Geomagnetic Disturbances

Zahid Qayyum
April 16, 2013
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

2003/10/28 11:12
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 (Backup)
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

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

Goethals- soil condition similar to Fresh Kills - Relative ranking of Goethals is 1 considering GIC, although Goethals is not a vulnerable transformer.
Comprehensive GIC Monitoring System
## GEO-MAGNETIC DISTURBANCE DISPLAY

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>NEUTRAL CURRENT</th>
<th>TEMPERATURE</th>
<th>HARMONICS</th>
<th>ALARMS</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Minor</td>
<td>Major</td>
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<tr>
<td>Transformer 1</td>
<td>2.02 A</td>
<td>2.01 DEG C</td>
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<td>NORMAL</td>
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<tr>
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<td>2.01 DEG C</td>
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<td>NORMAL</td>
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<td>2.01 DEG C</td>
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<td>NORMAL</td>
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<td>Transformer 6</td>
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<td>2.01 DEG C</td>
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<tr>
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<td>2.01 DEG C</td>
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<tr>
<td>Transformer 8</td>
<td>20 A</td>
<td>98.99 DEG C</td>
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<td>ALARM UP</td>
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<tr>
<td>Transformer 9</td>
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<td>2.01 DEG C</td>
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<td>NORMAL</td>
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<tr>
<td>Transformer 12</td>
<td>-3.00 A</td>
<td>2.01 DEG C</td>
<td>NORMAL</td>
<td>NORMAL</td>
</tr>
<tr>
<td>Transformer 13</td>
<td>2.04 A</td>
<td>2.01 DEG C</td>
<td>NORMAL</td>
<td>NORMAL</td>
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<tr>
<td>Transformer 14</td>
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<td>2.01 DEG C</td>
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<td>Transformer 15</td>
<td>1.45 A</td>
<td>2.01 DEG C</td>
<td>NORMAL</td>
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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.