Geomagnetic Disturbances

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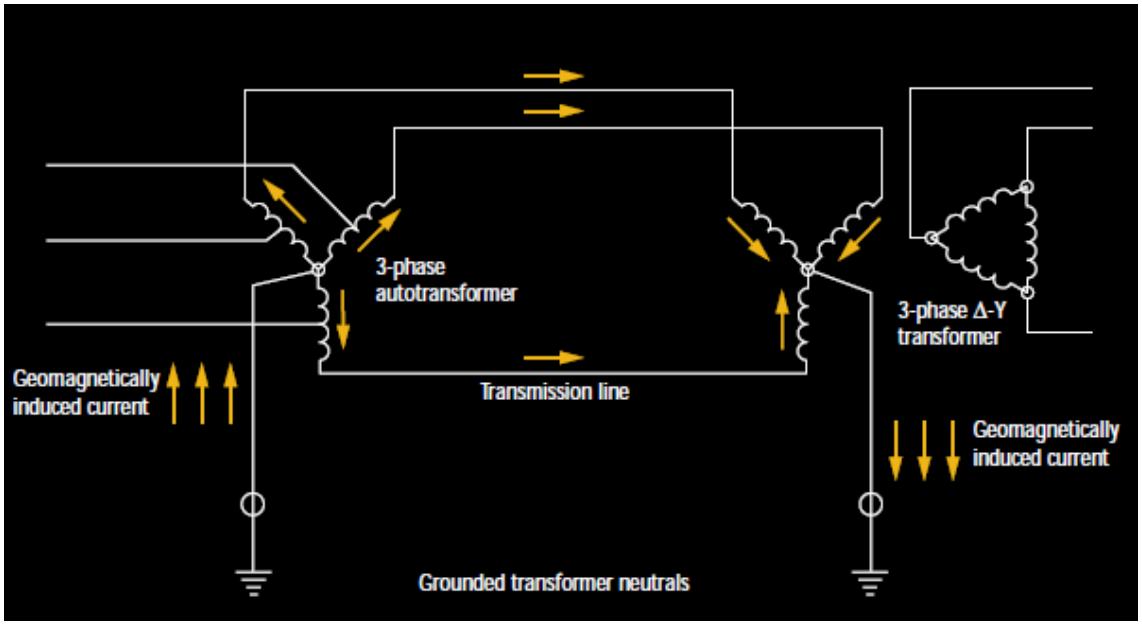
Agenda

- Background
- Past Events
- Operating Procedures
- Engineering Response
- Summary

Con Edison Delivers Energy to New York City and Westchester

- 3.3 million electric customers
- 1.1 million gas customers
- 1,740 steam customers
- 700 MW of regulated generation
- 36,781 miles of overhead transmission and distribution lines
- 96,324 miles of underground transmission and distribution lines
- 4,411 miles of gas mains
- 105 miles of steam mains and lines

GIC Impacts



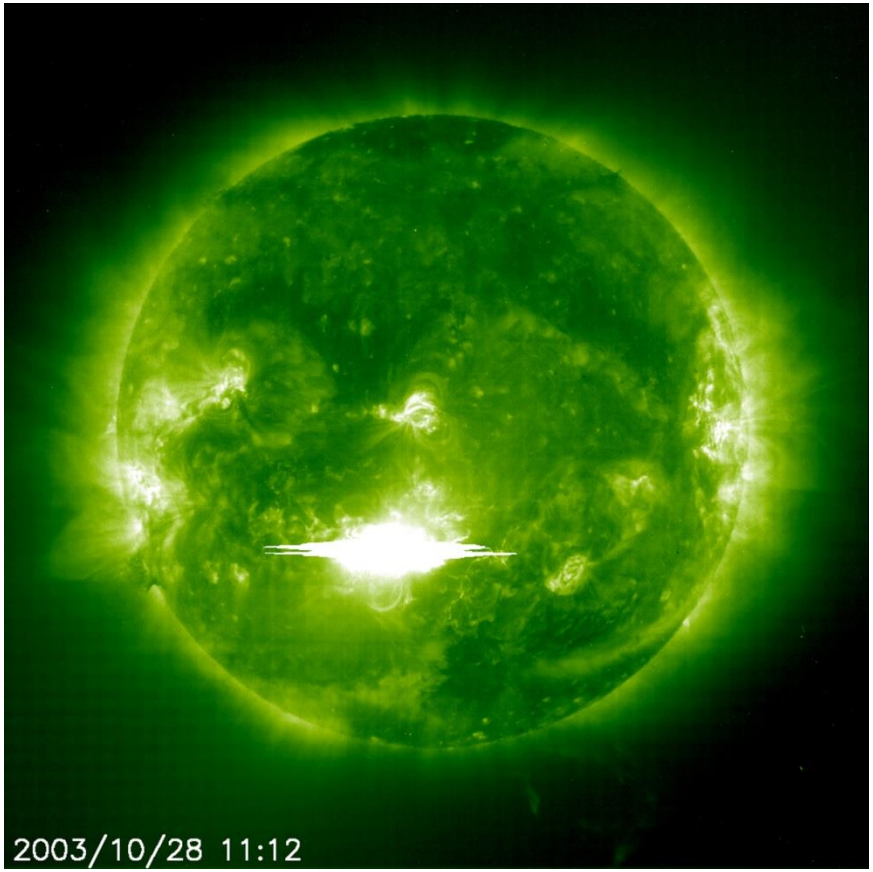
- Depressed System Voltages
- Harmonics
- Transformer Failure

