

New Generation Technologies and the Grid Codes

Ofgem Forum

London – 24/25 March 2004

Background

The transmission licensees of England & Wales and Scotland have made proposals to Ofgem to modify the GB Grid Codes to take account of the connection of new generation technologies, particularly wind generation.

As part of the process to consider these proposals, Ofgem organised a Forum to allow all parties affected by them to express their views and offer alternative solutions where appropriate. This Forum was widely publicised and representatives from manufacturers, developers and the licensees attended. This document provides a record of the Forum. The presentations are also available in PDF format.

Attendees

The industry representatives to the Forum were drawn from the Scottish Grid Code Review Panel and the Generic Provisions Working Group (GPWG) of the England & Wales Grid Code Review Panel. Ofgem's consultants, SKM, were also represented. The names of the Forum representatives are as follows.

Industry Representatives

John Scott	Ofgem	Chandra Trikha	S&S Transmission
Gareth Evans (Chair)	Ofgem	David Ward	Magnox
John Marks	Ofgem	David Gardner	SSE Generation
David Bailey	SKM	Guy Nicholoso	BWEA
Geoff Clarke	SKM	David Nicol	SP Transmission
Claire Maxim	Powergen	Hamish Dallachy	SP Transmission
John Morris	British Energy	Nasser Tleis	NGC
John Norbury	RWE Innogy	Mark Horley	NGC
Ham Hamzah	RWE Innogy	Joe Duddy	RES
Lindsay McGrow	SP Generation	Elaine Greig	AMEC

The manufacturers were invited to attend the first day of the Forum. The following representatives attended.

Manufacturer representatives

Stefan Hartge	Enercon	Michael Rasmussen	Vestas
Frank Fischer	Enercon	Stephen Hannay	RE Power
Stephan Wachtel	Enercon	Victor Lilly	DeWind
Simon Vince	Enercon	Jan Thisted	Bonus
Stefan Franko	Alstom	Peter Jones	ABB

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Agenda

Day 1 – Presentations

Venue: City Inn Westminster, 30 John Islip St, London SW1P 4DD.

Registration and Coffee

10:00 Welcome and Introduction by Ofgem

10:15 Manufacturers' presentations

10:15 Vestas

10:45 Enercon

11:15 Alstom

11:45 DeWind

12:15 Manufacturers' Q&A

12:45 Lunch

13:15 Licensees' presentation

15:15 Coffee

15:30 Developers' presentation

17:30 Close

Day 2 – Structured debate

Venue: Ofgem, 9 Millbank, London SW1P 3GE.

Coffee

9:00 Introduction by Ofgem

9:15 Fault ride-through

10:45 Frequency range

11:15 Frequency control

12:15 Lunch

13:00 Reactive range and Voltage Control

14:30 Coffee

14:45 Negative phase sequence

15:15 Any other business

15:45 Close

The Terms of Reference for the Forum are provided here as Attachment 1.

Day 1 – Presentations & Open Discussion

Forum opening

The Technical Director of Ofgem, John Scott, welcomed everyone to the Forum and briefly summarised its aims and objectives.

Gareth Evans introduced the Ofgem team, the Forum members, Ofgem's consultants and the manufacturers – Bonus, Vestas, Enercon, DeWind, RE Power, Alstom and ABB. He then explained the process that is now in train to update the GB Grid Codes to take account of new generation technologies, particularly wind.

- The three transmission licensees have submitted change proposals to Ofgem who have to approve them before they are adopted.
- Ofgem suggested a period of for further consideration of these proposals because of the concerns expressed by a number of parties.
- In response, the licensees have aligned the change proposals for the two GB grid codes and have met with manufacturers to ensure a full understanding of the impact of their grid code change proposals. As a result, the change proposals have now been further developed.
- This Forum provides an opportunity for all parties to discuss and exchange views prior to a resubmission of the change proposals to Ofgem.
- Ofgem's target is to make a decision on the proposals in June this year.

Gareth Evans then explained the format of the Forum.

- Day 1: Industry representatives and manufacturers - bringing everyone up-to-date – the technology, aligned proposals and the alternatives available.
- Day 2: Industry representatives to discuss the licensees aligned proposals in the context of the licensees' obligation (summarised here) to maintain safe, secure and economic operation of the grid system.

He stressed that all the manufacturers that the licensees have visited were invited to attend and thanked those that had accepted the invitation. Finally, he stated that the Forum was a public event and that a record of it, including the presentations, would be published on Ofgem's website.

Manufacturers Presentations

The format of the morning session included presentations from Vestas, Enercon, Alstom and DeWind. This was followed by a Q&A session. The presentations are available in PDF format.

Representatives from each of the manufacturers formed a panel and an open Q&A session was conducted. Notes from the Q&A session are provided here.

Manufacturers Q&A

- RWE: What about certification on a wind farm basis?
 - Enercon: More important to test individual turbines. Certificates can only be done on this basis as every windfarm is different.

