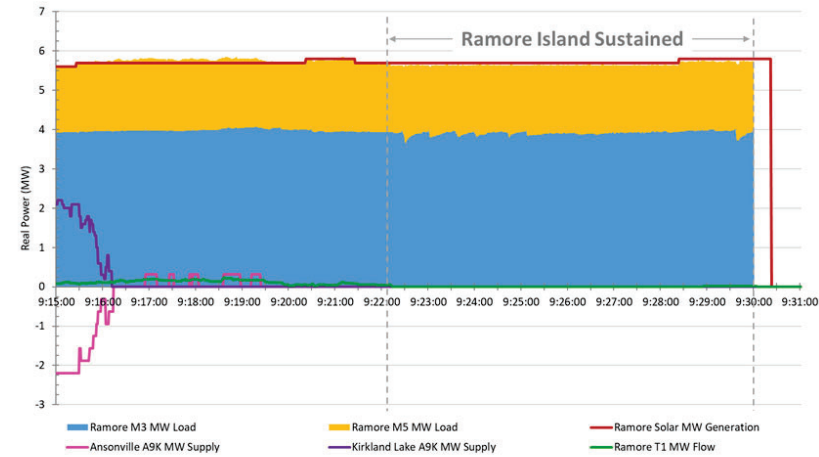
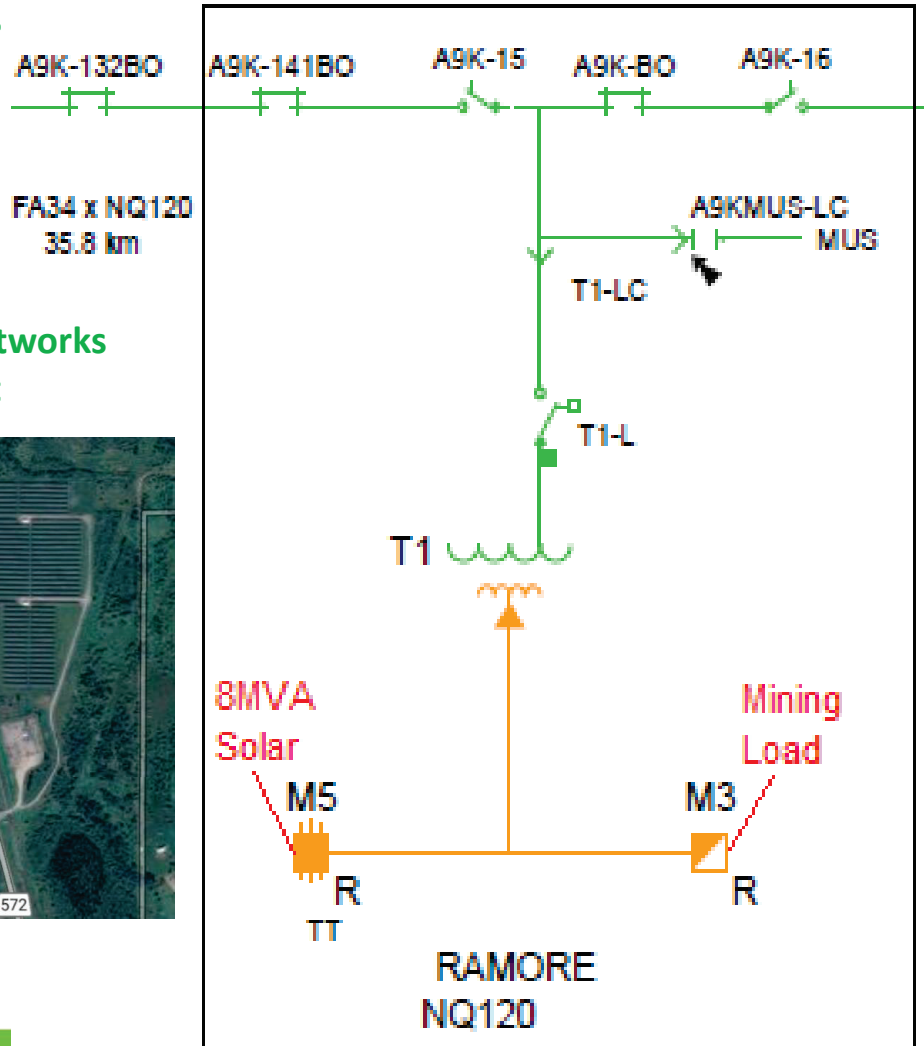
1. At ~9:17 work the crew manually opened A9K-16 instead of A9K 15
2. At 09:21, control room operated one of two Ansonville breakers
3. At 09:22, control room opened the second Ansonville breaker as planned
4. Island forms and is undetected by transfer trip logic because A9K-16 was a manual disconnect



