Synchro Phasor Monitoring System

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Generator Forum 15th May
Presentation Content

• Update on status of SPM system

• Use of SPM system during North-South Separation

• Use of system during Storm Darwin

• Use of SPM to observe generator behaviour during Testing

• Recent Power System Events of Concern
SPM System Status Update

• 19 PMU’s now operational
  – 14 in Ireland
  – 4 in Northern Island (Coolkeeragh * 2, Moyle & Castlereagh House)
  – 1 in UK on East West Interconnector
  – Additional Units planned for NI

• Additional recorders installed in Ireland with PMU capability will be connected to the SPM system as bandwidth required to stream data becomes available

• Real Time Phasor Data now available to NCC and will be available to CHCC in near future
Control Centre Frequency Oscillation Monitoring Display

- System Frequency Measurements
- Frequency Spectrum Analyser
- Generator Stability Status
- Oscillation Magnitude (MW) & Frequency
North-South system Separation 28th Nov 2013

Forced Outage of Louth-Tandragee 275 kV Interconnector

System Frequencies pre/post System Separation

Moment of Separation
North-South Re-Synchronisation 30th Nov 2013

System Frequencies during System Re-synchronisation

Matching of System Frequencies

Moment of Re-Synchronisation
North-South Re-Synchronisation 30th Nov 2013

Voltage Phase Angles during System Re-synchronisation

Matching of System Angles

Moment of Re-Synchronisation
The Synchro-phasor Monitoring System Provides Control Centre With

• Immediate Identification of System Splits
  – Information of the state of each sub system
  – Means to direct efforts when re-synchronising two parts of the system

• Generator MW & MVAr output

• Bus Voltages / Frequencies / Phase angles

• Oscillation magnitudes and frequencies

• Indication of Faults, Fault Types and Durations

• Partial Backup for Scada/EMS failure
Use of Phasor Monitoring system during Storm Darwin 12th February

• 67 faults on 110 kV System from 11:36 to 16:21
  – Seven 110 kV load stations disconnected
  – Three 110 kV wind farms disconnected

• Eight lines forced out of service at end of storm

• All generators rode through all faults
Voltage Dips Across the Network
11:30 to 15:30
Impact at various networks nodes available to operators seconds after fault
Line Trip, Auto-Reclose & Trip
1 Ph to E fault, line structure okay, attempt restoration

1 s per division
Line Trip, Auto-Reclose & Trip
Ph to Ph fault, possible structural damage, no restoration attempt

~ 0.5s per division
Fault evolving from 1 to 2 to 3 phase (suggest structure failure thus no attempt to restore)
Use of Phasor Monitoring system during Storm Darwin 12th February

- SPM system can provide detailed fault information to control centre in real time

- This supplements existing information such as Protection relay signals

- New information is graphical thus faster and easier to interpret
  - In many instances can reduce decision making time
Use of SPM to observe generator behaviour during Testing

• The SPM now allows observation of generator testing in real time
  – Any issues the machine is causing for the system or other generators can be observed

• Should allow for more secure operation of the system when tests with significant impact potential are being carried out

• Allows decisions to be made on continuing with test programme or pausing to investigate issues
Example of Setpoint Step Change to AVR

Measured Voltage and Reactive Power

-24.0 239.2
-26.9 239.0
-29.7 238.8
-32.6 238.6
-35.4 238.4
-38.3 238.2
-41.1 238.0
-44.0 237.8

238.9 kV L-L
-24.6 MVAr

12/03/2014 17:20:00
Reaction of Generator MVAr output to Disturbance introduced by Transformer Switching

Measured Voltage and Reactive Power

- 234.2 kV L-L
- -74.7 MVAr

12/03/2014 20:45:00
Reaction of Generator MW Output Disturbance introduced by Transformer Switching
Recent Incidents

- Two Major Incidents currently under Investigation
  - 22\textsuperscript{nd} April Under-frequency Load Shedding following generator trip
  - 27\textsuperscript{th} April Major System Oscillation following generator trip
System Frequency 22 April 2014 17:31 to 17:46

- 370 MW Gen Trip
- 180 MW load disconnected approx
- Frequency sub 49.9 Hz ~ 9 min
Comparison Event

- 357 MW Trip 27 May 2013
- Frequency recovered to 49.9 Hz ~ 9 seconds post Nadir
System Frequency 27 April 2014 21:40

- 370 MW Trip 27 April 2014
- Severe Oscillation in generator outputs around Nadir

20s per division
Frequency & Voltage Oscillations

Frequency Oscillation 27 April 14

Graph showing frequency oscillations with a time scale from -2 to 8 and a voltage scale from 135 to 130.
Looking Ahead

• Trend is to have fewer conventional units committed than in the past

• No Margin for underperformance of any unit
  – In terms of reserve provision, stability, fault ride through, voltage support

• EirGrid & Generators to Collaborate on
  – More robust testing of machine capability and dynamic performance
  – Enhanced Performance Monitoring
  – Linking payments to actual performance with the potential for declaring services unavailable following evidence of under performance
  – Incentives to deliver the required performance
Thanks for your Attention

Questions