



# Forced Oscillation Examples

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*Phenomena, analyses and resolutions*

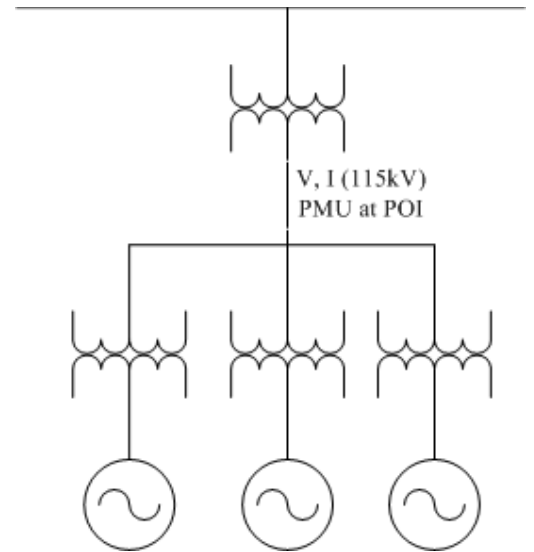
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SENIOR ANALYST



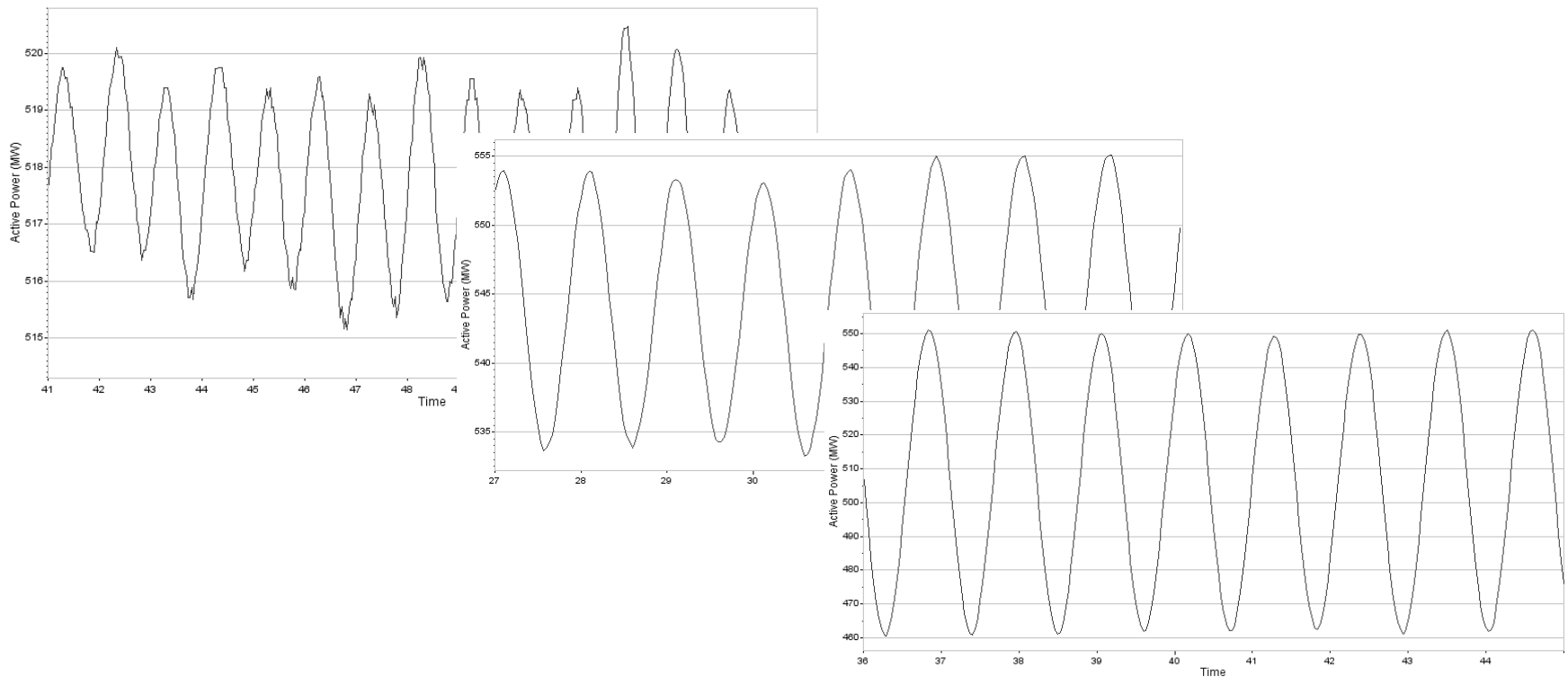
# Persistent 1 Hz Oscillation

*Combined Cycle Unit, 2 Gas + 1 Steam*



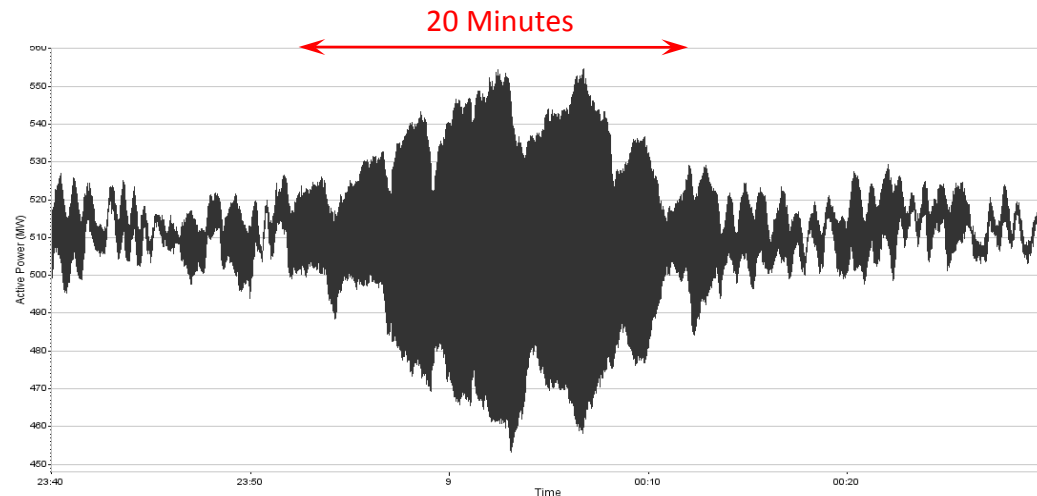
# Persistent 1 Hz Oscillation – Phenomena

- Normally < 5 MW pk-pk
- Raised to 20 MW pk-pk from time to time
- Occasionally grew to 100 MW pk-pk