Ontario Canada Ramone Sub Sept 12, 2020, 0920 to 0928 EDT



Hydro One Networks
8MW PV Plant



Ontario Grid Control Centre (OGCC) Telemetry Documentation

- From 9:22 until 9:30, Ontario Grid Control Centre (OGCC) SCADA system recorded a VI-n sag at Ramore Sub as low as **14.64kV (0.92pu)**.
- Note the DER terminal voltage would likely be higher than .92 as this is the sending end of the DER island.
- Lowest frequency recorded during the island was **58.4Hz**, though it generally remained above 59.4Hz.
- Solar DER had a 2.0s undervoltage (27) trip setting set to 0.88pu.
- Under frequency (81) settings are listed in the chart below.

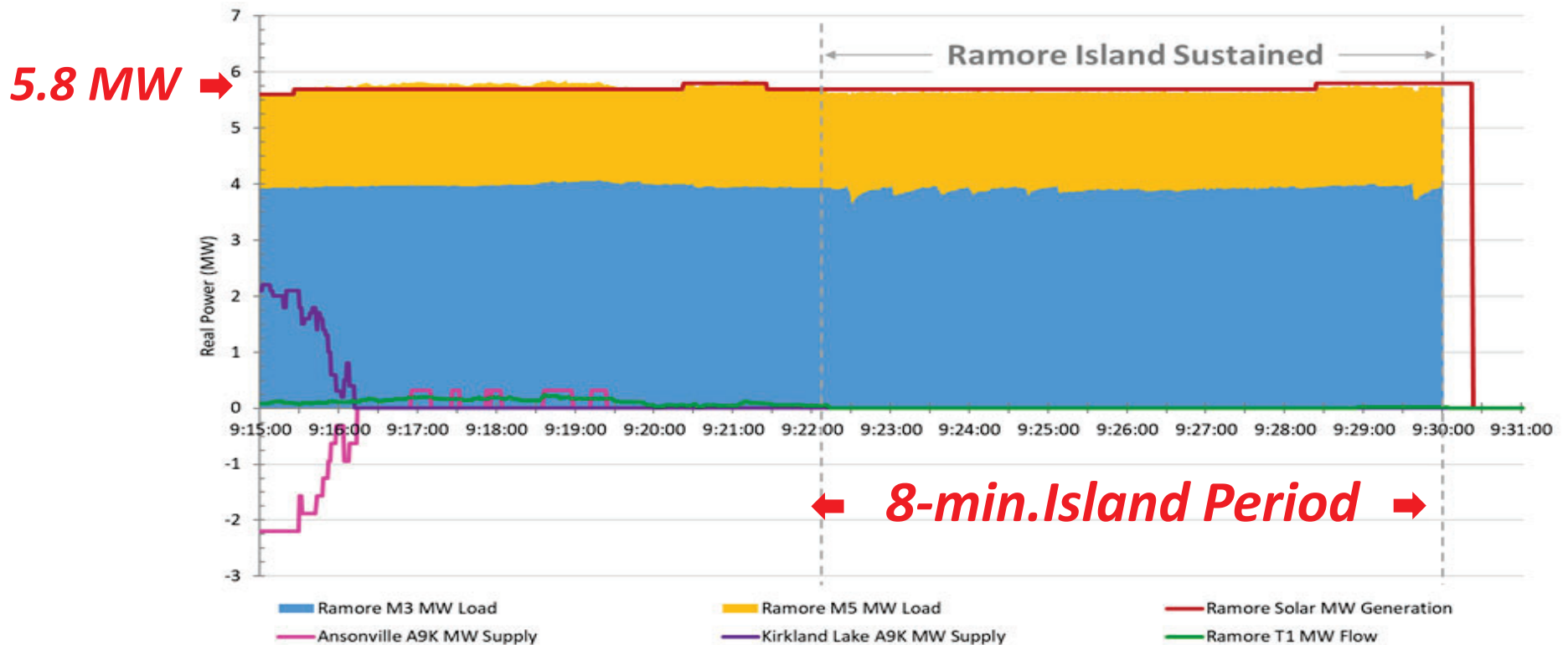


Ramore Telemetry

Under Frequency 81U	
Parameter	Setting
Setting 1	57.0Hz
Time Delay	0.08 sec
Setting 2	58Hz
Time Delay	35 sec
Setting 3	59Hz
Time Delay	300 sec