- DeWind: Would this level of certification be required for a CCGT?
 - RWE: CCGT is a single unit and so unit testing covers the power station level.
- ABB: Have looked at Point of Common Coupling (PCC) solutions including SVC and STATCOM
- Alstom: Responsibility lies with developer
- RWE: Our problem is guaranteeing on a wind farm level
- Econnect: Should recognise there are wind farm level solutions also. These cannot be certified.
- SP Generation: Are PSS/E models available for all manufacturers?
 - Enercon: Yes. Models must be tailored for individual Grid Codes.
 - Vestas: Yes
 - DeWind: Not at present
 - Alstom: Do not produce entire turbines. FGW have created official models that have been agreed by manufacturers.
 - RE Power: Unsure
 - ABB: Available for some components and HVDC Light summer 2004.
 - Bonus: Yes, also Matlab
 - RWE: Control systems vary, so hard to standardise models.
 - Alstom: Control systems will always vary. Also there are patent issues.
 - DeWind: Have complex Matlab model that is too detailed and confidential. Need simplified standard – maybe IEEE.
 - Magnox: For synchronous generation, model doesn't fit well with standard.
 - NGC: IEEE controller models don't fit with actual ones submitted by manufacturers. We use validated models submitted to us. Other analysis tools than PSS/E are used. Want description of performance plus block diagrams and data. RMS time-domain model is suitable. Can be submitted on a confidential basis.
 - SKM: Could identify standard test networks to validate models.
 - NGC: FGW have developed test methodology. Suggest this approach with FGW is considered in order to design generic and project specific methodologies.
 - RWE: Turbine model sometimes doesn't help – especially for fault ride-through. We have to produce overall windfarm models.
 - RWE: Have to carry full risk. Need assurances and cost information – also warranties.
 - DeWind: All manufacturers are saying that requirements can be met. The subject of guarantees is a commercial issue that is subject to competition.
 - RE Power: Are already giving guarantees on a project-by-project basis.
 - Ofgem: The summary table should provide this assurance.
 - RES: We seek PSS/E models as DNOs use this. Block diagrams would be useful, but manufacturers don't like doing this.
- AMEC: Banks are very cautious. To the component manufacturers: have you done analysis where compensation is best placed?
 - ABB: Are doing this now.
 - Alstom: Have done this. There are advantages at a central point. Most economic for fault ride-through for active stall is in turbine.
- Ofgem: Is it better to measure at the PCC?
 - RWE: Need to look more system-wide.
 - DeWind: Has to be both systems and turbine.
 - Alstom: There are windfarms populated with different manufacturers' turbines.

- Ofgem: What about the issue of zero impedance faults?
 - DeWind: Does it ever happen?
 - NGC: Yes and should be noted that our proposed requirement applies to higher voltage levels than the EON requirement.
- Econnect: How do manufacturers approach Grid Codes?
 - Enercon: Dialogue with licensees.
 - Vestas: Meetings and Grid Code documents.
 - DeWind: Look at documents and involve technical engineers.
 - Alstom: These are looked at by the R&D manager and 2 technical staff.
 - RE Power: This is a core area for us. Technical team meet with the licensees.
 - ABB: More system view. Also look at political aspects.
 - Bonus: Implement in design plus run simulations.
- NGC: Everyone's understanding of this is now better. We can produce an informed guidance note to help this process.
 - Econnect: Guidance note can contradict Grid Code. Guidance doesn't have legal force.
- Enercon: Standard description of model requirements would be helpful. Developers should take more responsibility and hence risk.
- ABB: Keen to talk with standards body only once. Where does the BWEA fit in?
- AMEC: Active power drops under fault ride-through. Is this in keeping with licensees' requirements?
 - NGC: Yes, active power does drop through the fault because this is down to the fundamental physics of the system. However we require that power should be restored immediately after clearance of the fault.

Licensees presentation

The afternoon session included presentations by the licensees and the developers. These are available in PDF format. The notes that follow summarise the issues raised by each presentation.

- RES: For NPS is the fault at the PCC?
 - NGC: Yes it is at Point of connection to publicly owned network. This requirement also appears in the Distribution Code.
 - SKM: Is this at 132kV in Scotland?
 - Don't see the point of applying this at PCC rather than supergrid – to be discussed tomorrow.
- Enercon: What does voltage control at the terminal mean?
 - NGC: This is discussed for both PCC and generator terminals. For a direct drive system, this is at the Grid side of the inverter.
- RES: The example shown of instability with 300MW of wind plant. What compensation is assumed?
 - SPT: None assumed. This justifies the need for MVArS.
- Bonus: Is it really a requirement to export MVArS at +5% of nominal voltage? This would give rise to very high terminal voltage.
- Powergen: To what extent does Scotland have to provide frequency control?
 - SPT: Scotland provides its fair share of frequency control – currently 14% of GB.
 - Magnox: Should this remain 14% under BETTA?