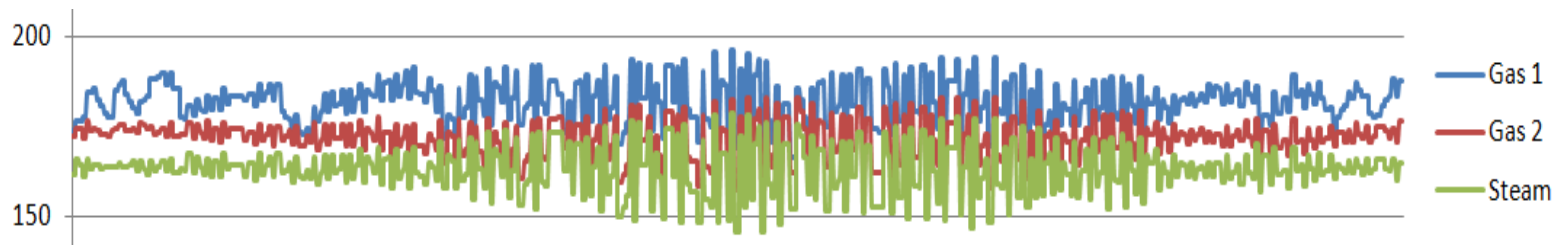


# Persistent 1 Hz Oscillation – Phenomena

- A 100 MW pk-pk example
- Observed in PhasorPoint after the event

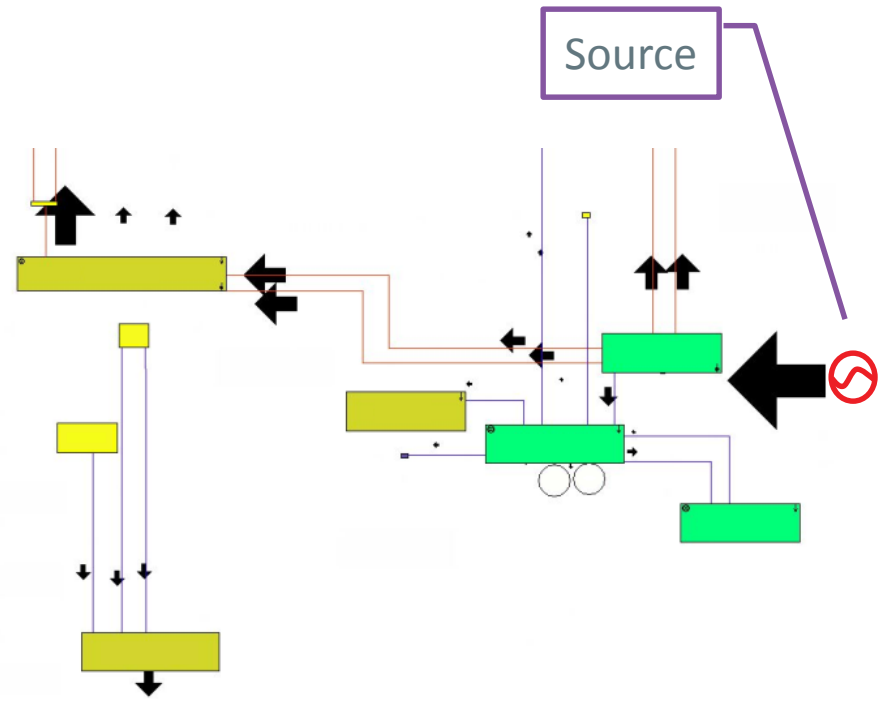


- SCADA Data
  - Oscillations are from all three units



# Persistent 1 Hz Oscillation – Analyses

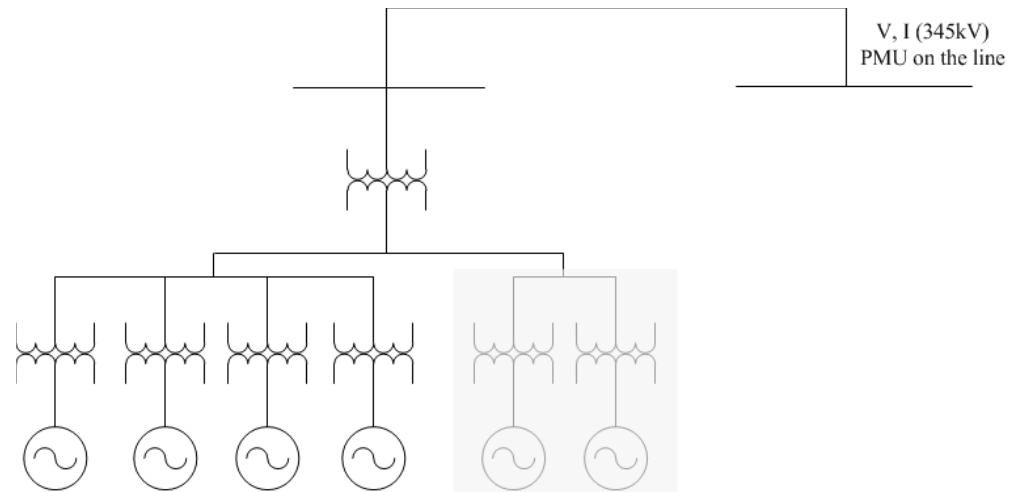
- Started observing oscillations since 2013, soon after DOE SGIG
- Complications
  - At least two local 1 Hz modes in this area
  - Several participating generators
- Locating the source
  - Most consistent oscillatory behavior
  - Oscillates when other generators were offline
  - Oscillation Source Location (OSL) tool confirmed the source later



