nationalgrid

Meeting Note

Meeting name	GC0062: Fault-ride-through
Meeting number	3
Date of meeting	8 May 2014
Time	10:00 – 14:00
Location	National Grid House, Warwick.

Attendees

Name	Initials	Company
Graham Stein	GS	National Grid (Chair)
Tony Johnson	AJ	National Grid
Richard Ierna	RI	National Grid
Duraisingam Balasingam	DB	National Grid
Paul Wakeley	PW	National Grid (Technical Secretary)
Hervé Meljac	HM	EDF Energy
Dave Draper	DD	Horizon Nuclear Power
Campbell McDonald	CM	SSE Generation
Philip Belben	PB	Horizon Nuclear Power

Apologies

Name	Company
Mick Chowns	RWE
Phil Jenner	RWE

1 Introductions/Apologies for Absence

1. GS welcomed representatives to the meeting and thanked them for joining. The purpose of the workgroup meeting was to consider the initial study results prepared by National Grid to support the development of fault-ride-through requirements for large synchronous generators which were appropriately consistent with the ENTSO-E Requirements for Generators (RfG) Network Code. GS advised the output was to consider the study results and identify what further study work would be required.

2. The minutes of the previous meeting were discussed, updated and agreed. The meeting note can be found under the 'Workgroup' tab on the Grid Code website[1].

2 Fault-ride-through RFG compliance

Please refer to the presentation "Meeting 3 Presentation - RfG Compliance" on the Grid Code Website[1].

3. AJ summarised his understanding of the current drafting of the ENTSO-E Requirements for Generators (RFG). It was noted that the RFG is still in Comitology and this process seems to be proceeding slower than initially expected, although a Network Code is expected to be in law by the end of 2016. The RFG will apply, by default, to "new generators", i.e. those who have not let contracts for major plant items two years after entry in to force of the Network Code.

4. The workgroup were made aware of the existing Joint GCRP/DCRP Workgroup on GB Application of RfG (GC0048), which is considering options for implementing the RFG in the D-Code and Grid Code as appropriate. AJ noted that the output of this fault-ride-through workgroup is expected to inform the GB national implementation of RFG.

5. AJ reported that the requirements in the RFG associated with fault-ride-through are contained in a number of areas:

   - The voltage against time profile and associated parameters, specifying the minimum level above which a Power Generating module must stay connected and continue stable operation.
   - The specification, by the TSO, of pre- and post-fault conditions for fault-ride-through capability:
     - Conditions for the calculation of the pre-fault minimum short circuit capacity at the Connection Point;
     - Conditions for pre-fault Active and Reactive Power operating point of the Power Generating Module at the Connection Point and Voltage at the Connection Point;
     - Conditions for the calculation of the post fault minimum short circuit capacity at the Connection Point.

6. The compliance process under RFG is similar to the GB process of EONs, IONs and FONs, however, the details of the simulations required to demonstrate compliance with the fault-ride-through requirements under RFG are more comprehensive. There is no requirement for on-site testing in respect of Synchronous Generators.

7. A number of approaches are possible for providing the required data to support generator compliance, such as the operating points (e.g. active power output, power factor etc) and the pre- and post-fault conditions. GS noted that there is a range of options including fixing a common set of parameters for the whole network on a global basis, setting a range for the network again on a global basis, or specifying them on a site specific basis bilaterally.

8. Workgroup members felt it appropriate to detail as much as reasonable in common transparent documents such as the Grid Code, but that it was right to have some site specific information placed in the Bilateral Agreements which would impact on the design of the Generating Unit.

9. A concern was raised about specifying the initial operating point. AJ had suggested that a 'worst case' from a system perspective is a scenario of Generators operating at maximum power output, at full lead. Workgroup members noted that this is an unlikely (but not an impossible) scenario and it would not be desirable to adopt a sum of worst cases. In particular, the pre-fault operating point for the generator needs to be credible. AJ advised that for the

[1] http://www2.nationalgrid.com/UK/Industry-information/Electricity-codes/Grid-code/Modifications/GC0062/

purposes of the study work discussed in the meeting, the system voltage profile was established by adjusting the target voltage at each Generator substation which was then used to develop a system operating condition which was robust to the full set of secured events defined under the SQSS.

3 Initial finding from study work

Please refer to the presentation "Meeting 3 Presentation - FRT Study Work " on the Grid Code Website[1].

10. The initial findings of a series of studies performed by NGET using the full England and Wales multi-machine study in Digsilent Power Factory were presented. The studies were run to establish what voltage profile a generator at some distance from the fault could experience.

11. In establishing these studies a number of assumptions were made:

   - Generator / Demand was modelled on a 2013 summer minimum, with different levels of penetration of non-synchronous generation, to investigate the effect of different levels of system inertia and synchronising torque. CM requested that the full range of assumptions should clearly be documented.
   - The generator closest to the fault (the one to be studied) was set to full power output and maximum power factor lead. All other generators were set as per the original 2013 minimum study except where the high and medium case non synchronous scenario necessitated some synchronous generation to be replaced by non-synchronous generation. Three scenarios were reported on, as follows.

<u>Seabank-Whitson- Clfynydd, Melksham – Imperial Park circuit (secured double circuit fault)</u>

12. The first set of studies (slides[1] 14-17) considered a secured double circuit fault on the Seabank-Whitson-Clfynydd, Melksham – Imperial Park circuit that cleared within 140ms.