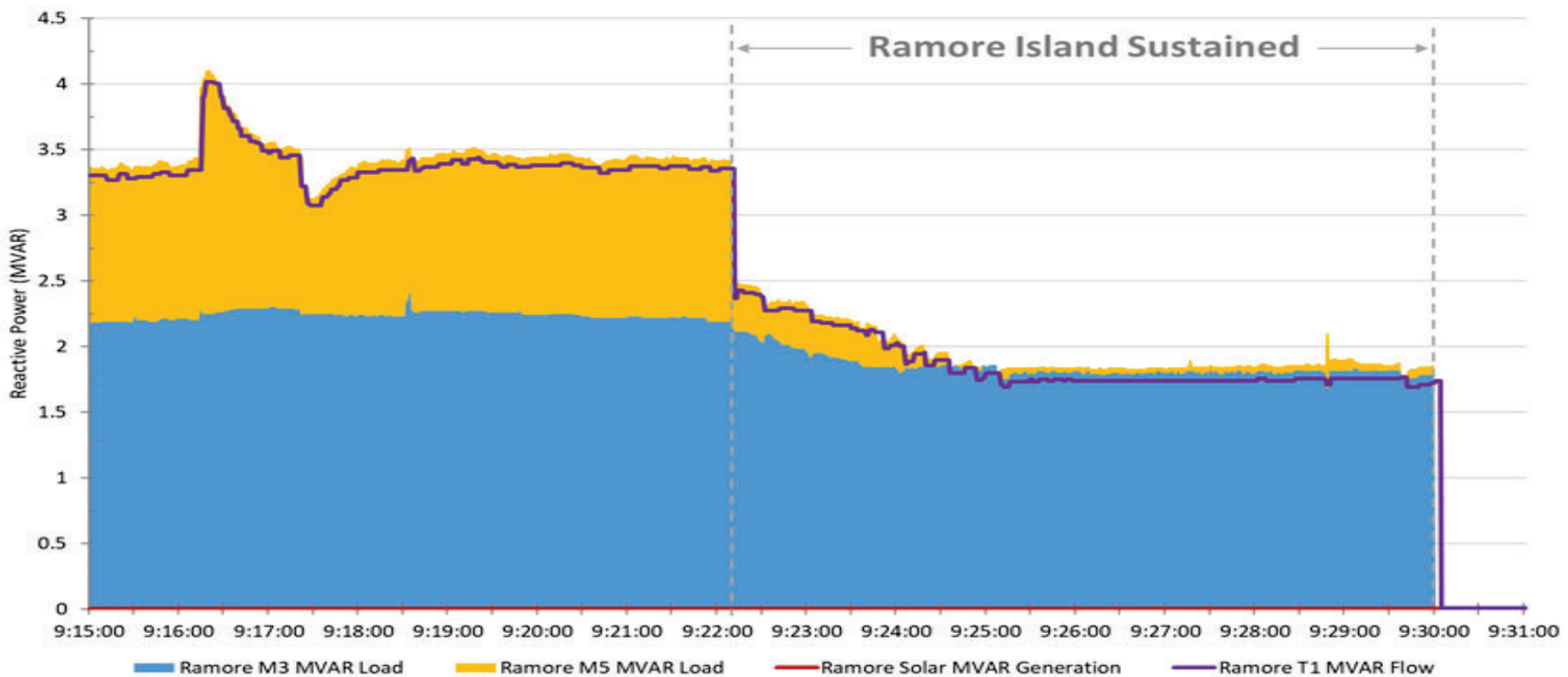
Real Power 6-ways (MW), see legend

- Prior to island, loading from A9K through Ramore T1 was at negligible levels- Solar DER output closely matched M3 + M5 loads (~5.8MW). Remained steady during island.