# Persistent 1 Hz Oscillation – Resolutions

- ISO-NE Actions
  - Contacted the plant
  - Plant acknowledged the problem with internal measurements
  - Real-time Operating Procedures
    - Limited its output during a major transmission outage
- Generator Owner Actions
  - A series of investigations during two outages
  - Repairs
    - Fuel supply valves
    - Control systems
  - Model Change
    - Excitation system parameters
  - Added a PSS
  - Oscillation was mitigated since



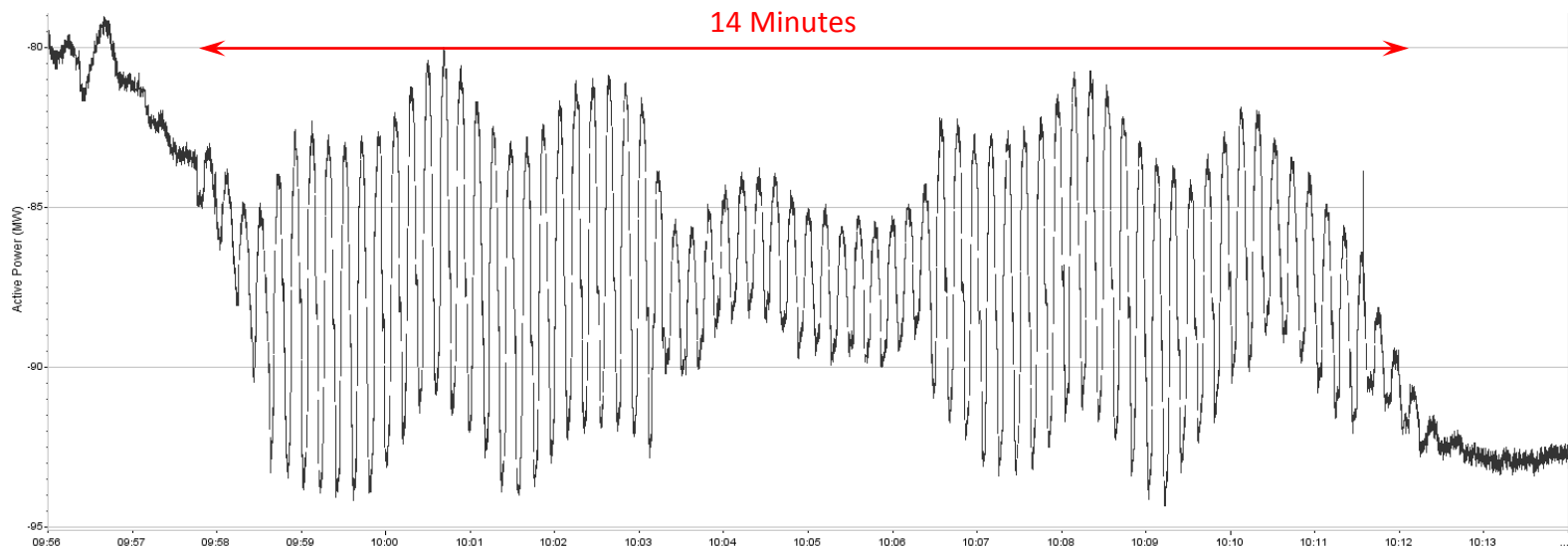


## 0.08 Hz Oscillation During Start-Up

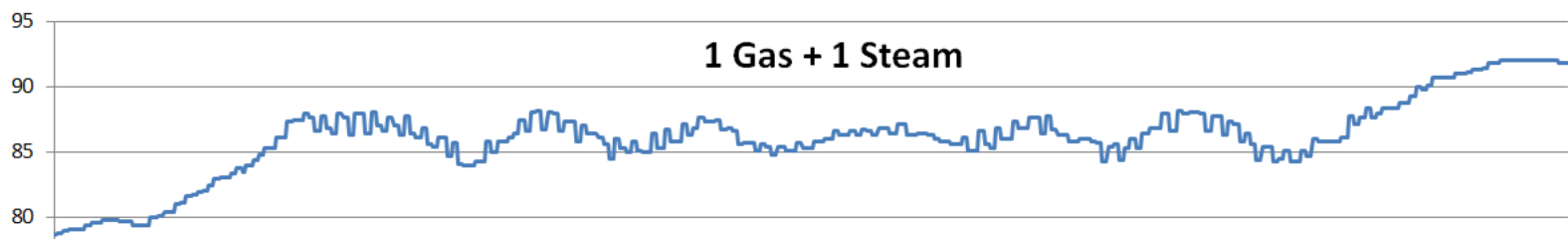
*Combined Cycle Unit*

# 0.08 Hz Oscillation During Start-Up – Phenomena

- A 10 MW pk-pk example
  - Alert sent from PhasorPoint and Oscillation Source Location (OSL) tool