- SPT: Situation would change. Islanding could be a problem if Scotland produces less.
- SPT: Negative phase sequence has always been included in the Scottish Grid Code at the machine terminals. There was no requirement for fault ride-through for synchronous plant. This has now been put in for fairness.
- Econnect: Retained voltages are stated at full output power. What would it look like at low output and for 3 second duration?
 - NGC: Believe that retained voltage is largely independent of active power output– solely on reactive current fed from machine and external impedances to fault.
- Alstom: Are Licensee simulations validated?
 - NGC: Tool validated for 35 years.
- RWE: Most of these problems could be eliminated by carrying more reserve.
 - NGC: No, carrying more response is not a solution for Fault Ride Through but this is a subject for discussion tomorrow.
- Powergen: Steady-state vs. dynamic VArS. Does it all have to be provided at the machine terminals?
 - NGC: Not necessarily, it is up to the developer/manufacturer to optimise provision. E&W ask for voltage control set points not power factor control. Slow variation could be by tap changer. Must also be fast in response to voltage changes at point of connection..
 - Alstom: Tap changers would cost extra money. Power electronics is cheaper – around €50k/MVAr. Require clarification about what is required of voltage control from the machine.

Developer presentation

- Powergen: Need certainty about requirements and risks that must be managed.
- NGC: Stability of Grid Codes – most requirements are static. Minor reviews can be initiated by NGC, AEO or Ofgem at any time. What would you like to see? Believe that these proposed changes will be robust to changes in wind turbine technology as they are functional. Balancing due to intermittency will become a more important issue in the future but is not a Grid Code issue now.
- RES: Hope that the Grid Codes will be fixed for some time. It is unknown how the whole nation will act. Should leave open the option for review.
- RWE: Would like more justification for the modifications. In Ireland there is a public study.
- Enercon: In Germany there are many windfarms that do not ride through faults. This has become a real problem.
- Amec: What is the best technical option? Is this necessarily at the generator terminals? Are there any other problems?
- RWE: Round 2 offshore windfarms could run at a different standard as there is no demand nearby. Could there be a better solution?
- SPT: Could achieve system stability either at the generator terminals or by installing large transmission lines – which is less favourable.
- ABB: ABB are keen to provide expertise. Would want to be a part of review.
- Alstom: We should look at both turbine and system solutions.
- RWE: Question to manufacturers :- are things clearer after this Forum?
 - Enercon: Require clarification after review is finalised. Also on a per-project basis.
 - Alstom: Can be done. There will be problem projects. Still some doubts and fears. Have found the GB process to be professional.

- RE Power: Will be remaining issues. Happy with the process. Requirements are technically possible. Good to have views from developers.
- ABB: Simple English and diagrams are good.
- Bonus: Very clear.
- Ofgem: This is an open and transparent process – please feel free to contact us.
- SKM: Views on tolerances. Can 1 turbine in a farm drop off?
 - RES: There will be lost energy during fault recovery. Should bear this in mind.
- RWE: Nervous of further clarification required. Target should be clarity. If Grid Code is ambiguous should be made clearer.
 - RWE: Manufacturers always say they can comply. Still require clarity.
 - Enercon: Developer should not ask for compliance – should specify design in detail.
 - RWE: Some developers don't have the technical expertise. Can only take manufacturer's word for it.
 - NGC: Agree that Grid Codes should be clear. We have made a lot of progress in comparison with 18 months ago. We should try to get all parties together – close liaison with manufacturers and developers.

Day 1 close

- Ofgem thanked all parties for attending and contributing to the day's discussions.

Day 2 – Industry Representatives Structured Debate

The second day of the Forum was attended by the industry representatives. The day was structured to examine the most significant connection requirements in the aligned grid code change proposals.

The notes that follow provide a concise summary of the need for the requirement, the main points of discussion, areas of agreement and disagreement.

1. Fault ride-through (FRT)

Need

The licensees explained that they secure the transmission system against specific contingencies. Regarding generation, the system is secured to withstand the loss of up to 1320MW instantaneously. The primary objective of introducing the FRT requirement is to ensure that the system is not at risk of generation losses greater than 1320MW. NGC summarised the aligned FRT proposal.

