Staff Subcommittees on Electricity & Electric Reliability
Agenda

• 10:00 - 11:00 am  Tour of the Newtown Creek Biodigester Plant

• 1:00 – 2:00 pm  Frequency Response Decline in the Eastern Interconnect
  • Troy Blalock, South Carolina Electric & Gas Co.

• 2:00 – 2:15 pm  Update on the Cause of the April 7, 2015 Outage in Washington DC.
  • David Souder, PJM
Newtown Creek Egg Biodigester Plant, Manhattan New York
Frequency Response Decline in the Eastern Interconnect
Troy Blaylock,
Power System Reliability Specialist
South Carolina Electric & Gas Co.
Frequency Response Initiative
NARUC Staff Subcommittee on Electricity and Electric Reliability

Troy Blalock – South Carolina Electric and Gas
NERC Resource Subcommittee – Vice Chairman

July 12, 2015
• Why Primary Frequency Response is Important
• Define Primary Frequency Response
• Discuss the NERC Advisory Generator Governor Frequency
• Discuss the Identified Issues
• Next Steps
• Questions
Why Primary Frequency Response Is Important

- Essential for Reliability of the Interconnections
  - Cornerstone for system stability
  - Line of defense to prevent Under Frequency Load Shedding (UFLS)
  - Prevent equipment damage
- Essential for System Restoration
  - Droop response is critical in restoration efforts
  - Hydro units and gas turbines are some of the first units to be restarted
- Compliance with NERC Standards BAL-003-1, BAL-001
  - Prevent future regulations related to generator frequency response performance
- To accurately predict system events (Transmission Models)
Frequency
Primary Frequency Response

- Primary Frequency Response is the actions to arrest and stabilize frequency in response to locally detected frequency deviations. Primary Response comes from generator governor response, load response (motors) and other devices that provide immediate response based on local (device-level) control.

- Generator Governor Response within 0-10 seconds.

Frequency Point A is the frequency prior to the event
Frequency Point C is the nadir or lowest point
Frequency Point B is the settling frequency
Classic Frequency Excursion Recovery

- **Arresting Period**
- **Rebound Period**
- **Nadir**
- **Primary Response Evaluation Period**
- **Secondary Response Control**
Generator turbine governors either mechanically or electronically control the primary control valves to the turbine. Steam, Water or Fuel is what is regulated.

Graphic from GE info bulletin PSIB20150212
Present Interconnection Profiles

TYPICAL INTERCONNECTION FREQUENCY RESPONSES FOR 2014

Frequency Traces of Medians for 2014 Generation Candidate Events

Time [seconds]
Current Interconnection Profiles

**BAL-003 Field Test - Interconnections 2014 Candidate Events**

Profiles Using Frequency Traces for Same 1-Second Median

**Eastern**
- T(0)
- C: Nadir
- B: Nadir
- A: Nadir

**Western**
- T(0)
- C: Nadir
- B: Nadir
- A: Nadir

**ERCOT**
- T(0)
- C: Nadir
- B: Nadir
- A: Nadir

**H. Quebec**
- T(0)
- C: Nadir
- B: Nadir
- A: Nadir

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CERTS

Advanced Systems Researchers
Decline in Eastern Interconnection Frequency Response

Eastern Interconnection Mean Primary Frequency Response


Source 2010-2011: Daily Automated Reliability Reports

* 1999 Data Interpolated
Present Eastern Interconnection Frequency Response

“Lazy L Profile”

No “Point C” to “Point B” Recovery

Response “Withdrawal”
Generator Governor Frequency Response Advisory

- Advisory issued February 5th
- Initiated by NERC Resource Subcommittee
  - Interconnections frequency response has declined
  - Eastern Interconnection Lazy L profile
  - 2010 and 2013 Generator Survey Data
What Has Been Learned: 1) Dead Bands Exceed Recommendations

- **Dead Bands Vary**
  - Most exceed 36 mHz or 2.16 RPM
  - Large amount of responses reported they did not know
  - Most settings result in NO governor response unless catastrophic event

NERC Frequency Response Initiative Report - August 2012, Bob Cummings
What Has Been Learned: 2) Unit Response is Squelched or Withdrawn

- Coordination with plant Distributed Control System (DCS) is **essential** when operating in MW Set Point Coordinated Control.
Frequency 60.000 Hz

Graphic from GE info bulletin PSIB20150212
Frequency decline 59.940 Hz

Graphic from GE info bulletin PSIB20150212
**Frequency Decline 59.940**

**Plant level (DCS) Load Control**

- **GT Load Control**
  - **GT Governor**
    - Speed-load demand
    - Fuel command