- SCADA data showed a 2 MW pk-pk variations





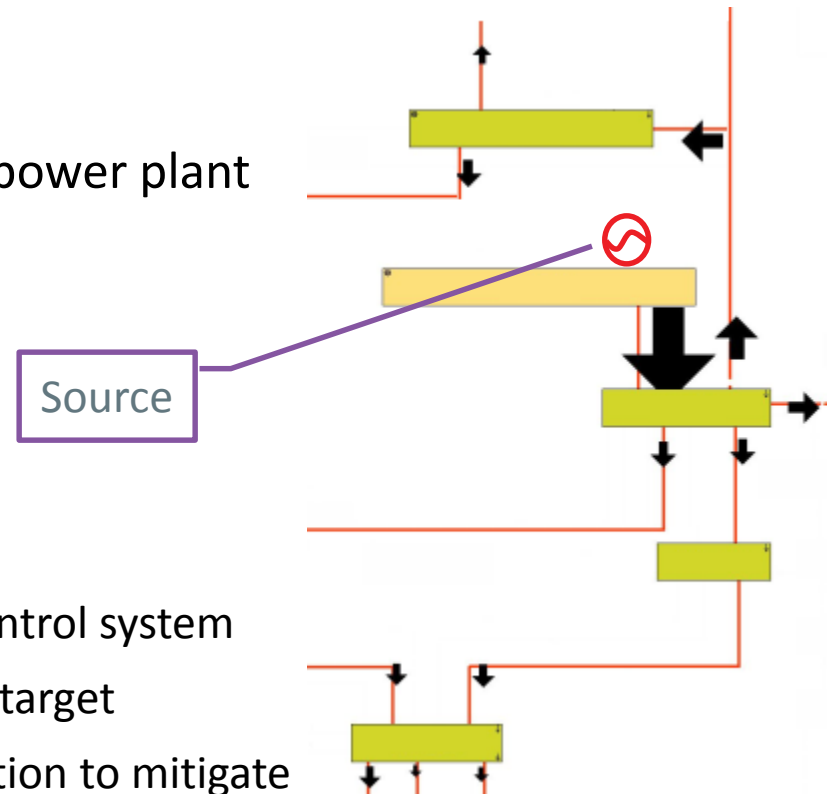
# 0.08 Hz Oscillation During Start-Up – Analyses

- ISO-NE Analyses

- Oscillation was confined within the power plant
  - No reliability concerns
- OSL tool identified the source

- Generator Owner Analyses

- A known issue
  - Unstable steam turbine pressure control system
  - Constantly hunting and missing the target
  - Usually limit the valve opening position to mitigate
- A new system was just put in to increase the sensitivity
- A new operator who is not familiar with the problem
  - The supervisor was not able to be reached in time



