Minutes

Meeting name	GC0028: Constant Terminal Voltage
Meeting number	3
Date of meeting	20 June 2014
Time	10:00 – 14:00
Location	National Grid House, Warwick, CV34 6DA

Name	Initials	Company
Graham Stein	GS	National Grid (Chair)
Antony Johnson	AJ	National Grid
Bieshoy Awad	BA	National Grid
Philip Jenner	PJ	RWE
John Norbury	JN	RWE
Paul Newton	PN	EON
Herve Meljac	HM	EDF

Apologies

Fraser Richardson	FR	Scottish Power

1 Introductions/Apologies for Absence

73. GS started the meeting and the attendants introduced themselves. Apologies were received from Fraser Richardson. GS explained that the objective of the meeting was to update the workgroup on the progress that has been made so far and to seek their views on what the next steps are.

2 Approval of Minutes

a) Workgroup meeting 2 minutes - 4th April 2014

74. The draft minutes circulated by AJ and the comments received from JN were discussed. HM noted a typo on item 41 and advised that the voltage collapse in Brittany occurred in 1987 rather than 1997. The comments were accepted and the final minutes were approved.

b) Update on actions

75. The Workgroup agreed to present the Workgroup report to the GCRP by January 2015. The terms of reference will need to be updated to reflect this.

Action: AJ to update Terms of Reference.

76. AJ confirmed that CC.6.1.7 relates to “voltage fluctuations” at the point of common coupling with a fluctuating load. He advised these limits are checked through monitoring during the compliance process.

77. AJ, following a discussion with NGET Generator Compliance team, advised that National Grid is not prescriptive on the number of taps required so long as the Grid Code requirements of CC.6.3.2, CC.6.3.4 and CC.6.3.8 can be satisfied. This can be calculated based on the reactive range required (0.85 PF lag to 0.95 PF lead at the Generating Unit Terminals), the change in system voltage (1.05p.u – 0.95p.u voltage) and the limit on step voltage which in England and Wales under BC2.A.2.6 is fixed at ±25MVAr.

78. The workgroup discussed that the ±25MVAr tolerance and the limitations on voltage step changes will probably dictate that generating units of very high Registered Capacity (eg an 1800MVA unit) would require a transformer with very large, maybe a prohibitive, number of taps. One suggestion was that defining the tolerance as a percentage of the machine rating may provide a way around this.

79. HM suggested that cutting the corners of the Grid Code requirements, as with the case of Embedded Power Stations, would reduce the need for a very large number of taps without increasing the risk to the system. This is based on the assumption that there is no need for a generator to provide its maximum reactive output (ie 0.85 PF lag) at 1.05pu system voltage or to absorb its maximum reactive (ie 0.95 PF lead) capability at 0.95pu system voltage. AJ mentioned that the Transmission System is constantly changing and that we need to ensure that any change proposed will have an effect that lasts for the life of the generators and that we need to ensure that we are not undermining our ability to manage system voltages in the future. He added that over a comparatively short space of time, (over the last 10 years) there has been a significant fall in the MVAr demand.

80. GS pointed out that "cutting the corners" is one of the options under consideration (Option 3) but there is a need to demonstrate that the preferred option does not affect reactive reserves or have a detrimental effect on the Transmission System.

81. PN pointed out that, in his view, BC2.A.2.6 does not seem to be very specific and can easily be missed/misinterpreted. Hence, there may be some need to look at adding some clarification in the Connection Conditions.

Action: AJ to look at the possibility of adding some clarification on BC2.A.2.6 within the Grid Code Connection Conditions

82. HM suggested that the ±25MVAr tolerance should be omitted as, in his view, precision is not that critical and that the restriction on voltage step changes are sufficient. PN raised the point that reactive power payments are based on actual production. If this is very far off from the value instructed by NGET, some generators might be paid for a service that they were not required to provide.

83. A question was raised on whether NGET tests generating units for compliance against the ±25MVAr tolerance.

Action: AJ to discuss with the Generator Compliance team and feedback to the workgroup on whether these requirements are tested or not.

84. HM pointed that the reliability of the tap changer controller is of a higher priority than the capital cost in some circumstances. The more complicated the tap control arrangement and the more sophisticated the tap changer controller is, the more likely they may fail. It was noted the losses on energy production could outweigh any capital investment on transformers.

3 Options and Study Work

85. The options slide was discussed.

86. With regard to Option 1 as presented on slide 4 of the presentation issued on the 4th April and as updated by PJ, a comment was made that a 1.0pu constant terminal voltage is not an advantage on its own. However, the advantage is the predictability of what the voltage will be at all times.

87. The workgroup discussed the options and how they fit with RfG Article 12 Clause 2.b

88. HM's view is that RfG were written in a way that allows for variation in requirements between different countries. Hence, as none of the three options includes a significant change from the current requirements, they will all fit the RfG requirements.

89. JN mentioned that both Option 1 and Option 2 provide the same reactive capability over the same range. Option 2 utilises the capability of existing equipment to meet these requirements. Whereas Option 1 requires an over-specified tap control arrangement as it limits the terminal voltage to 1.0p.u.