Reactive Power 4-ways (Mvar)

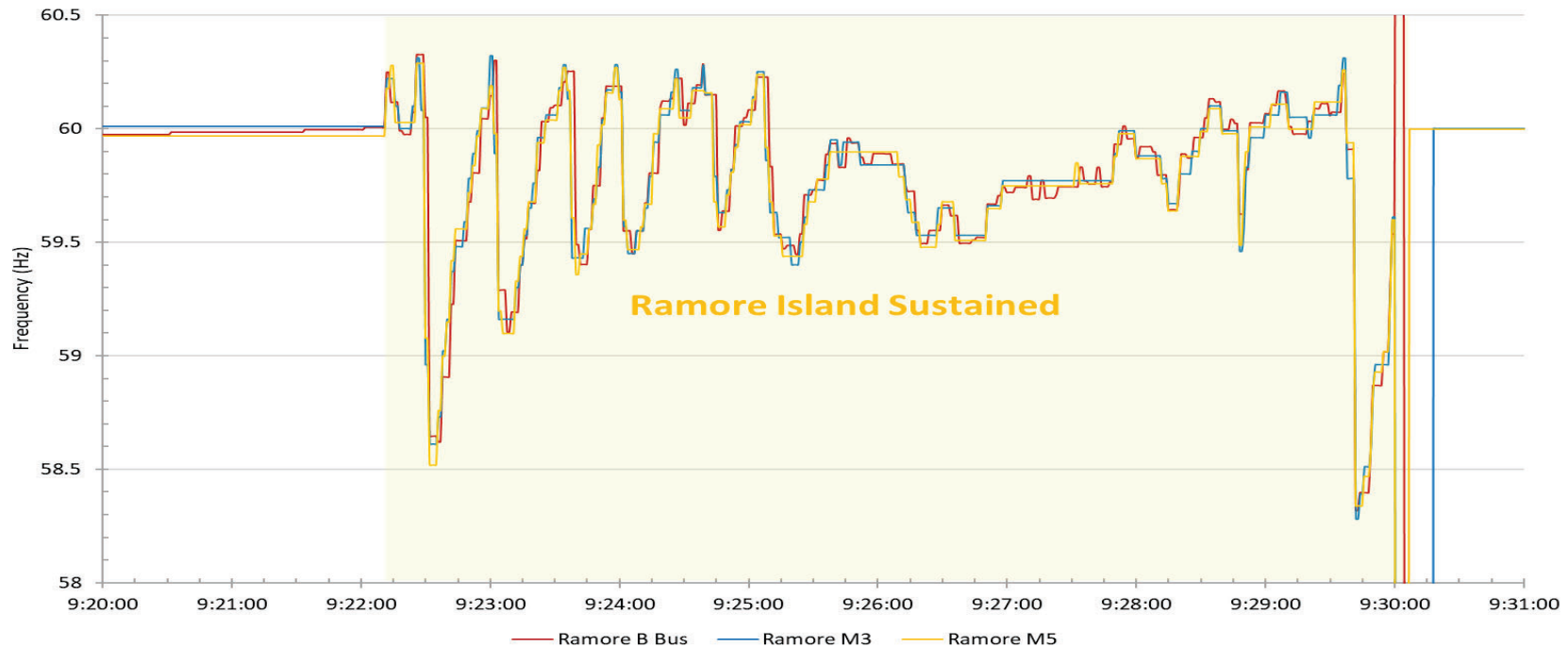
- When island was established, VAR demand from Arsonville dropped by approx. 1Mvar
- Charging admittance from open transmission line to Arsonville (A9K) supplied Mvars post-island