Past Events

- March 13, 1989 – Hydro Quebec Blackout
  - Seven SVC's tripped
  - Five 735 kV lines tripped
  - Reduced System Voltage and Frequency
  - System Collapsed
- March 13, 1989 – NYPP Reported Impacts
  - Generator tripped offline
  - Voltage decline reported at some substations

Past Events

- 2003 Halloween Storm
  - More Intense Utility Response
  - No blackouts in North America



Operator Actions:
GMD Warning Notification System

- NYISO
  - Notifies Con Edison of GMD Alerts
- Solar Terrestrial Dispatch
  - Provides Warnings/Alerts (Primary)
- NOAA Space Weather Prediction Center
  - Provides Warnings/Alerts (Back up)

Operator Actions

- **K7 or Higher storm is forecast**
  - Discontinue 345kV & Capacitor Bank outages where possible
  - Monitor GMD displays/sites
  - Monitor Reactive Displays
  - Notify generators
  - Coordinate with the NYISO
- **Real time Alert >= K7 & GIC observed**
  - Maintain System Voltages
  - Reduce Power Flows were possible
- **Real time K9 Alert**
  - Thunderstorm Warning

Thunder Storm Warning

Design & Assessment Actions:

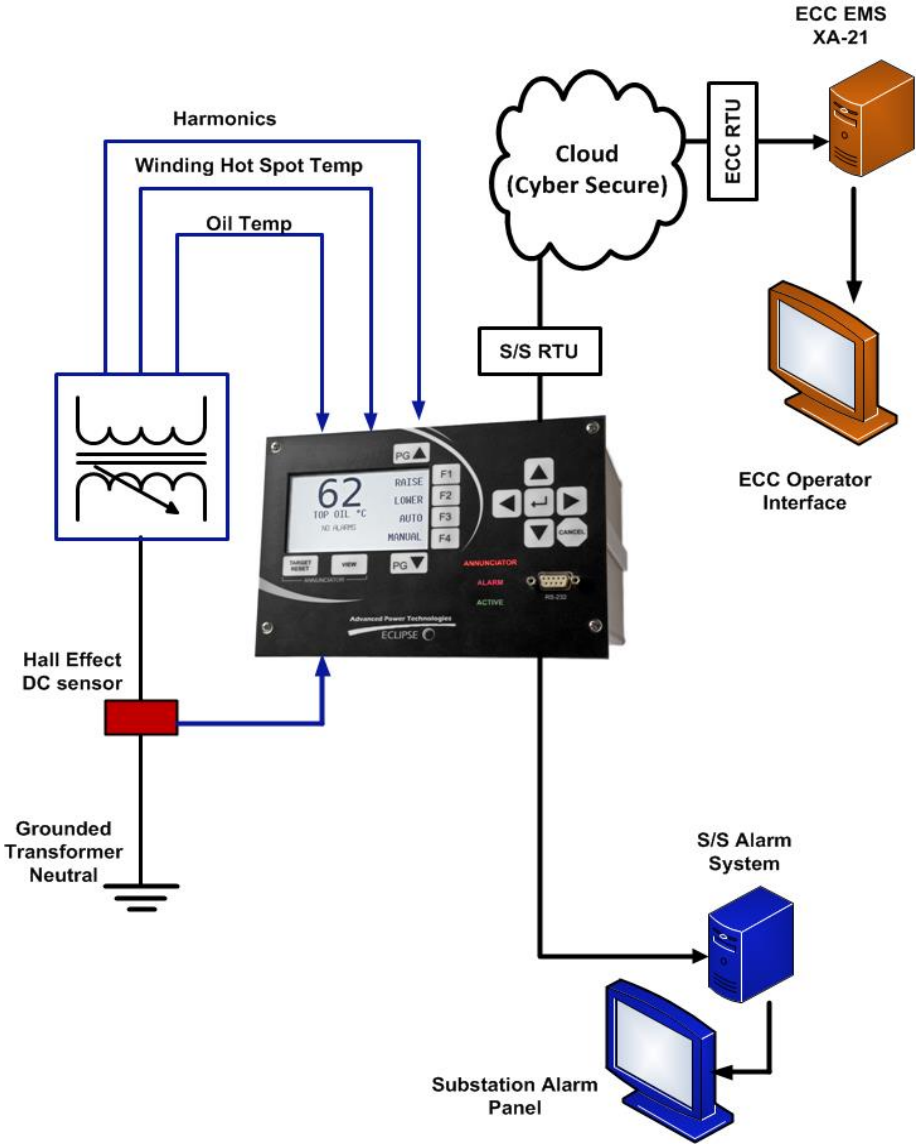
- Modeling and Simulation
  - Simulate the effects of GIC on the power system
- Review Relaying
  - Verify that the protective relaying on capacitors banks are adjusted for harmonics
- Inventory Assessment
  - Identify high voltage transformers that could be damaged from high levels of GIC
- Design Information
  - Install monitoring devices on GIC-vulnerable equipment