90. Assessment of the consequences of any of the three options on existing derogations requires some understanding of the background of these derogations.

Action: AJ to provide background information on existing derogations whilst respecting the issues of confidentiality.

91. The idea of excluding Option 3, on grounds that it reduces the reactive capability available for the System Operator was debated but it was agreed that all options need to be assessed.

92. AJ presented the slides circulated in advance of the meeting. The first the study was presented which is a full GB system study with a double circuit fault on the Canterbury North – Kemsley, Canterbury North - Cleve Hill double circuit during high demand conditions.

93. The initial results presented suggests that the studied Generating Units provide higher reactive output for Option 1 compared to Options 2, 3a and 3b; the difference in reactive power output between Option 1, 2 and 3b is marginal; the voltage profile for options 2 and 3b are slightly better than Option 1; and the voltage profile for Option 3a is less than Option 1. It was noted that Option 3b assumes a significantly high voltage increase/tap (2.5%). It was also noted that Option 3a assumes 6 taps which is a lot less than the number that a generator transformer would normally have.

94. The workgroup discussed the fact that despite the reactive support provided from the generating unit is higher in Option 1 than in Option 2, the voltage profile seems better with Option 2. One reason might be the reactive support from another part of the system. Another reason might be that the results show the refractive output of the Generating Unit and does not actually show the reactive power delivered to the system. Looking at this graph might provide some explanation.

95. AJ mentioned that an initial study had also been run with all generator tap ranges on the GB system having been halved. It was noted that the study still converged and did not make a significant difference to the results. It was noted that the study performed was a basic load flow where system voltages had not been stressed and hence was unlikely to highlight any issues.

96. AJ noted that as the first set of multi machine studies had proved inconclusive. It was noted some basic theoretical analysis for a transformer with variable taps had also been investigated which was presented. BA explained that the reasoning behind this analysis was to try to establish better understanding of system behaviour. It will also serve to explain any conclusions in simple terms. The workgroup commented on the presentation and the analysis.

97. It was noted that the theoretical analysis seemed to suggest that a benefit (increase MVArs to the System) could be obtained from utilising a restricted tap range and increasing the Generator terminal voltage. This would have to be verified in a system study. It was also noted that if the voltage was low, would there be a reduced benefit – ie fewer MVArs to the System. It was noted that this issue would require further investigation.

4 Workgroup discussion and Next Steps

98. The workgroup discussed that the study case set up seems to suggest that reactive power will need to be transferred over a long distance to support voltage at a remote busbar. HM commented that transmission of large quantities of reactive power is generally not desirable. BA commented that this might be the only option in some cases if a fault left a demand group fed through a long radial connection.

99. HM raised a comment on the characteristic showing the response of reactive power output for a step change in voltage at the Grid Entry Point in relation to that showing the reactive power output as a function of the voltage at the Grid Entry Point at different tap settings. Whereas the latter shows a set of "parallel" straight lines, the former suggests that these lines are not actually parallel to each other. A note was made that the equations include quadratic terms, i.e. these are not parallel straight lines, however further investigation is required to clarify this.

100. The workgroup discussed typical unit parameters. PJ, HM, JN, and PM pointed out the following:

101. A typical generating unit transformer would have ±21taps. The minimum number of taps is generally in the order of ±19 taps. The maximum number of taps would be ±25 but only in very rare occasions. Tap ranges above ±25 are generally not practical.

102. Typical values of Voltage per Tap are around 1.11% or 1.25%. Usually, this does not exceed 1.67% but in exceptional cases may reach 1.7%. Values above this would violate the restriction on voltage step changes. It will also require complicated mechanical arrangements.

103. Limitations on terminal voltage are rarely dictated by the Generating Unit itself. A typical Generating Unit is able to operate between 0.95pu and 1.05pu. Operating outside this range would result in some overheating and/or over-fluxing. Restrictions would arise from the capability of the AVR itself or from the plant auxiliaries. This would limit the terminal voltage setting to approximately ±0.03pu.

104. It was pointed out that the Study Cases on the GB system accounts for the variation in transformer reactance when the tap setting changes. However, for simplicity, the model used to show the theoretical background did not account for this variation.

105. The workgroup requested a clarification of whether the GB system model includes models of voltage dependent loads.

Action: AJ to confirm how the voltage dependency of loads is modelled in the studies under consideration.

106. The workgroup discussed that the options should be assessed against a background where the Generating Unit is required to absorb VArs as well as a background where it is required to generate VArs.

107. The workgroup discussed that the studies need to demonstrate the effect of each of the three options on the reactive power delivered to the system, i.e. at the HV side of the transformer, as well as the reactive output of the generating unit.

108. PJ suggested that if none of the options stand out as particularly desirable, maybe the workgroup should consider assessing if any of the options are particularly bad.

109. HM indicated that EdF's preference is to provide a range of reactive capability requirements over a specific voltage range. Then let the Generator decide the best way to meet these requirements without specifying whether it needs to be done via tap changer control or via terminal voltage control.

110. The Slides are available at:

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

5 AOB

111. It was agreed that the next meeting should be scheduled for the 19th September.