Reactive Power Demand Pre-Event and During Islanding

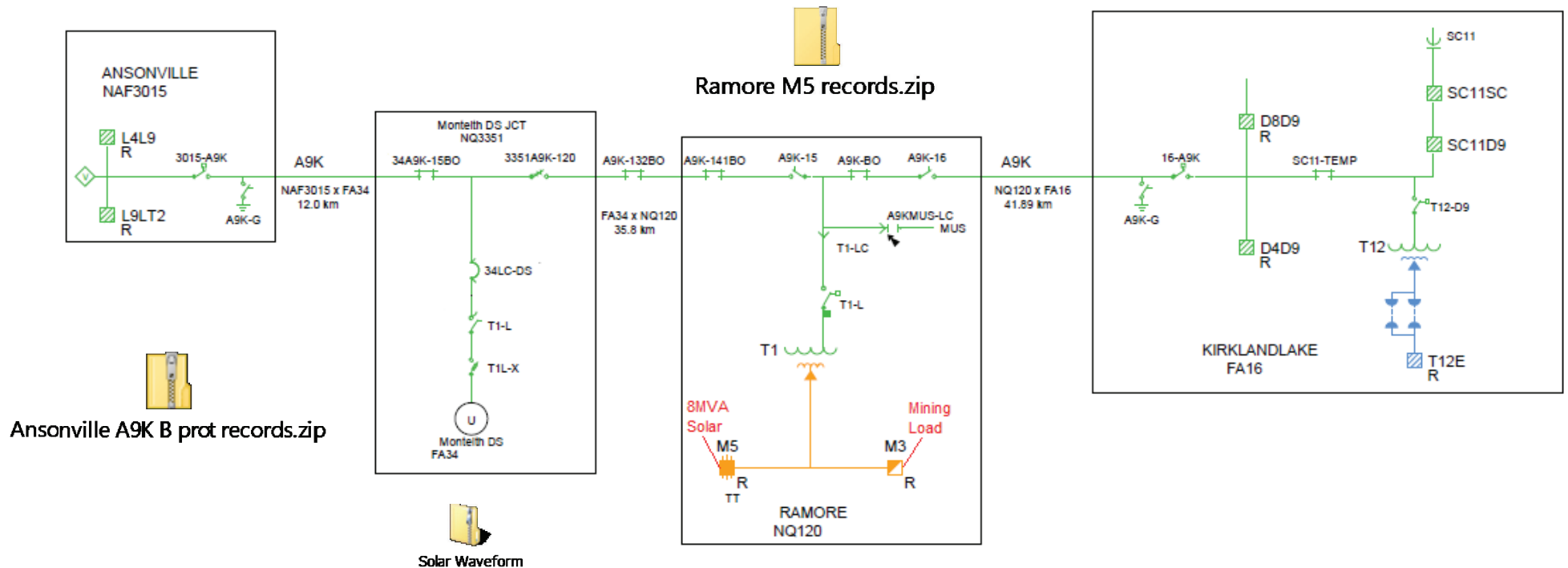
Island Frequency Plots

- During islanded condition, a sawtooth pattern was initially seen in the frequency, followed by a slightly varying pattern between 59.5 and 60.3Hz.
- **Speculations:** oscillations caused by inverter active anti-islanding and damping from induction motor load on M3