- **GT1**
  - Gas turbine 1 power set point
  - Load drop band
  - Generator

- **GT2**
  - Gas turbine 2 power set point
  - Load drop band
  - Generator

- **GT1 power** + **GT2 power** = **152 MW**

- **Plant droop gain (MW/Hz)**
  - Measured Frequency
  - Plant Load Target (from AGC or other)

- **Plant gain** + **Dead band MW**

- **4 MW**
  - **400 MW**
  - **404 MW**

- **Unit A load split %**
  - Dead Band MW

- **Net plant output**
  - **100 MW**

- **Plant auxiliary load**

- **Graphic from GE info bulletin PSIB20150212**
Frequency 60.000 Hz

**Plant level (DCS) Load Control**

- **Plant Load Target** (from AGC or other)
  - **0 MW**
  - **450 MW**
  - **450 MW**
  - **150 MW**
  - **150 MW**

**Frequency biased Plant Load Target**

- **Plant droop gain (MW/Hz)**
  - **Dead band**

**Net plant output**

- **Number of GTs in emissions compliant operation**
  - **X Unit gain (MW/Hz)**

**Plant frequency bias**

**Unit A load split %**

**GT Load Control**

- **GT1**
  - **150 MW**
  - **Gas turbine 1 power set point**
  - **Unit A load split %**
  - **GT Load Control**
  - **GT Governor**
  - **Kd**
  - **Fuel command**
  - **Speed - Load demand**
  - **Load Deadband**
  - **Generator**
  - **Gas turbine**
  - **LHDG**

- **GT2**
  - **150 MW**
  - **Gas turbine 2 power set point**
  - **Unit A load split %**

**GT Load Control**

- **GT Governor**
  - **Kd**
  - **Fuel command**
  - **Speed - Load demand**
  - **Load Deadband**
  - **Generator**
  - **Gas turbine**
  - **LHDG**

**Plant auxiliiory load**

**Steam Turbine**

**Graphic from GE info bulletin PSIB20150212**
Frequency 59.940 Hz

Plant level (DCS) Load Control

6 MW

Plant Load Target (from AGC or other)

400 MW

406 MW

+/− Dead Band MW

Boiler

60.000 Hz

406 MW

Plant droop gain (MW/Hz)

+ Dead band

Plant Load Target

−

Measured Frequency

Frequncy biased Plant Load Target

PID
Integrate plant load error to form unit set point

Fuel control

Unit demand

Air and Feed water

Net plant output

Turbine control panel

Control valve demand

Steam turbine speed

Generator

Steam Turbine

Plant auxiliary load

Steam turbine power

406 MW

Graphic from GE info bulletin PSIB20150212
Tale of Two Tales

No Frequency Algorithm in DCS

3 -175 MW GE7FA Gas Mark Vle Turbine

Frequency Algorithm in Plant DCS
What Has Been Learned: 3) BA EMS Pulse Control Squelching Response

Balancing Authority EMS Pulse Control Squelching Frequency Response to the Generator

200 MW

Pulses Signals

Generator

200 MW

Frequency Decline to 59.92 Hz

200 MW

203 MW

Pulses Signals

Missing Algorithm to calculate 203 MW

200 MW

203 MW
1. OEMs, including GE, Siemens, and ABB, have and continue to communicate to its customer base through advisories and customer meetings.

2. Architect and Engineering Firms have been asked to communicate to their customer base.

3. Regions have been asked to formally communicate to GO’s and BA’s about the identified issues and request a timeline to address the issues.

4. NERC RS developing a Generator Governor Guideline for recommended settings for all Interconnections

5. Suggesting changes to FERC for governor requirements in the Large Generation Interconnection Agreement and Small Generation Interconnection Agreement
• NERC Resource Subcommittee
• North American Generator Forum [www.generatorforum.org]
• Original Equipment Manufacturers
• Industry Trade Associations
• Architect /Engineering Firms
• Balancing Authority
Participating Entities

NERC
 NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

GE imagination at work

Schneider Electric

BURNS McDONNELL

SIEMENS

EMERSON Process Management

TOSHIBA Leading Innovation

ABB Power and productivity for a better world™

EthosEnergy

CBI

ALSTOM

FLUOR

BLACK & VEATCH Building a world of difference:
Questions
Staff Subcommittees on Electricity & Electric Reliability
Update on the Cause of the April 7, 2015 Outage, Washington DC.
David Souder,
Director of Operations Planning, Operations Support Department, PJM