Discussion Points

- RWE asked why this requirement is to only apply to asynchronous generation. NGC stated that this is also applied to synchronous generators although implicitly but that they would be happy for it to be applied to all plant but explained that the Generators on the GPWG requested this separation and that placing additional requirements on synchronous generation was not in the scope of the working group. SPT stated that this provision has been included for synchronous plant in Scotland. (**Post-meeting Ofgem comment:** Is this an alignment issue that should be addressed?).
- SKM asked if the licensees had quantified the capacity of plant that could be affected if the proposed zero voltage condition was raised to 15%. The licensees explained that this would depend on the location of the fault and the density of wind generation in the area of voltage depression. They expressed concern that the 1320MW limit could be exceeded.
- The basis of the 1320MW limit was discussed. NGC explained that it was judged to be the economic optimum based on their own analysis and that it is a requirement of their security standards. There was some disagreement about the justification for the 1320MW limit but Ofgem explained that this was outside the scope of the Forum's terms of reference. NGC commented that Ofgem had approved the security standard that includes this limit.
- The risk of losing a significant capacity of distributed generation was discussed. Much of this generation is not subject to the grid codes and its protection philosophy is quite different. It is generally required to trip as a result of system faults. NGC now monitors the behaviour of distributed generation in response to supergrid faults and there is no evidence to date that there is a material risk of the loss of this plant causing the 1320MW limit to be breached. NGC stated that as a long term average including 1990 there were in the region of 350 faults per annum on its system. They presented three slides that reiterated the economic case for the 1320MW limit made during the NGC review of security standards approved by Ofgem in 1999 following extensive industry consultation. RWE questioned the value of this analysis.

- RES made the point that the cost of providing fault ride-through should be taken into account in the economic analysis. NGC commented that the manufacturers report the costs to be negligible, 1-3% on wind turbine cost. RES did not agree that 1-3% is negligible. This could be quite significant.
- SKM commented that the worst case risk could be assessed locationally to establish the need for FRT. NGC commented that this could lead to locational sterilisation for subsequent comers.
- Ofgem suggested that the discussion should move on to the detail of the licensees FRT proposal.
- RWE raised the issue of a grandfathering provision. NGC commented that most existing plant is too small to be affected (i.e. is not required to comply with the grid codes).
- RWE questioned the basis for the FRT proposal that is now included in the aligned proposals. They expressed the view that it is more onerous than the previous proposal. It was also judged to be more onerous than the equivalent EON requirement. However, it was agreed that the format of the proposal added clarity and this was welcomed. NGC disputed the statement that the FRT is more onerous than EONs and reminded that EON also applied at 60kV and above. NGC stated that they were happy to discuss points of detail and consider alternative proposals.
- The issue of unbalanced faults was raised. NGC stated that it is not the intention to apply the voltage time curve with the three minute duration for unbalanced faults.
- There was considerable discussion of the post-fault system voltage profile proposed by the licensees. In particular, the justification for a 3 minute depression at 80% could not be understood. NGC: 80% figure takes account of low frequency high amplitude power oscillations. Also takes into account time response of automatic voltage control equipment where transmission system voltage can drop below 90% but remain above 80% for up to 3 minutes. Voltage oscillations between Scotland and England can happen. They stated that these are based on practical voltage assessments.
- NGC commented that the proposed voltage profile only applies at 275/400kV, whereas the EON requirement is from 60kV upwards. NGC asked developers' views on adopting 15% retained voltage at 100kV and above. RWE said that this would be an improvement. Would allow control action or disconnection.
- Ofgem attempted to summarise the debate: broad support for the need for fault ride-through; support for the structure proposed; disagreement over parameters. Ofgem commented that if all manufacturers can meet the EON requirement (this is not confirmed but believed to be the case) then it is only the differences in the GB requirement that are at issue.
- Econnect commented that there is not a full understanding of the consequences of failing to meet the requirement. Also, the commercial environment is different to Germany.
- Ofgem asked whether the developers could put forward a consolidated alternative proposal. They confirmed that they would do this.
- NGC said that they would improve clause d) of fault ride-through requirement so that it excludes unbalance. They will also consider time period for restoration of power.
- RES: There is some inconsistency between sections c) and d). If voltage <95% not obliged to provide rated power. NGC will consider power recovery time period. Powergen commented that they were not sure that mechanical power can be restored immediately. NGC; stated that manufacturers said they could do this as stated in agreed minutes. RES did not share this confidence.

- Ofgem encouraged the developers to speak directly to the manufacturers to ensure that they got first hand information. They agreed that they would do this.
- NGC; commented that there are many uncertainties covered by the 0.2Hz margin between the level of frequency deviation for the largest secured generation loss and the trip setting of the first stage of customer under frequency demand shedding – e.g. load / frequency sensitivity. They don't want to reduce system security margins. 60MW above 1320MW limit is enough to cause drop in frequency by 0.2Hz. RES; Depends how quickly turbines can restore power output. NGC; manufacturers say in the region 100 ms +.
- SKM; questioned the references to mechanical rather than electrical power. They suggested that c) in the proposal is redundant. NGC explained the background for using mechanical rather than electrical power but given the substantial progress made NGC would consider use of Active Power
- NGC; repeat proposal for 15% retained voltage at 132kV and ask whether the developers would welcome the EON proposal.
- Ofgem; ask developers when they could offer a coordinated alternative proposal. Econnect: a few weeks: Powergen; need time to develop counter proposal: RWE; will look at current technology. Econnect offer to co-ordinate and propose a target date.

