Centrica

Enhanced Frequency Control Capability

Work Package 2.2 - Large Scale Thermal Generation

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Contents

1 Executive Summary

As required by the NIC rules, Centrica fully collaborated with the entire project team and presented their findings at the final EFCC dissemination event in Cheltenham in February 2018.

The previous six months project work is outlined below and this document forms the final report for work package 2.2 - Large Scale Thermal Generation.

2 Limited Operational Notification

Following lengthy discussions, it was agreed with National Grid that a Limited Operational Notification (LON) would be drawn up to enable the revised (RoCoF based) logic to be utilised in anger on GT-21 only. The LON was in place from 01/01/18 until 30/04/18.

Unfortunately during the periods which South Humber bank was instructed to carry frequency response by the normal market mechanism, no significant frequency deviations occurred therefore the effectiveness of the revised frequency response logic could not be observed. It should be noted that this is not all that surprising as the module did not run all the time during this period and, like most CCGTs, is only utilised for frequency response on a portion of the period it is running. This portion is reducing over time as National Grid increasingly utilise demand side sources of frequency response rather than response from conventional generation.

As the sale of South Humber Bank Power Station to Energetický a průmyslový holding (EPH) took place on 1 September 2017 and the project reached a natural conclusion for South Humber Bank Power Station at the end of April 2018, coincident with expiry of the LON. Centrica's involvement in the project ended with the expiry of the LON, other than writing closing reports and attending final project meetings.

3 Passive Monitoring

As previously reported, the revised frequency control logic (using Rate of Change of Frequency as an input rather than deviation in frequency from 50.0 Hz) was installed in one (GT-21) of the two gas turbines at South Humber Bank. Between February 2017 and January 2018 the logic was not driving the response of the plant, and was working in a passive mode. So, throughout this period we were able to review any significant frequency deviations that occurred on the National Grid and look at how the conventional frequency response logic would have driven the plant, as well as how the revised frequency control logic would have driven the plant. Review of these events was encouraging and consistently showed that the revised frequency logic would give more response in the early stages (sub 10 seconds) of a significant frequency event.

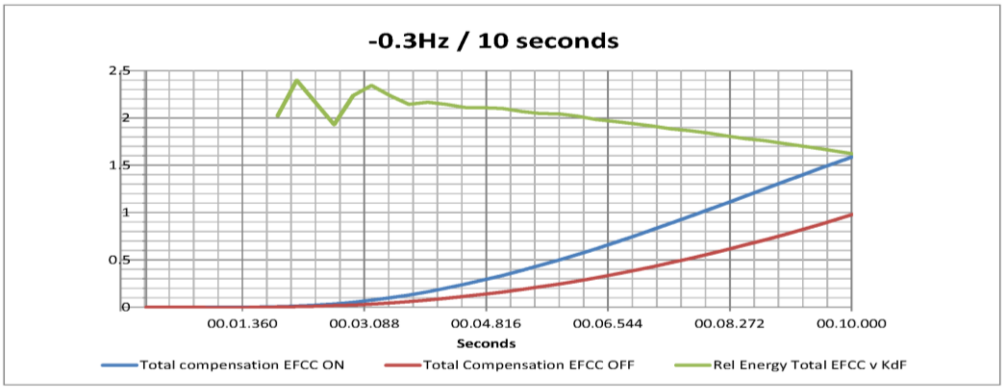

Figure 3-1 Improvement in response delivery in the first 10s of an event during testing

This review was also shared with the wider EFCC project team, promoting good discussion and furthering the teams understanding of plant and system characteristics in frequency incidents.

