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NE Blackout of August 14th 2003

- Overview of What Happened
- Causes of Blackout
- Contributing Factors
- Key Recommendations
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- Statistics
  - 50 Million people blacked out
  - 62,000 MW of load initially interrupted
    - Approximately 11% of Eastern Interconnection
  - 531+ generating units at 261 plants tripped
  - Over 100 transmission lines tripped
  - Sammis – Star trip at 4:06 PM – Blackout essentially complete by 4:13 PM
  - High speed cascading lasted approximately 12 seconds
  - Thousands of discrete events to evaluate
  - Time stamping - critical
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- 12:15 MISO’s State Estimator Mismatch
  - Bloomington – Denois Creek 230 kV Outage
  - Line status not linked to state estimator

- 14:02 Stuart – Atlanta 345 kV line outage
  - Causes problem with MISO’s state estimator
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Figure 4.8. Reactive Reserves Around Ohio on August 14, 2003, for Representative Generators in the Area
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- 13:31 East Lake 5 Unit trips
  - Operator intervention coupled with exciter problem
  - Key generator outage in Cleveland area causes increased loading on FE’s 345 kV system
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FE Computer Failures
- 14:14 FE alarm and logging software failed
- 14:20 Several FE remote EMS consoles failed
- 14:41 FE control system server failed
- 14:54 FE back-up computer failed

Other Events
- 14:27 Star – South Canton 345 kV line relayed
- 14:32 AEP called FE regarding Star – South Canton
  FE had no alarm or log of this line trip
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FE 345 kV line failures

- 15:05 Harding – Chamberlain line trip
- 15:32 Hanna – Juniper line trip
- 15:41 Star – South Canton line trip

These lines tripped by gnd relay due to tree contact
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Juniper ground fault current build up (fault current)

Line Trips

Faulted phase current

Harding - Chamberlain 345 kV fault at 15:05 EDT
DFR recorder taken from Harding - Juniper @ Juniper
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Situational Awareness and Reliability Coordination

- FE was not aware of outages until 15:45 despite calls
- AEP called FE back regarding 14:27 operation of Star – South Canton line – disbelief
- 15:35 AEP asked PJM to work on 350 MW TLR to relieve overload on Star – South Canton line
- 15:36 MISO called FE regarding loss of the Hanna – Juniper 345 kV line
- 15:42 Calls from IT staff regarding failure of alarms
Collapse of 138 kV System

- Between 15:39 and 15:58:47, seven 138 kV lines tripped
- Pleasant Valley – West Akron 138 kV tripped after sagging into distribution line
- 15:59 West Akron bus relays due to breaker failure
- 16:05:55 Dale – West Canton 138 kV line trips
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- 16:05:57 Sammis – Star line trips
- Zone 3 relay initiation
- Load encroachment
- 120% of emergency rating
- 1500 MW of load shedding prior to Sammis – Star would have prevented disturbance
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Cascade Phase

- 16:08:59 Galion – Ohio Central – Muskingum tripped
- 16:09:06 East Lima – Fostoria Central line tripped
- Significant power swings – system poorly damped and barely stable
- Zone 3 relay operations
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High Speed Cascade

- 16:10:36 Argenta – Battlecreek 345 kV line trip
- 16:10:36 Argenta – Tompkins 345 kV line trip
- 16:10:36 Battlecreek – Oneida 345 kV line trip
- Sumpter Units trip
- MCV Units trip
- 70 degree phase angle
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- 16:10:38 Hampton – Pontiac 345 kV line trip
- 16:10:38 Thetford – Jewell 345 kV line trip
- 16:10:38 Erie West – Ashtabula – Perry 345 kV line trip
- Cleveland separated from Pennsylvania
- 3700 MW swing from Michigan/Ohio thru Pennsylvania, New York, Ontario into Michigan !!!
Figure 6.19. Generators Under Stress in Detroit, as Seen from Keith PSDR
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- 16:10:43 Keith – Waterman 230 kV line trip
- 16:10:45 Wawa – Marathon 230 kV line trip
- 16:10:45 Branchburg – Ramapo 500 kV line trip
- Northeast Island formed!
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- 16:13 Cascade complete
- 25,588 MW load shed by underfrequency relays
- 18,448 MW load shed by UFLS in NE Island
- Uncoordinated tripping of generators by frequency and voltage
Key Recommendations

- 44 recommendations from task force; 14 recommendations from NERC
- Make reliability standards mandatory
- Shield operators who initiate load shedding
- Strengthen institutional framework for reliability mgt
- Correct the direct causes of the NE blackout
- Strengthen the NERC Compliance Enforcement Prog.
- Support and strengthen NERC’s Reliability Readiness Audit Program
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- Improve near-term and long-term training and certification requirements for operators
- Establish clear definitions for *normal, alert and emergency* conditions
- Make more effective and wider use of system protection measures
- Evaluate and adopt better real-time tools for operators
- Develop enforceable standards for t-line ratings
- Strengthen reactive power and voltage control pract.