Agreements

It was agreed that there was a need for wind generators to be able to ride through system faults and that an FRT requirement should be included in the grid codes. It was also agreed that the basic structure of the licensees' proposal was acceptable.

It was agreed that the developers would develop a single alternative proposal. The licensees agreed to consider the impact of adopting a requirement similar to the EON requirement.

Disagreements

It was not agreed that an FRT requirement should be introduced immediately. It was not agreed that the voltage-time curve parameters of the licensees' proposal were acceptable.

Actions

- Guy Nicholson to offer a target date to produce counter proposal for Fault Ride Through. **Post-meeting note** – the date is 22 April.
- Developers to consider whether EON Fault Ride Through requirements applying to faults at all voltage levels above 60kV would be acceptable to them and propose acceptable clauses.
- Licensees to consider fault ride-through requirement to include consideration of grand fathering rights and unbalanced faults.
- Licensees to provide background/explanation of the voltage profile after fault clearance.

2. Frequency range

Need

It is a fundamental requirement for generating plant to be able to operate at frequencies above and below 50Hz. It is the licensees intention that all plant governed by the grid codes should be able to operate over the same frequency range. NGC summarised the aligned proposal.

Discussion Points

- Econnect expressed a concern that induction generators will produce high power at high frequency.
- RES; commented that one manufacturer was concerned about a fault at 52Hz. Would have to uprate breaking systems. One said could not run at 47.5Hz continuously.
- NGC said that they have the most up-to-date information from manufacturers. They say that they can fully meet the requirement which applies in conjunction with the power/frequency characteristic i.e. greatly reduced output at 52Hz and 5% output reduction at 47Hz.
- Amec: suggested that this requirement should be redrafted. NGC: Requirements are divided in Grid Code as frequency range in CC.6.1 covers NGC and all Users while section CC.6.3 only applies to Generators.
- RWE: asked for an explanation of the situation in Scotland with condition 4.3.1 g). SPT: explanation - more likely to have an island situation in Scotland. Would want windfarm to trip – could trip immediately. RES: With this clarification they are happy. SPT: Will add clarification.
- Magnox: Confirm difference in England and Wales.
- Ofgem: encouraged discussion of the use of the word “continuous”. NGC: Not part of this process. More complex than this would appear. Can be considered in the longer term. Magnox: Would benefit from a graph.
- Magnox: What is the status of the Technical Characteristics document? NGC: This is being revised. Powergen: Should be made available with caveats.
- Econnect: Have some concerns with capabilities. Would this have to be a derogation? NGC: There is scope for frequency-sensitive relays.
- RES: Will return to the manufacturers to confirm that they can meet this requirement.
- RWE: Regarding 6.3.3 questioned whether this had been discussed with manufacturers as drafted or proposed. NGC: Response was yes with all manufacturers.
- RES: For fixed speed this is impossible (flat area). Not particularly concerned though as this couldn't be verified anyway due to the normal fluctuations in output of the windfarm with wind speed. NGC: Agreed very small changes would be acceptable as is currently the practice with other plant. Hence fixed speed would be considered to meet this requirement on this basis.
- Ofgem: commented for clarity that the summary of manufacturers' capabilities doesn't apply to all machines made by each manufacturer. NGC: Agreed.
- RWE: Is there one machine that meets all of the requirements?
- NGC: There are products that meet all requirements. Longest timescale to deliver all the requirements is one year.
- Ofgem: Developers must get this comfort directly from manufacturers.

- Amec: Graph with shaded area for CC.6.3.3 would be clearer. NGC: will look into it.

Agreements

All parties agreed that this is a necessary requirement.

Disagreements

The developers did not hold the view that all manufacturers could supply machines that complied with this requirement at the extremes.

Actions

Developers to make contact with manufacturers to get confirmation of their latest current/future capability.

3. Frequency control

Need

Transmission system operators have to have sufficient frequency responsive plant to allow system frequency to be maintained within statutory limits at all times. NGC gave a brief description of the frequency control requirement.

Discussion Points

- Econnect: High frequency response should have no economic impact. Would like to provide this. Only issue is speed of implementation. Happy with limited high frequency response. Turbines all have pitchable blades and can run at reduced power. Only issue is control software. Hardware is there. There are some economic questions. Will this actually be called on?
- Ofgem: Can licensees see a need for wind generators to provide this service? NGC: If we knew how much frequency responsive plant there would be in the next five years we would have more confidence. In 2010, 8-10GW of wind in England & Wales and 8GW in Scotland gives around 17GW plus distribution connected generation which would lower total system demand. If this doesn't happen, could possibly secure system without wind frequency control. Otherwise would have to buy frequency control from wind generators even at a high bid price. Constraining off wind and constraining on frequency responsive plant would be very costly. Inherent hardware ability is there for wind generators and control software modification has insignificant or no cost as confirmed by manufacturers. This calls for the requirement.
- SPT: Have seen this problem in Scotland. Have had to put on conventional plant for frequency control. Need capability to be delivered say 2 years in the future. This would allow time for software development.
- RWE: commented that frequency control is a non-locational service. SPT: This is not entirely the case. There is a possibility of islanded networks. Need locational frequency control for these to survive.