GIC Monitored Transformers

	Manufacturer	Core Design	Station Soil Type	GIC Relative Ranking(GIC) (Worst = 1)	Relative Ranking Transformer Health Index(Worst = 1)
1	Westinghouse,	Shell Form	Natural sand and Silt over rock	1	**(70) 7**
2	Allis-Chalmers,	Shell Form	Rock Site	2	**(55) 3**
3	Allis-Chalmers,	Shell Form	Rock Site	2	**(49) 1**
4	Allis-Chalmers,	Shell Form	Natural sand site	3	**(67) 6**
5	Westinghouse,	Shell Form	Natural sand site	3	**(71) 8**
6	Westinghouse,	Shell Form	Rock Site	4	**(63) 5**
7	Allis-Chalmers,	Shell Form	Rock Site	4	**(52) 2**
8	Allis-Chalmers	Shell Form	Gravel and brick fill over natural sand	5	**(96) 10**
9	Allis-Chalmers,	Shell Form	Fill and sand over rock	6	**(89) 9**
10	Allis-Chalmers,	Shell Form	Gravel and brick fill over natural sand	5	**(74) 8**
11	Allis-Chalmers	Shell Form	Gravel and brick fill over natural sand	5	**(61) 4**
12	Westinghouse,	Shell Form	Rock Site	Not modeled in GIC study	**(71) 8**

Goethals- soil condition similar to Fresh Kills -Relative ranking of Goethals is 1 considering GIC,although Goethals is not a vulnerable

Comprehensive GIC Monitoring System



GEO-MAGNETIC DISTURBANCE DISPLAY

LOCATION	NEUTRAL CURRENT	TEMPERATURE	HARMONICS	ALARMS		
				Minor	Major	Critical
Transformer 1	2.02 A	2.01 DEG C	NORMAL	NORMAL	NORMAL	NORMAL
Transformer 2	-1.20 A	2.01 DEG C	NORMAL	NORMAL	NORMAL	NORMAL
Transformer 3	-2.04 A	2.01 DEG C	NORMAL	NORMAL	NORMAL	NORMAL
Transformer 4	-3.30 A	2.01 DEG C	NORMAL	NORMAL	NORMAL	NORMAL
Transformer 5	2.02 A	2.01 DEG C	NORMAL	NORMAL	NORMAL	NORMAL
Transformer 6	-1.70 A	2.01 DEG C	NORMAL	NORMAL	NORMAL	NORMAL
Transformer 7	2.02 A	2.01 DEG C	NORMAL	NORMAL	NORMAL	NORMAL
Transformer 8	20 A	98.99 DEG C	NORMAL	ALARM UP	NORMAL	NORMAL
Transformer 9	1.32 A	2.01 DEG C	NORMAL	NORMAL	NORMAL	NORMAL
Transformer 10	-3.43 A	2.01 DEG C	NORMAL	NORMAL	NORMAL	NORMAL
Transformer 11	2.88 A	2.01 DEG C	NORMAL	NORMAL	NORMAL	NORMAL
Transformer 12	-3.00 A	2.01 DEG C	NORMAL	NORMAL	NORMAL	NORMAL
Transformer 13	2.04 A	2.01 DEG C	NORMAL	NORMAL	NORMAL	NORMAL
Transformer 14	-3.10 A	2.01 DEG C	NORMAL	NORMAL	NORMAL	NORMAL
Transformer 15	1.45 A	2.01 DEG C	NORMAL	NORMAL	NORMAL	NORMAL

Summary of Actions

Actions Completed

- Participate in EPRI Sunburst & NERC GMDTF
- Finalized NYS GIC Study.
- Equipment Assessment
- Developed GMD display
- Installed Comprehensive GIC monitoring at 7 locations.

Actions in Progress.

- Comprehensive monitoring device planned for remaining vulnerable transformers.
- Evaluate neutral blocking devices- re-test and evaluation.
- Develop in house GIC study capability.