REAL TIME GIC SIMULATOR

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OUTLINE

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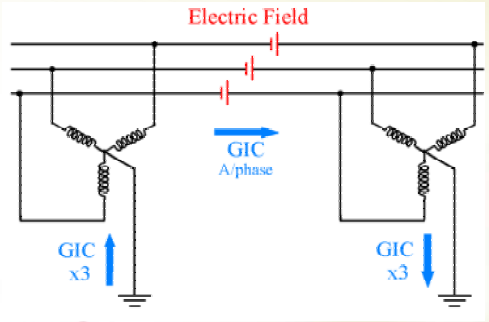
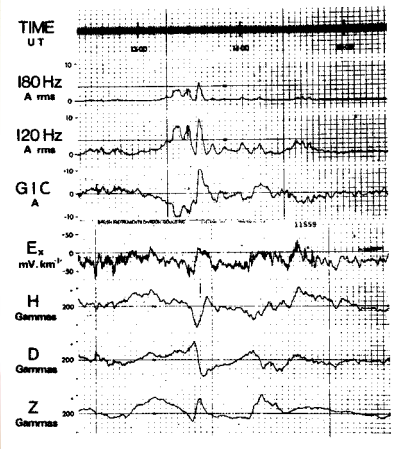
5. GIC Monitoring
6. Real-time GIC Simulation
7. Data Assimilation
8. Forecasting
9. Conclusions

POWER NETWORK IN ONTARIO

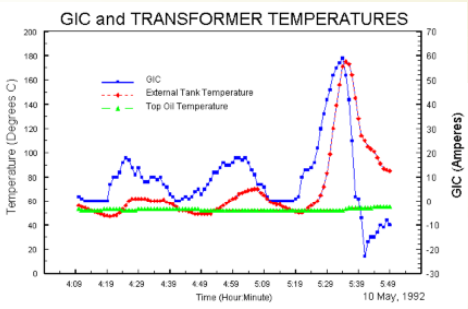
Production of GIC



Effects on Power System



GIC Effects on Transformers



Effects of March 1989 Storm On Ontario Hydro System

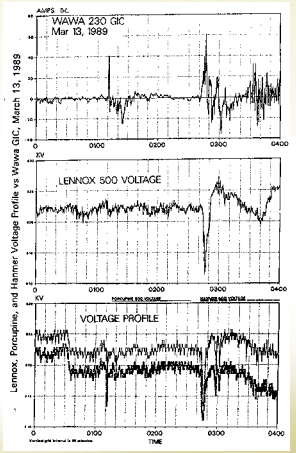
•Harmon GS: A 68 MVA, 13.8 kV hydro unit: removed from service by negative sequence relay.

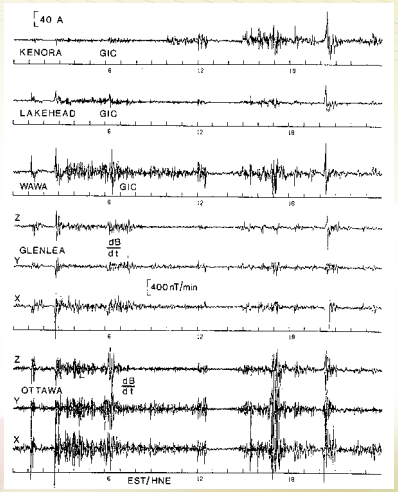
• At Bruce B nuclear generating station: Negative sequence overcurrent alarms for 2 minutes, on four 960 MVA 24 kV nuclear generating units.

• In Belleville, Two 44 kV 32 MVAr shunt capacitors tripped by unfiltered neutral overcurrent relays

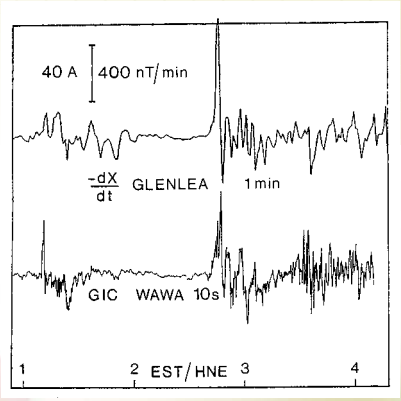
• Voltage dips coincide with increased GIC

March 1989 Recordings on Ontario Hydro System

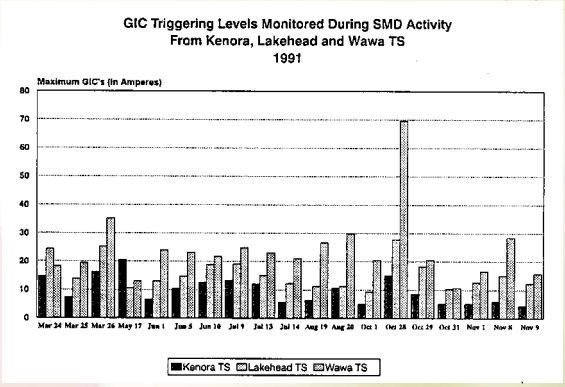




Relation between GIC and dB/dt



GIC DURING STORMS IN 1991



ADVERSE EFFECTS OF GIC

System Disturbances

The saturation of transformers results in the generation of harmonic currents. Major power equipment can be tripped due to susceptibility to dc and harmonic signals of protective relays

A possible scenario: simultaneous loss of key generation or transmission facilities, or the tripping of transformers in pivotal transformer stations can lead to system disturbances or blackouts

Equipment Damage

Overheating of large generator units and transformers and capacitor banks to a lesser degree due to excessive harmonic currents can result in costly damage and loss of production.

GIC MONITORING SITES

GIC SIMULATION

- Real-time Magnetic Observatory Data
- Calculate Electric Fields
- Model GIC in Power System
  - Continually Update System Model
  - Display in System Control Centre

DATA ASSIMILATION

- GIC Monitoring
- GIC Model Results

GIC FORECASTING

- Advantage: Advance Warning
- Disadvantage: Loss of Accuracy

CONCLUSIONS (1)

•Geomagnetic disturbances drive GIC in power systems

• Cause transformer saturation leading to increased VAR demand, high harmonic levels possibly causing relay misoperation, voltage dips and system stability problems.

• Major geomagnetic storms in the past have produced significant GIC on the Ontario power system and effects ranging from relay trips to voltage dips.

•To be prepared for future geomagnetic disturbances, the Hydro One system operators need information on the GIC levels in the power system.

CONCLUSIONS (2)

• GIC information will be provided by a combination of monitoring at selected sites and a real-time model of GIC in the power system driven by magnetic field observations.

• Initially monitoring and modelling routines to be separate.

• Optimum results should be obtained by a data assimilation approach to combine the GIC data with the modelling.

• Modelling components can be used in the future with forecasts of magnetic disturbances to provide GIC forecasts.