4 GE Equipment

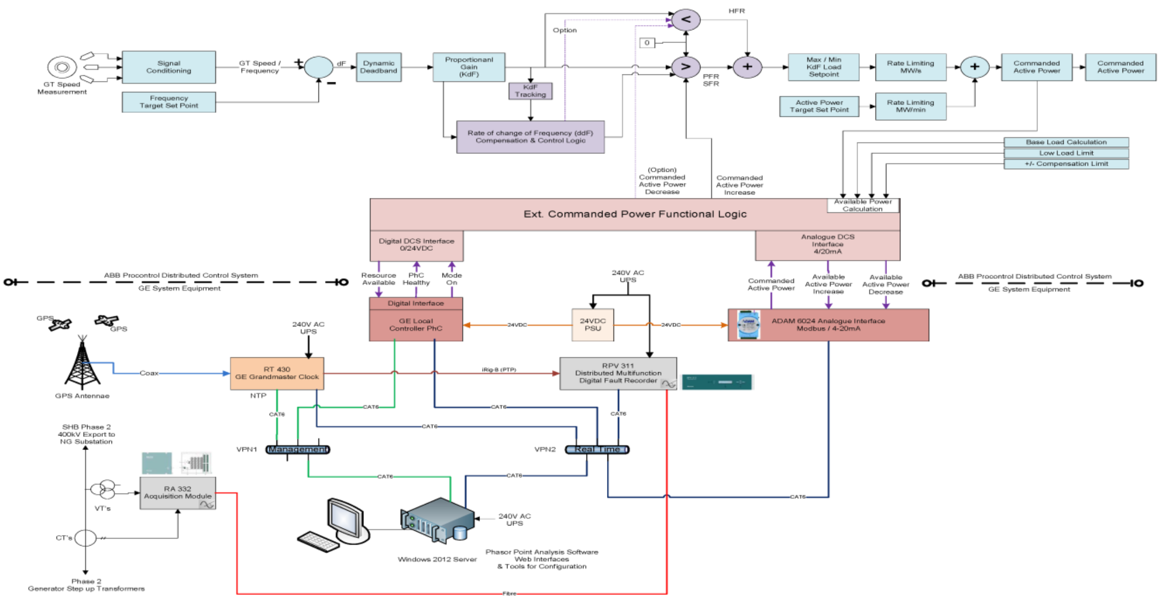

Figure 4-1 – South Humber Power Station – Schematic showing GE Monitoring Installation

At the end of the previous report the GE System installation was completed and the successful SAT had been undertaken on November 22nd 2017. Since this period events captured by the system PMU have been shared with project partners both as trends and CSV files. The CSV files have been utilised in testing for work package 2.2 as described in section 5.

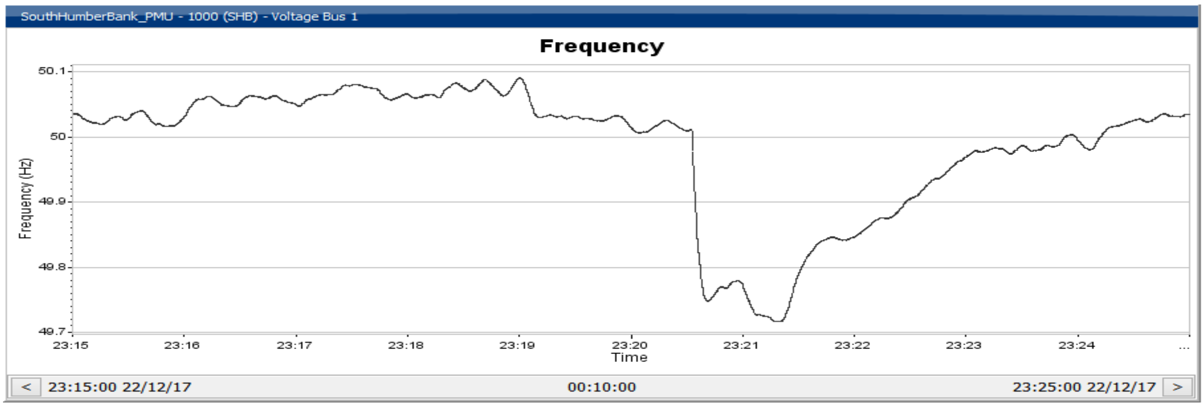

Figure 4-2 PMU Trend of Frequency Event Trend recorded at South Humber Bank Power Station

RPV 311 Log files from the system have also been provided to GE (as requested) to assist with their software / firmware development during the period.

5 Improved Modelling Capability

The capture of real time events using fast data from either the GE supplied PMU or the DEPP (Alstom system that was already installed at the power station) fast data recorder had previously been used in the dynamic mathematical software simulation however the control elements within this model form a simplified representation of the real control system.

Whilst an offline simulation utilising real gas turbine control system hardware had been developed it was not previously possible to input real events beyond Grid Code compliance standard ramps and steps into the offline hardware simulation environment. This capability has been developed through use of VBA coding and protocol translation tools to allow real events to be played back directly into the hardware simulation test rack environment where the actual control system code response can be observed and analysed this allows the real control system code to be optimised against real world events.