13. In this case all substations observed a voltage drop consistent with the Mode A requirements of the Grid Code CC.6.3.15.1(a). No stability issues were identified with this study.

<u>Seabank-Whitson- Clfynydd, Melksham – Imperal Park circuit (500ms fault)</u>

14. The second set of study results (slides 18 – 22) considered a fault on the Seabank-Whitson-Clfynydd, Melksham – Imperial Park double circuit. In this case however circuit breaker X105 at Seabank 400kV substation was modelled to remain closed such that the fault was cleared by backup protection operating within 500ms. This had the effect of tripping the entire busbar section at Seabank 400kV substation. .

15. Slide 19 illustrates the operation of the backup protection. As circuit breaker X105 sticks, busbar circuit breakers X130, X305 and X410 operate instead within 500ms of fault inception. Seabank Power Station 1 (CCGT) is not operating, but Seabank Station 2 (CCGT) was operating at full output (367 MW) and at full MVAr lead, remaining connected to a live busbar and the single circuit to Melksham.

16. In this situation a drop in the Transmission voltage was observed (slide 20) at substations remote from Seabank for longer than 140ms. The fluctuations in the substation voltage at Seabank are due to the predicted pole slipping of Seabank 2. In reality, Seabank 2 would have been expected to trip under this scenario due to its proximity of the fault and the continued low voltage.

17. Slides 22- 26 show the same 500ms fault at Seabank, expect with a retained voltage of 50%. It was noted that the slides should reflect the retained voltage V not the impedance Z. Under these scenarios the local generation was observed to remain stable. RI advised that he had run a more onerous case in which for the first 140ms the retained voltage of 0V was applied (ie a solid three phase short circuit fault) and for the subsequent 360ms the retained voltage was 50%. Again the Generator was operating at Rated MW output in the full leading mode.

18. It was noted that these studies provided a useful insight into the fault effects but further analysis would be required, in particular the high post fault generator terminal voltage observed.

Drax – Eggborough Double Circuit (500ms fault)

19. The final set of results (slides 27- 28) considered a double circuit fault on the Drax-Eggborough circuit, and a stuck circuit breaker at Eggborough (X505). In this situation the back-up protection of X105 and X120 circuit breakers would operate to clear the busbar section.

20. AJ provided verbal results suggested that generators some distance away from the fault would have been able to ride through that fault with similar observations noted to that as the Seabank case.

Summary of initial results

21. Based on the initial study results, AJ advised that it had been possible to start populating a possible voltage against time curve of which two initial options were available (see Slide 31). However, he acknowledged that there was significant further work required to define the curve, and we are also need to consider the capability of the plant connected to the system.

Observations on the studies

22. A workgroup member noted that the post-fault voltage in the studies shows voltage recovering to 1.0pu, whilst the RFG requirements are for retained voltage of 0.9pu. It was noted that fault-ride-through with a retained voltage of 0.9pu is harder for a generator than 1.0pu. AJ noted that in the study results, the retained voltage of 1.0pu may be a function of using the summer minimum when the system is inclined towards high voltage.

23. The effect of the quantity of synchronous generation on these particular studies was limited. A workgroup member warned against confusing matters of rate-of-change-of-frequency, with fault-ride-through.

24. The credibility of a generator operating in the full lead at full power output was questioned. Workgroup members are concerned we could potentially accumulate too many contingencies to make the scenario implausible. DD asked if it was possible to select a number of generators operating away from full lead. AJ advised that the study is set up to control each available generator between the available Grid Code requirements to ensure the Transmission System can be operated in accordance with the requirements of the SQSS.

25. GS noted that an objective of the study is to identify factors that may be of interest and eliminate those that are not if possible. RI noted that at this stage (based on the studies completed so far) there was no significant effect on changing the generation background between synchronous and asynchronous plant.

4 Actions

26. Building on the initial studies presented at the workgroup, National Grid are to prepare further studies to consider additional factors, to gather further data to allow the workgroup to proceed with discussions on changes to the GB fault-ride-through requirements. These further studies will cover, ensuring that all assumptions / parameters in each study are fully documented:

- The system at winter peak (to simulate a situation where voltage is inclined to be low) with a fault adjacent to a large volume of generation;
- Other scenarios in addition to the double-circuit fault and stuck breaker;
- Simulate the required recovery voltage of 0.9pu;
- Investigate the over-voltage issues at the Generator Terminals (RI reported this may be a problem with the Automatic Voltage Regulation (AVR) settings in Powerfactory, but this shall need further investigation);
- Give further consideration to the initial operating point of the plant in question: is full power output and full lead credible;
- Further consideration needs to be given to the effect on auxiliaries;
- Further investigation of System Frequency impact.

27. The next meeting is proposed to be held on Tuesday July 15 2014 at which these further study results will be considered.

ID	Actions	Captured	Owner	Status
1	Circulate Grid Code Panel Paper pp12/14 on fault-ride-through	WG 1	NGET	Closed
2	Setup meetings for 2014 (Next meeting in early February, then at 8 to 10 week intervals)	WG 1	NGET	Closed
3	Prepare an initial review of fault ride through compliance in GB	WG 1	NGET	Closed
4	Prepare preliminary analysis of voltage recovery profiles and a proposal for analysis required to demonstrate the need case.	WG 1	NGET	Closed.
5	Full range of study assumptions to be provided	WG 3	NGET	
6	NGET to prepare undertake further study work as identified in paragraph 26.	WG 3	NGET	