- RWE: Needs to be a market mechanism. No economic test in place. RES: This would give developers great comfort. NGC: Currently dispatch frequency control on BM Units.
- Ofgem: could this be relaxed for earlier installations? RES: Requires development of a market. SPT: Only talking about technical requirements here. It would be okay to retrofit software in the future. RES: We are looking at Ofgem to develop a market. Ofgem: BSSG are looking at this.
- NGC: Way forward – reconsider E&W proposals and timing to be different from Grid Code implementation date.
- SKM: Plant may need to be constrained off if they can't do this – negative signalling as they would be paid. Perhaps plant without capability should be scheduled off at no cost. NGC: Only part solution because it does not deal with cost of constraining on plant with the capability.
- RWE: Welcome suggestion of delay.
- RWE: Intention to impose this on medium power stations? NGC: they would also have to have the capability.
- RWE: Question of this applying to license exempt power stations under the Distribution Code. No sense for medium power stations to provide frequency control.
- SPT: Nobody has questioned us in 15 months and 2GW of enquiries. RWE: Have different experience. SP Gen: There are more important issues to talk about.
- RES: Finance risk is the only issue. Powergen: Still worried about license exempt medium power stations.
- RWE: Request for illustration as in presentation. NGC: Licensees will consider this.
- Econnect: Important to focus on mission-critical things – this is not one of them.

Agreements

At some level of wind generation penetration it will be vital for wind generators to provide this service. Machines with pitchable blades are physically capable of providing this service; it is a matter of software development to actually achieve it. Retro-fitting is a real option here. Not all manufacturers have a solution commercially deliverable now but all are expected to in one year.

Disagreements

The developers do not see the need to make this an immediate requirement. The need is related to levels of penetration and the developers have a more conservative view here than the licensees. The developers also challenge the need for this facility on wind farms as small as 5MW (in the north of Scotland area only).

Actions

- Guy Nicholson to provide BWEA forecasts for wind development.
- Licensees to reconsider phasing and the acceptability of a retro-fitting option.
- Licensees to consider dates for implementation of frequency control.
- Licensees to consider illustration of frequency response delivery from a wind farm.

- Frequency Control Requirement – Licensees/Developers to consider providing capability but not called into service at a future date.

4. Ramp rates (note – added to Agenda)

Need

The issue of ramp rates is covered by BC1 in the E&W Grid Code. The requirements of BC1 do not cause the developers a concern. However, the situation is different, pre-BETTA, in Scotland and so specific ramp rates have been proposed. The need is related to the control of power flows on the Scottish networks.

Discussion Points

- Econnect: No mechanism for energy lost through ramping to be compensated for.
- Ofgem: Is there a quantification of this loss? Econnect: There is no precedent. Example high wind restart – then it would be reasonable to ramp. Can't deal with lulls in the wind. The risk of large changes from tripping is very low. Don't believe it's available for operation now. RES: There is an issue of wear-and-tear on the pitch control system.
- RWE: Unnecessary risk for developers. Topography might mean wind farms comply anyway. Why is this more onerous in Scotland? SPT: Ramp rates based on experience of controlling the system. Control engineers have been caught out by the variation and unpredictability of windfarm output.
- SKM: Current problem also relates to managing exchanges between transmission system operators. Post BETTA, could GB ramp rates be agreed?
- RES: Any operational problems in normal operation? SPT: Have had problems managing transfers over short timescales. Another problem is forecast of output. Just seeing the start of the problems now. If you fall off and come back straight away, this is no problem. If you stay off, need to ramp back up.
- RES: There is not just a software costs there is also an operational cost.
- SP: Don't expect this to apply at all times. Normal fluctuations in wind speed are not a problem. RES: This should be made clear.
- Ofgem: Does BC1 of the England & Wales Grid Code help? Magnox: Only for bigger plant.
- SKM: After BETTA does this issue go away? SPT: Couldn't live with BC1 in Scotland. Would need tolerance from NGC for transfers. Transfers are measured half hourly and spot values +/- 100MW).
- **Post-meeting note** – this issue was not discussed in the recent manufacturer meetings.

Agreements

It is understood that in specific situations ramp rates can be an issue. Complying with BC1 of the existing E&W Grid Code does not present a problem.

Disagreements

The developers remain concerned about the Scottish proposals. They are not clear that they are deliverable.

Actions

- Scottish licensees to clarify that there is a requirement to control ramp rates of operational plant excluding normal wind speed fluctuations.
- Scottish licensees to consider alternatives to ramp rate requirement pre BETTA.
- Gareth Evans, David Nicol and Bridget Morgan to discuss post BETTA ramp rates.