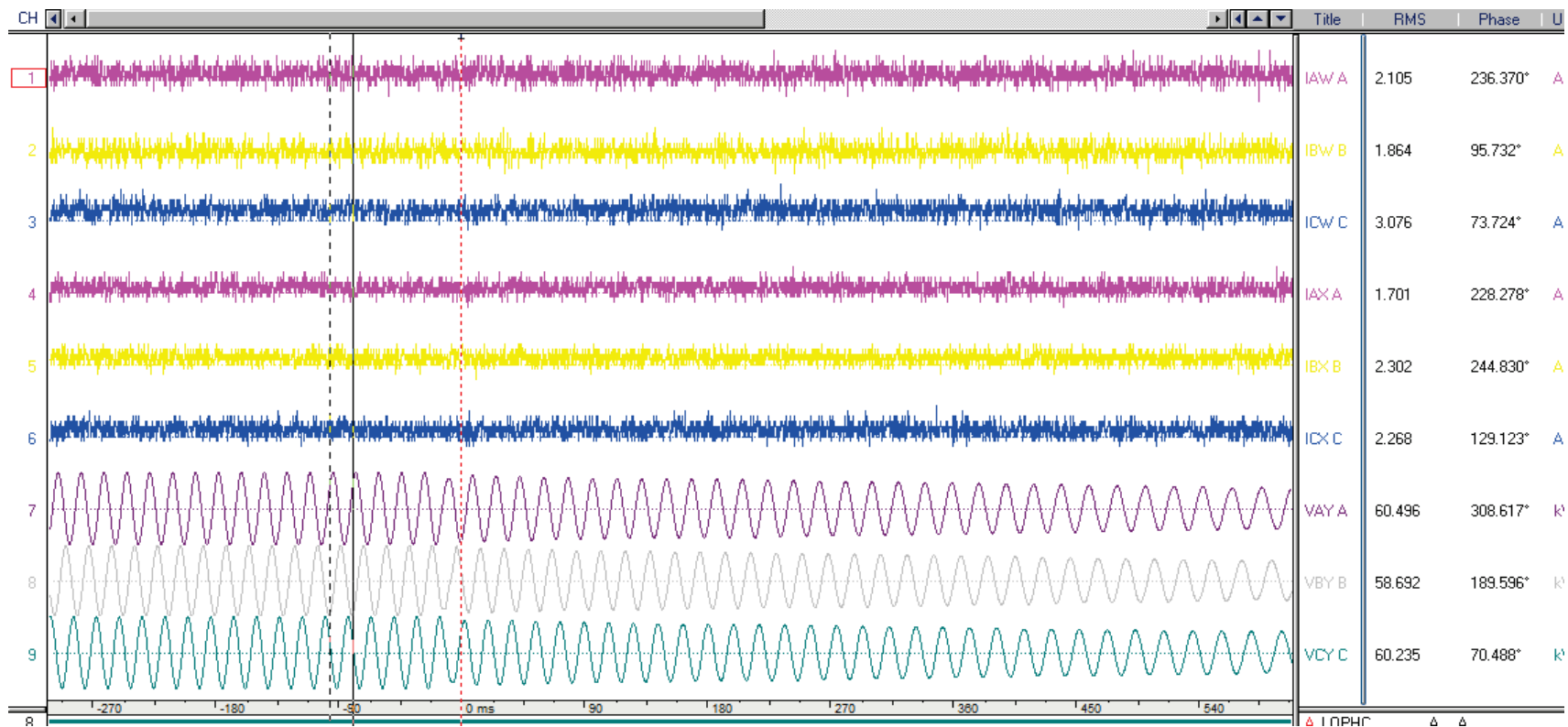
Waveforms Observed

- When the island condition was ended, oscillographies were triggered on the Ramore Line Backup Protection, the Ansonville A9K 'B' Line Protection, and at the Solar DER Site.