# 0.08 Hz Oscillation During Start-Up – Resolutions

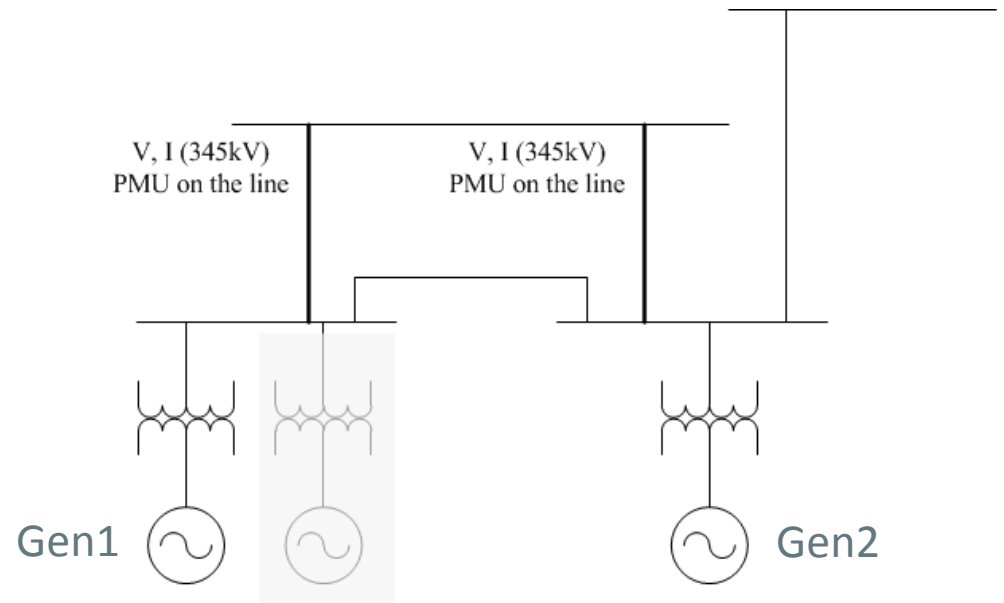
- ISO-NE Actions

- Performed the analyses and identified the source
- Operations support contacted the plant
- Keep observing and follow up

- Generator Owner Actions

- Re-tune the HP steam turbine pressure control system
- Educate the new operator about the situation
- Investigate the possibility of a valve position limiter during start-up