5. Reactive range and voltage control

Need

Voltage control is a service that has to be provided on a 'local' basis. The increasing penetration of wind generation, particularly on weaker networks, makes it necessary for wind generators to be able to assist in the control of system voltage. SPT gave a brief description of the reactive range and voltage control requirements.

Discussion Points

- RWE: We have to provide full power factor range at +5% voltage. This could give excessive voltage at the machine terminals.
- SPT: Should be similar to synchronous machines which use a tap changer. Could tap grid transformer. RWE: This is not a problem at 132kV.
- RES: There is a requirement to limit voltage to 1.03 p.u. Doesn't this eliminate this?
- SKM: Unreasonable to manage voltage and reactive power at the same time.
- Magnox: If you have plant at 33kV that are not allowed to control volts they should be allowed a derogation. SP Gen: We have installed equipment that has never been used.
- Ofgem: Could this requirement be related to the connection voltage level? Derogations do not offer a way forward.
- NGC: Also need dynamic VARs for voltage control. Combination of tap changer and dynamic.
- Ofgem: What can we do going forward?
 - RWE: Could restrict the requirement to a range of voltage.
- SPT: Was the original drafting better?
 - Amec: Keeping choice open is best option.
 - RWE: Most people resigned this should be at the machine terminals.
 - SPT: Could build flexibility into the Grid Code.
 - Amec: There is a question over ownership boundary.
- Ofgem: Nature of challenge is very local.
 - SPT: Could get use out of this and would consider.
 - NGC: Should be agreed on a site specific basis.
 - RWE: How do we capture this?
 - Econnect: This makes getting bids difficult.
 - SPT: Would be happy to remove clause of voltage control at the machine terminals. Voltage control at the PCC is probably too slow.
 - RWE: Generators of 5MW have to do the full reactive range.
 - Ofgem: Is there a need for this?
 - Econnect: Some debate over the ownership of 33kV assets and whether windfarm is distribution or transmission connected.
 - Magnox: What matters is where voltage is controlled.

- SPT: May need more complicated definition of PCC.
- SKM: Needs wording to the effect of “subject to justification”.
- Amec: Should we subcontract steady-state VARs back to the TSO?
- SPT: Voltage control can be at either the machine terminals or the PCC.

Agreements

On balance, specifying this requirement at the PCC is the best option. It gives maximum flexibility to the developer. Clear differentiation of the need for steady state and dynamic voltage control is required.

There is no technical issue here, only a cost one.

Disagreements

The developers do not agree that the full voltage control range is required on all windfarms that have to meet the grid code requirements. This applies particularly for connections at lower voltages.

Actions

- Guy Nicholson to come back with suggestions on managing voltage and reactive power.
- Scottish Licensees to consider wording on full reactive power at $\pm 5\%$ nominal voltage control requirement to the effect that this may be agreed on a site-specific basis.
- Developers and Licensees to propose revised wording for voltage/reactive control of distribution ($\leq 33\text{kV}$) connected wind farms.

6. Negative phase sequence

Need

- NGC explained that there will always be negative phase sequence currents present, even in non-fault operation, and that plant must be able to withstand this as well as the currents due to a 2-phase fault at the point of connection. They gave a brief description of the negative phase sequence requirement.

Discussion Points

- RES: The requirement is for 3 phase fault ride-through at transmission level. This is at the PCC. This is anomalous. You wouldn't expect these faults to propagate.
- Econnect: Onerous to ride-through backup protection. Has huge cost implications. NGC: this is not supported by manufacturer summary table. Econnect: Propose this is removed for embedded systems.
- NGC: Have carried out voltage dip analysis and identified no immediate requirement to impose fault ride-through at 132kV. With respect to negative phase sequence we understand the concern. Would like to do similar analysis on unbalanced faults.

- Econnect: With regard to the transmission system, all faults should be considered under the fault ride-through clause, not separated. Have no problem with steady-state unbalance. Induction generators are good at balancing.
- NGC: There are two issues to be discussed: whether the fault ride-through requirement should be at 132kV, and where the clause should appear.

Agreements

Agreed that an ability to withstand NPS loadings is required.

Disagreements

Disagreement that it be applied at distribution connection point.

Actions

Licensees to perform analysis of propagation of unbalanced faults and consider aligning the requirement with that for 3 phase faults i.e. only required for faults at the $\geq 275\text{kV}$ level.

7. Thresholds

The issue of thresholds (i.e. – at what date/capacity level a particular requirement should become mandatory) was raised on Day 1. Ofgem agreed to include this in the Day 2 discussion.

All parties agree that the need to introduce these grid code changes is driven by the growth of wind generation. There is however disagreement about the penetration level at which they should become mandatory.

In theory, their introduction could be linked to actual MWs connected but this has practical difficulties for the licensees who are required to make legally binding connection offers without knowing if and when connection will actually occur. NGC plans and develops the transmission system based on signed offers for future connections.