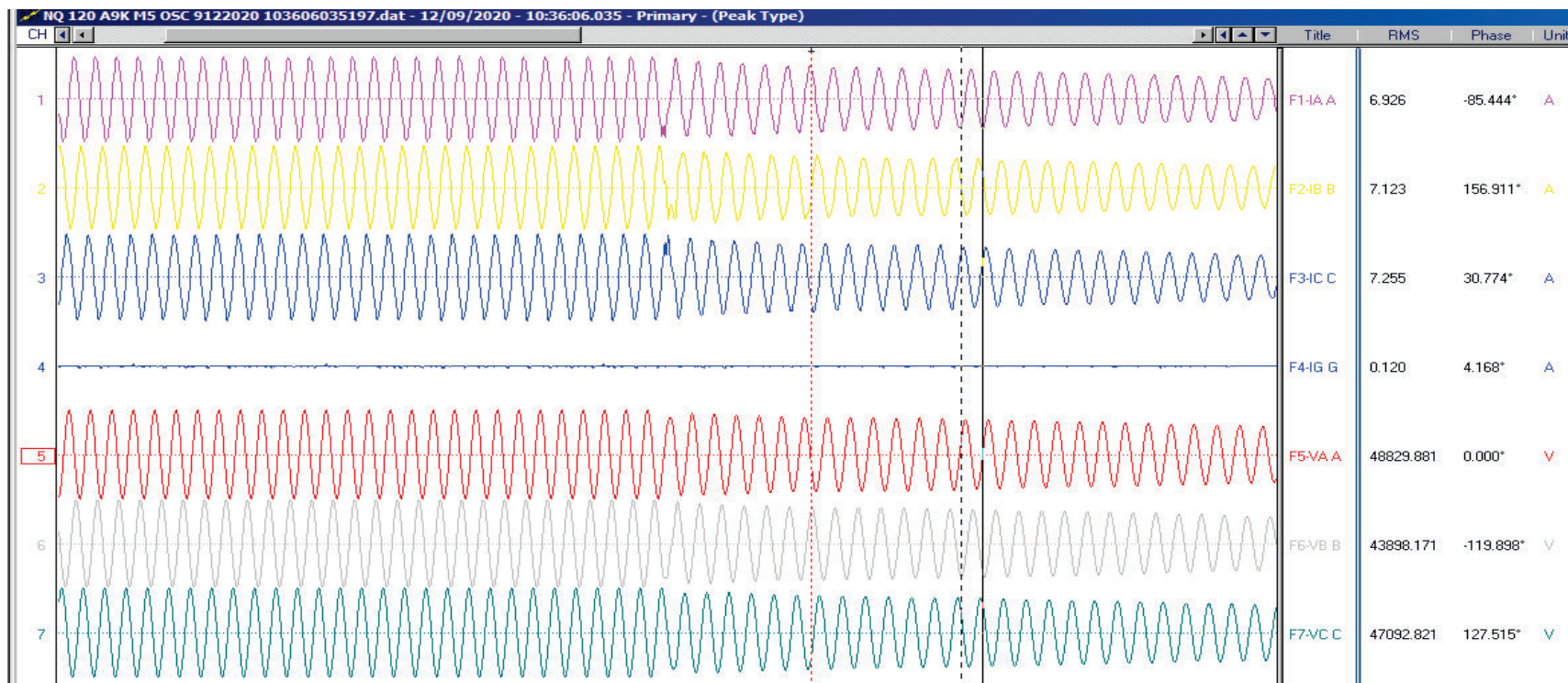
Island Voltage and Current at Arsonville

- Island is tripped off near the red dashed line.
- Voltage dissipates slowly, possibly due to spinning inertia of Ramore M3 mining motor load