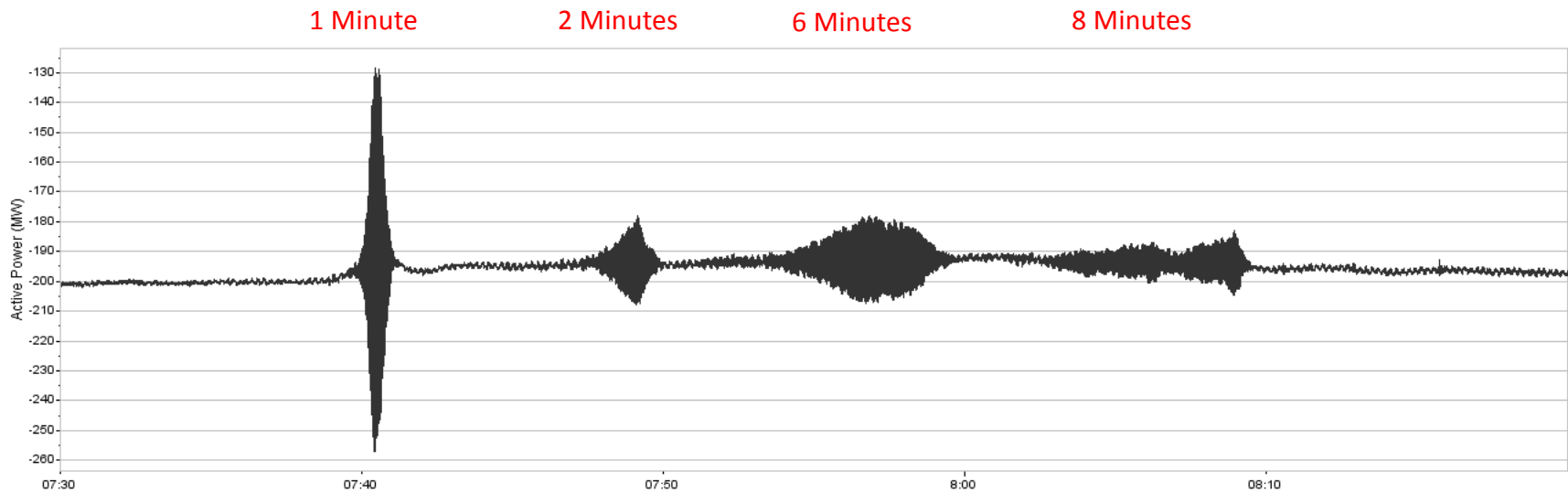


## 1.1 Hz Oscillation During Plant Testing

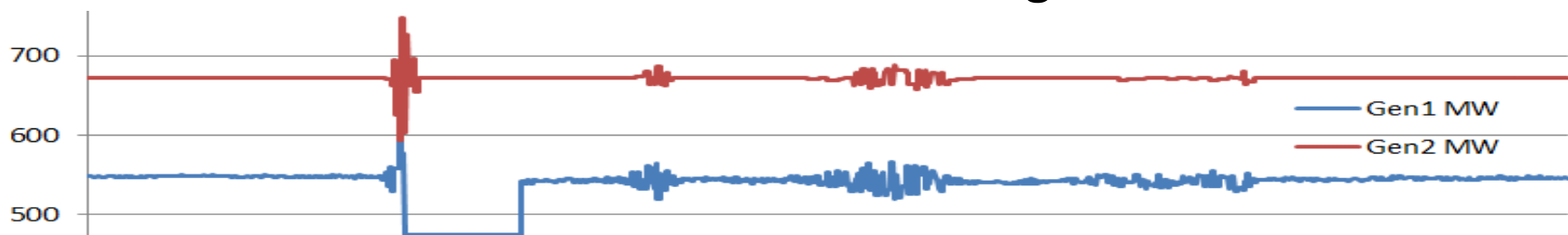
*Two Plants in the Area with Unobservable Lines*

# 1.1 Hz Oscillation During Testing – Phenomena

- A series of 4 oscillation events
  - The largest is 130 MW pk-pk

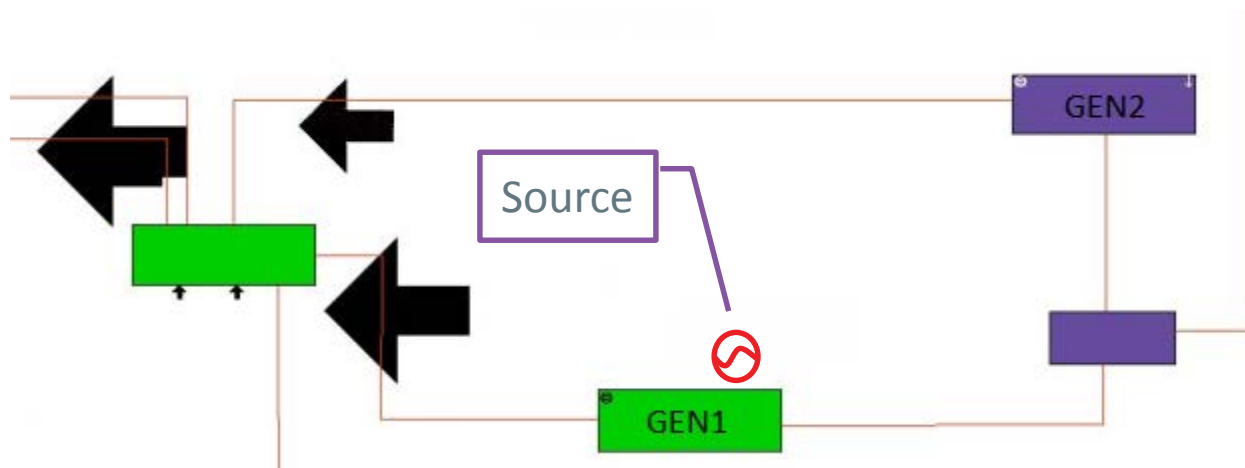


- SCADA data showed variations on both generators



# 1.1 Hz Oscillation During Testing – Analyses

- PhasorPoint and OSL tool alarmed the operations support
- OSL identified two suspects and GEN1 as primary suspect
  - Unobservable line between Gen1 and Gen2
  - Gen1 had a larger Dissipating Energy (DE) factor (arrow size)



- Outage record showed that Gen1 was conducting a full load leading Var test during the time period
- Gen1 was identified as the source of the oscillation

# 1.1 Hz Oscillation During Testing – Resolutions

- Several generators participated though with smaller amplitudes
  - A common frequency for many generators
- Oscillation was unexpected and provided insight into the full load leading Var test
- ISO-NE will follow up the test result



# Questions