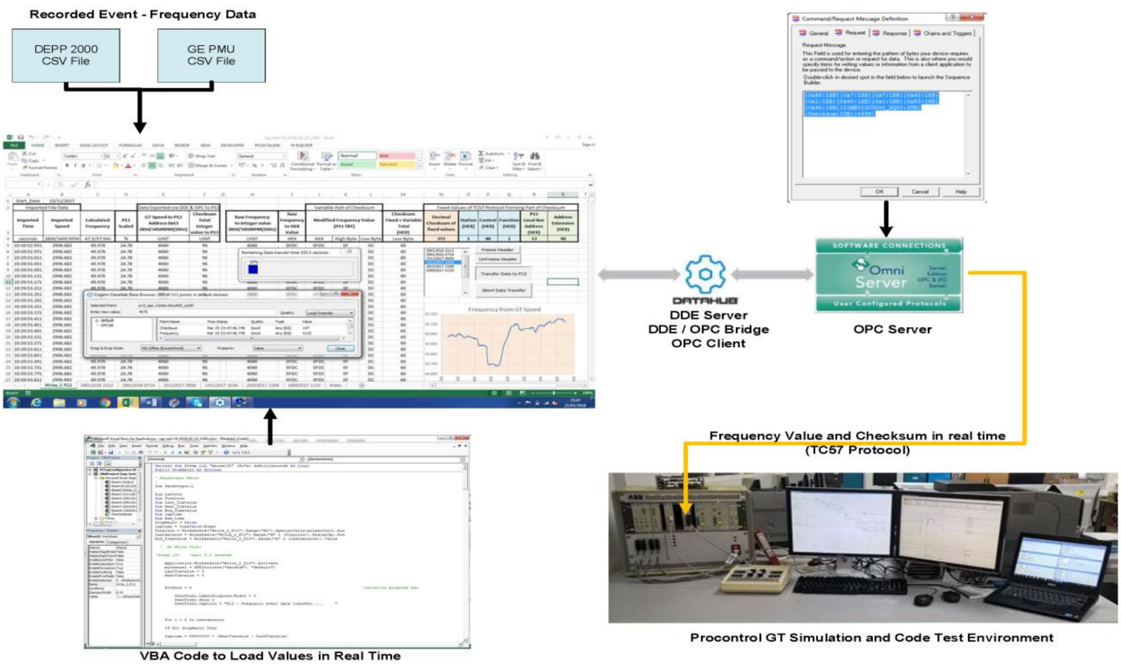

Figure 5-1 Procontrol Offline test environment - Event Playback Capability Development

6 Response Optimisation – Offset Tracking

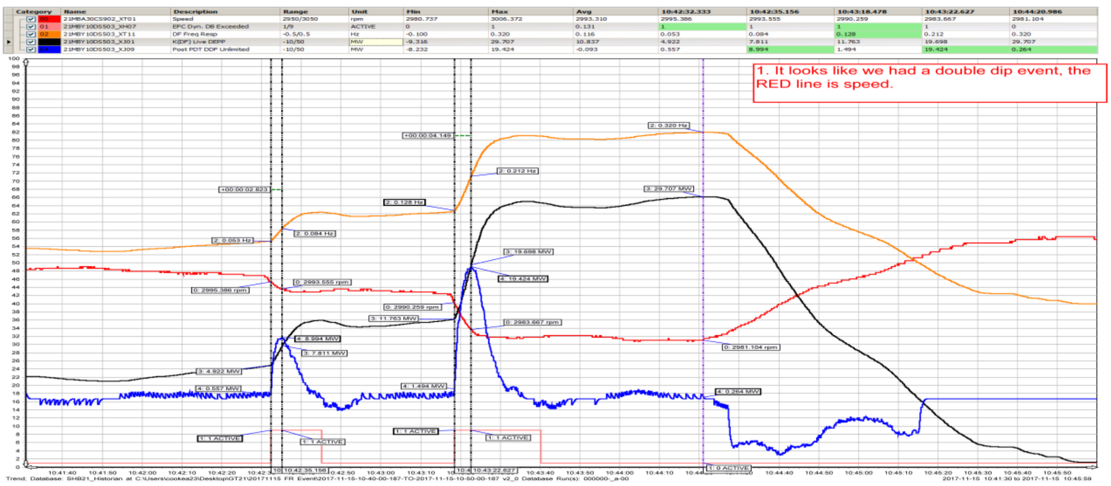

Figure 6-1 Passive monitoring of Event with 800 MW Loss of Generation

With reference to the trend in Figure 6-1 and the test logic, during a frequency event the fall in frequency (red line - Gas Turbine Speed) generates a demanded power compensation that is the greater of the kDF (conventional response - black line) and the dDF (RoCoF based response - blue line) control response.

The real event captured in passive mode above, clearly shows the requirement for tracking to take into account the effects of any offset from 50Hz that may already exist in the form of kDF (at the start of an event) in order for the dDF to be effective in delivering improved response times.

The tracking was optimised and is fully incorporated into the design. Offline testing in figure 6-2 below shows the same event played back through the offline software simulation. The black line shows the compensation with tracking whilst the orange line shows the conventional response.