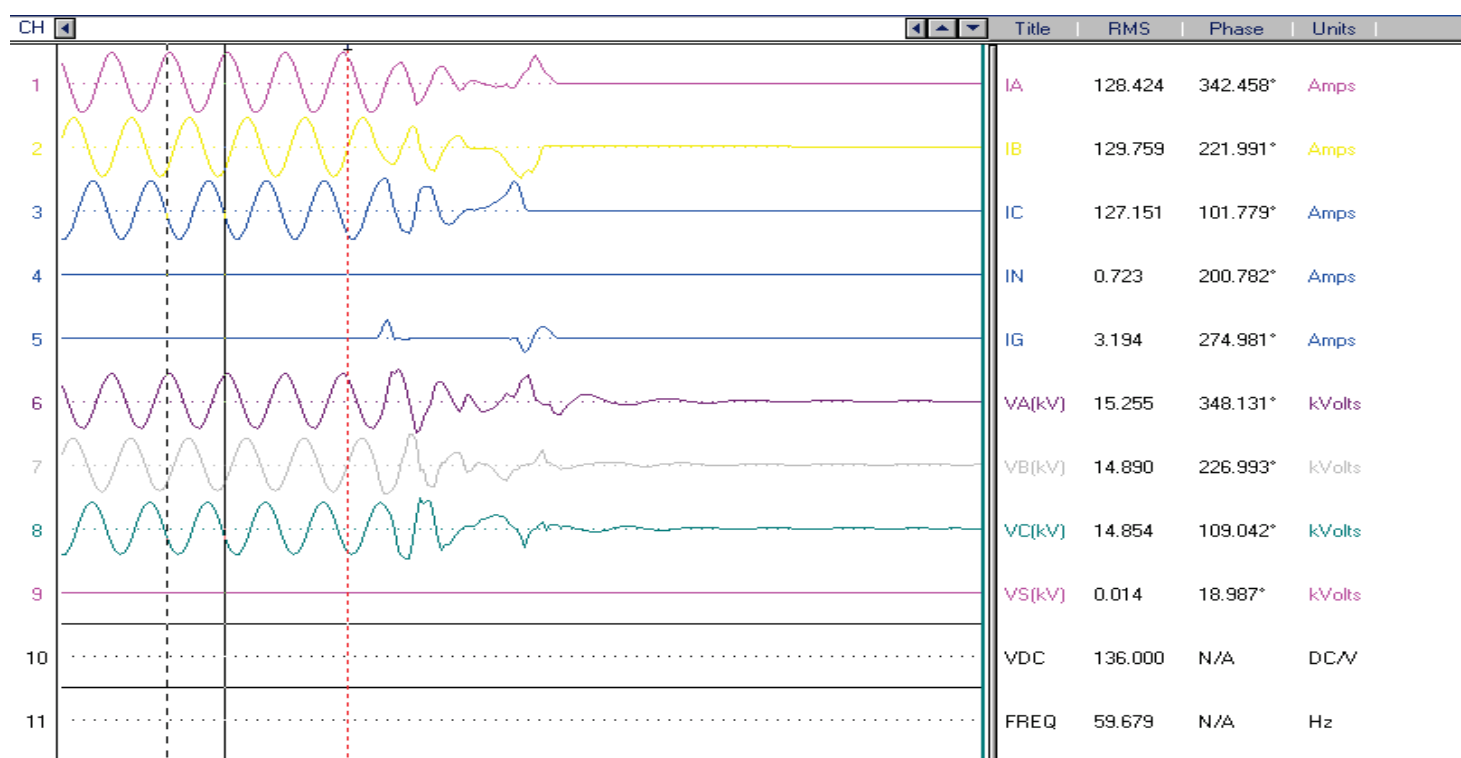
Island Voltage and Current at Ramore

- Voltage dissipates slowly, possibly due to spinning inertia with M3 mining load
- Note motor back emf during rundown after tripping of PV plant



Island Voltage and Current at DER

- Prior to the M5 trip, voltage is ~14.9kV (0.93pu) and frequency is 59.7Hz.
- Island ends when Ramore M5 is opened activating transfer trip.



Conclusions

1. This island condition was caused by an error in switching.
2. Because of the error, there was no automatic Transfer Trip initiated to the 8MVA Solar DER.
3. Voltage and frequency at the inverter and the intertie protection location did not reach the trip threshold.
4. On-board active islanding detection at the PV site may have been hampered by the motor load and transmission line var sourcing.
5. For the 8-minute duration of the island, the DER active anti-islanding algorithms did not detect the system was disconnected from the grid.



Q&A

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