nationalgrid

# Minutes

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| **Meeting name** | GC0028: Constant Terminal Voltage |
| **Meeting number** | 2 |
| **Date of meeting** | 4 April 2014 |
| **Time** | 10:00 – 14:00 |
| **Location** | National Grid House, Warwick, CV34 6DA |

| Name | Initials | Company |
|---|---|---|
| Graham Stein | GS | National Grid (Chair) |
| Jackeline Crespo-Sandoval | JCS | National Grid (Technical Secretary) |
| Antony Johnson | AJ | National Grid |
| Philip Jenner | PJ | RWE |
| Herve Meljac | HM | EDF Energy |
| John Norbury | JN | RWE |
| Paul Newton | PN | EON |

## Apologies

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| Martyn Cunningham | MC | Scottish Power |

## 1 Introductions/Apologies for Absence

31. Apologies were received from Martyn Cunningham. GS explained that the objective of the meeting was to investigate the impact of changing the generating unit transformer tap change ranges so that the Workgroup can assess the overall cost of transformers and balancing this against the impact to the system.

## 2 Approval of Minutes

**a) Workgroup meeting 1 minutes - 29th January 2014**

32. JN requested that item 5 be amended as follows: "JN noted that there was some confusion, a result of which being some generators have had to change the set point during compliance testing. The Workgroup also acknowledged that there are a number of sites which are operating above their rated terminal voltage and also a number of sites with derogations". AJ advised that this issue related to the ability of a Generator to demonstrate reactive capability for compliance purposes only.

**b) Workgroup terms of Reference**

33. It was noted that there was a typographic error on the suggested date for the presentation of the Workgroup report to the GCRP.

**Action:** GS to review Workgroup timescales.

## 3 Review of information on tap changers / transformer units

34. Two notes on the cost of tap changers/transformers units were circulated for review.

35. One note acknowledged that the issue of the reactive capability could be addressed during transformer replacement with a new unit. If specified correctly at the design stage, it would not necessarily introduce additional cost as it would not be materially different from that for procuring a like for like replacement. It is expected however, that the new unit would be different from the original in terms of tapping winding position and tap step size.

36. The second note reviewed the considerations, design limitations and associated cost.

*37.* The contradiction between the circulated notes was discussed. PJ clarified that there was no contradiction but that both notes addressed the same issue from different perspectives. For example, if a marginal change is added to the tap changer range (as may be expected during a transformer replacement whilst addressing compliance deficiencies), then the cost is reasonable. However, if extra requirements are added that can lead to particular margins being exceeded then the design may become significantly more expensive.

38. HM noted that instructions for specific MVAr output and the target values required are currently placed in BC2.A.2.6 whereas the reactive capability requirements are defined in CC.6.3.2 of the Grid Code . This creates an issue for generators in earlier stages of the design as they are not aware of the Balancing Code requirements. To address this it was suggested that the requirements should also be placed in the Connection Conditions section.

39. The workgroup discussed where the +/-25MVar output tolerance as defined in BC2.A.2.6 comes from. GS noted that there are no background details and this may have come from the CEGB approach to generator transformer design. However, he believes that the material issue is the step change in voltage. It was noted that under the SQSS, the maximum permitted steady state step change is 3% for operational switching, 6% for a single circuit loss and 12% for a double circuit loss. The Grid Code limits repetitive step changes to 1%.

40. JN asked if this would apply to Scotland. AJ advised that BC2.A.2.6 requires a tolerance of ±25MVAr for Gensets in England and Wales or the lesser of ±5% of rated output or ±25MVAr for Gensets in Scotland. HM offered to circulate a spreadsheet giving a rough idea of what this tolerance would look like. He questioned whether manufacturers have the capability to build this.

41. AJ asked what the practice in France is. HM responded that generation is well distributed and that is why voltage control works quite well. The French Grid Code is quite open and transformer taps are optional. In the past however, France had some issues controlling the voltage across the border with Spain but they have managed the situation. The only region where voltage control is an issue is Brittany. In 1987 they experienced voltage collapse.

42. PN noted that the different approaches used by other countries have been discussed at previous GCRP meetings and associated GCRP Working Groups. AJ noted that the generation profile in GB is quite different to the rest of Europe. It was also noted that in future more, Wind generation will be displacing synchronous plant.

43. AJ asked what are the French levels of demand. HM replied that peak demand is around 100GW and minimum around 30GW. Electrical heating causes issues in winter. One of the main issues is managing high voltages, especially at night because there is less generation and the Transmission System has a higher reactive gain. There is also an issue in the middle of France where there is not so much generation. The French dispatch centre deal with this by switching on water heaters. Hydro plants are also used for synchronous compensation purposes. They also switch out capacitor banks / switch in shunt reactors and in big cities switch out cables when not needed.

44. JN pointed out that currently in GB there is no compliance issue if you can achieve the target voltage level.

## 4 Workgroup discussion

45. Voltage fluctuations as described in Grid Code CC.6.1.7 were discussed and it was asked whether this is checked during compliance testing.

46. **Action:** AJ to confirm.