The use of dates to trigger connection requirements is considered by the licensees to be more transparent than capacity. It also gives clear signals to the manufacturers and avoids connection 'races'. On balance, the meeting accepted this view. However, the developers argued that the dates adopted should take account of the best estimates of likely penetration.

8. Any other business

- RWE: Scottish 4.3.1 g) Clarification. Don't stay connected longer than 2 seconds. Is this the same case as for the frequency range?
- RWE: Registered capacity should be 10 minute average. NGC: Registered Capacity definition for wind farm is consistent with existing definitions. Review of all Grid Code capacity terms i.e. RC, CEC, TEC, etc. is an outstanding issue with the GCRP.

9. Forum close

Ofgem thanked all attendees for their participation in the Forum.

Both the developers and licensees thanked Ofgem for the opportunity to discuss these issues in the Forum. It was agreed that the Forum should meet again in approximately one month to review further proposals from both the licensees and developers.

Ofgem agreed to make arrangements for this meeting. Ofgem asked that all attendees should express a view as to whether the manufacturers should be invited to the next meeting.

10. Additional Actions

1. NGC to consider the public domain release of the three slides relating to the economics of the 1320MW generation loss limit.
2. Licensees to consider making public, studies to justify Code revision as in Irish Grid Code.
3. Ofgem to consider issue of license exempt medium power stations.
4. CC6.3.3 – Licensees to consider the requirement in the light of current proposals going through the review process.
5. Scottish Licensees to remove phrase “If agreed by company” from 4.3.2(c).
6. Licensees to perform analysis of propagation of 2-phase faults and consider location of NPS requirement in CCs.
7. Licensees to consider moving defining Transmission unbalanced faults n Ride Through clauses.
8. Ofgem to consider modified connection approval process.
9. Licensees to confirm operational costs associated with proposed requirements with manufacturers.
10. Licensees to consider SKM’s suggestion that compliance is on best endeavours or with derogations.
11. Scottish Licensees to clarify and redraft clauses 4.3.1 (g) (i), (ii), (iii) and (iv).
12. Responses to be submitted by 22 April.
13. Ofgem to arrange Forum to meet by end of April.
14. Licensees to consider including a dynamic model description in the Planning Code.
15. OFGEM to consider review of 1320MW loss.
16. Frequency response market to develop.
17. Application of GC requirements for Licence exempt power plant.
18. Round two discussions on Grid Code issues should be initiated soon.

19. Licensees to propose a standard for dynamic models of wind turbines. Consider FGW modelling methods and turbine certification. David Bailey proposed the use of standard test systems for checking model performance.
20. Licensees to amend the diagrams illustrating power/frequency characteristic in CC.6.3.3(b) & (d) to highlight forbidden zones and emphasize the difference in vertical axis scale for wind turbines and DC converters. Consider including such a diagram in SDC4.3.1(b)?
21. Licensees to perform analysis of propagation of unbalanced faults and consider aligning the requirement with that for 3 phase faults i.e. only required for faults at the $\geq 275\text{kV}$ level.

New Generation Technologies and the Grid Codes

Terms of Reference for the Proposed Forum

24/25 March 2004 - London

The Forum will consider the proposals made by the licensees to modify the Grid Codes of Scotland and England & Wales. It has been convened by Ofgem who will Chair the Forum. Ofgem will not express views or opinions during the Forum but will facilitate the discussion.

The main objectives of the Forum are:

- To allow the licensees to make their case for the proposed Grid Code changes.
- To allow other parties to make their cases (prepared in advance) for alternative technical solutions to those already submitted to Ofgem by the licensees.
- To reach common positions where possible
- To document areas of agreement and disagreement, to attach priorities and to discuss possible solutions to areas of disagreement
- To assist the licensees to finalise their proposals
- To assist Ofgem in reaching a decision where consensus cannot be reached

In advance of the Forum, the licensees will provide the Forum members with details of the aligned proposals. These will bring together the previous proposals for the Scottish and E&W Grid Codes to remove any inconsistencies. The non-licensee representatives will provide to all Forum members, via Ofgem, all alternative proposals that they would wish to be considered by the Forum.

Following the Forum the following steps are planned:

- Finalisation of the proposals by the licensees in early April taking account of the output from the Forum
- Extra-ordinary E&W GCRP meeting (or by email) to discuss the finalised proposals, mid April
- Consultation on the changes to the proposals in the event that the finalised proposals include material changes, completion by 3rd week in May
- Re-submission of proposals to Ofgem, end of May
- Decision by Ofgem, end of June

Ofgem recognises that the development of markets for specific ancillary services could offer an alternative to mandatory Grid Code requirements for certain generator performance standards. Such market developments are being considered by the Balancing Services Standing Group (BSSG). As the development of such markets does not offer a short term alternative or complement to changes to the Grid Codes, it has been decided that they should not be discussed by the Forum.