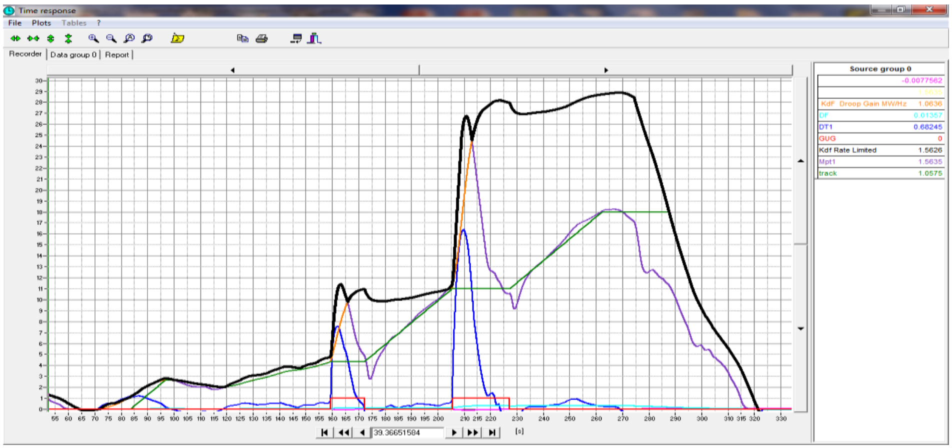

Figure 6-2 – SimApp Simulation showing playback with offset tracking enabled

Offline testing in figure 6-3 below shows the same event but this time played back through the offline test rack simulation using real control system hardware. The violet line shows the compensation with tracking whilst the orange line shows the conventional response.

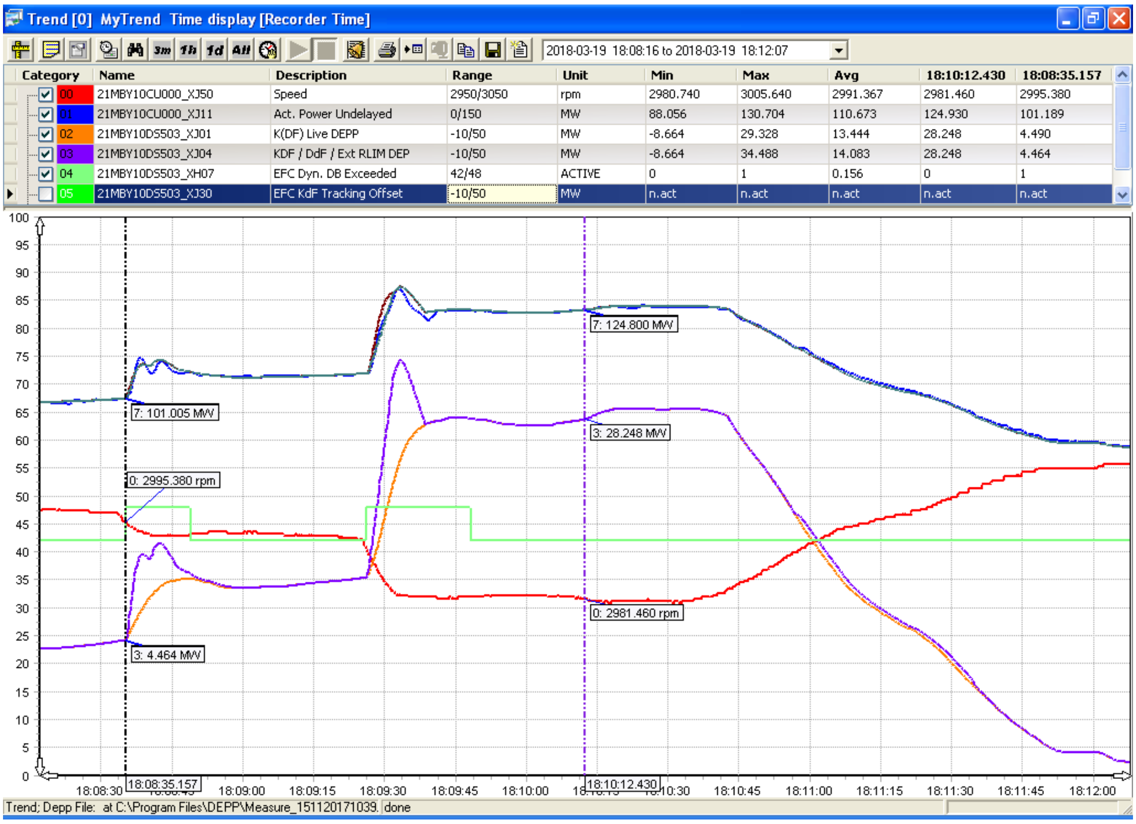

Figure 6-3 – Procontrol Test Rack Simulation showing playback with offset tracking enabled

7 Revision History

Revision	Revision Date	Details
1.0	05/06/2018	Original Release (PJW)
1.1	06/06/2018	Very minor updates (CP)