47. CC.6.1.4 and the interaction with the RfG was discussed. PN highlighted that although in the Grid Code it is advisory, the RfG is explicit. PN also noted that CC.6.1.7 for Rapid Voltage Changes is currently out for consultation and mainly addresses energisation and that the question is what applies to generation and what applies to load

48. AJ presented the results of study work performed using Digsilent Power Factory. The scenarios modelled were: Single Machine studies connected to an infinite bar (to study the effects on Generator Terminal Voltage) and Multi Machine studies to investigate the full GB Network under 2013 Winter Peak conditions). The studies covered all the three options discussed at the previous meeting to study the impact on pre and post fault voltage profile:

- Option 1 – Constant Terminal Voltage controlled to 1 p.u with full Transformer Tapping
- Option 2 - Adjustable Terminal Voltage with a limited Transformer Tapping Range
- Option 3 – Limited Transformer Tapping Range only

49. The Slides are available at:

http://www2.nationalgrid.com/UK/Industry-information/Electricity-codes/Grid-code/Modifications/GC0028/

50. AJ summarised the studies advising that each option tested did have an effect on the terminal voltage of the generator which would affect the System Operator's ability to control system voltage. Also, this would impact Excitation voltage and MVAr reserves. The impact on single machine studies was small but could be expected to be more significant across the total System. At this stage National Grid views are that Option 1 is the preferred approach. This option could be applied to new plant with derogations / bilateral arrangements permitted for existing plant (depending upon any future Grid Code change) who are unable to meet the current GB requirements.

51. PJ asked whether the impedance was an issue for the RfG. Also he questioned whether flexibility was important. AJ replied that National Grid experts agree with the view that flexibility is important.

52. PN asked if a functional specification for either option 1 or option 2 could be specified as it is important that the solution works for small generators. This would also apply for the RfG minimum requirement as it is not clear if this would be an issue for future generators connecting at 11kV.

53. **Action:** GS to talk to NGET's Generator compliance team to find out if there is a preference in terms of the number of transformer taps.

54. JN suggested defining reactive range as a percentage or max/min number of taps. This will capture smaller units and could be similar to the Scottish clause. PJ suggested that this could also be defined as a percentage of the voltage range that you can inherently capture as a percentage of MVars.

55. GS would like to capture the cost per tap or the cost per voltage step. JN raised the issue of confidentiality and Intellectual property. AJ advised that only key data would need to be presented and would fully respect confidentiality. He advised that a similar process had been adopted for wind farms in the past.

56. It was noted that it would be worth investigating if there is a maximum number of taps that are feasible.

57. PN asked if there were any requirements on the time that it takes between tap changes (e.g. how long it will take from the first to the last). AJ advised that they need to be activated within 2 minutes of the instruction. This is stated in BC2.8.4.

58. Option 1 of the presentation was discussed. AJ confirmed that nominal voltages were used and the transformer tapping range is symmetrical (ie nominal tap is in the middle of the tapping range). The study results in option 3 showed the effects of reducing the number of taps. The conclusion was that by reducing the number of taps the target voltage required could not be achieved.

59. PJ agreed that the graphs showed what was expected. GS questioned whether the number of taps is relevant to the point or only applicable in extreme cases. AJ replied that the number of taps affected the range. GS asked if this had a material dynamic impact. AJ replied that they all have an effect albeit a small one but it becomes more apparent under times of system stress when the Generators are operating at their maximum operating range.

60. AJ commented that the Rated Field Voltage (RFV) of a synchronous plant was not an issue and other stability requirements are described in CC.A.6.2.4.2.

61. PN noted that CC.6.3.4 defines what National Grid wants in term of the functionality for the onload tap changer.

62. JN believe that there could be an issue if the Grid Code is too prescriptive. It was noted that the System Operator would like to have the ability to control voltage regardless of how the requirement could be achieved.

63. AJ pointed out that if the requirements are relaxed NGET will still require generators to be stable whilst avoiding the installation of additional reactive compensation equipment.

64. JN suggested that the legal text is amended to include changes to BC2. GS reminded the group that the proposed solution will need to comply with the Grid Code objectives and that the consultation needs to outline the 3 potential options to put the discussion into context.

65. AJ noted that option 1 is clear and unambiguous. However the disadvantages are that it makes the extreme of the ranges more difficult to achieve plus it also would result in extra cost.

66. PJ suggested that the workgroup should concentrate on the modifications to the Grid Code that apply to existing generators as RfG will cover future requirements that will be discussed at a different working group. AJ clarified that at this stage, all RfG requirements which are currently consistent with the existing GB requirements will be mapped across with no change. GS advised that it is logical to look at what tap change performance might be needed. GS suggested looking at minimum conditions (e.g. voltage control issues of last summer) as these may give a better indication.

67. The workgroup agreed to circulate minutes and legal text for comments to parties with derogations.

68. **Action:** JCS circulate minutes and slides as above

69. PN suggested it would be worthwhile to document why variable terminal voltage is not acceptable to National Grid. AJ responded that when generators apply to connect to the MITS, National Grid will need to ensure the requirements of the SQSS can be satisfied. If a number of Generators have different operating terminal voltages this can make it difficult to ensure a compliant operating condition.

70. PJ suggested that if the ceiling limit of the excitation/AVR could achieve more than the GC minimum, then operating at a higher terminal voltage will not reduce the post-fault dynamic response, a key concern of option 2. AJ agreed that maintaining the same field forcing margin could address the concerns outlined for option 2 but would require further analysis.

71. PN suggested that by reducing the number of taps by 1 could be balanced by the capability to have an equivalent increase in terminal voltage. Tests will need to be done to validate this option. The general consensus was that more analysis needed to be performed. AJ will consider the scope and what needs to be included (e.g. number of taps per unit, changes to

generation mix, steady state vs dynamic) and to show the global effects for synchronous plant only.

72. The workgroup members agreed that the next meeting should be scheduled in 8 to 9 weeks to allow time for more studies to be completed.

## 5 AOB

73. None