

New Generation Technologies and the Grid Codes

2nd Forum – Meeting Notes

London – 30 April 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 during 24/25 March 2004 to allow all parties affected by them to express their views and offer alternative solutions where appropriate. As a result of this Forum the licensees and developers have produced revised proposals and Ofgem organised a 2nd Forum on 30 April 2004 to discuss these proposals. The 2nd Forum was attended by representatives from manufacturers, developers and the licensees. 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

Gareth Evans	Ofgem (Chair)	Guy Nicholson	BWEA
David Bailey	SKM	Richard Ford	BWEA
Geoff Clarke	SKM	David Nicol	SP Transmission
Claire Maxim	Powergen	Hamish Dallachy	SP Transmission
Paul Newton	Powergen	Nasser Tleis	NGC
John Norbury	RWE Innogy	Helge Urdal	NGC
Ham Hamzah	RWE Innogy	Antony Johnson	NGC
Lindsay McGrow	SP Generation	Joe Duddy	RES
Brian Punton	S&SE Transmission	Elaine Greig	AMEC
Chandra Trikha	S&SE Transmission		

Manufacturers were invited to attend the Forum and the following representatives attended.

Manufacturer representatives

Peter Jones	ABB	Jan Thisted	Bonus
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New Generation Technologies and the Grid Codes

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London – 30 April 2004

Agenda

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

Purpose: This is intended to be the final meeting before the licensees produce their proposals for consultation and subsequent submission to Ofgem. The purpose of the meeting is to reach consensus views on as many of the issues as possible. The high level goal is for the licensees to be able to submit their proposals to Ofgem with the full support of the Grid Code Review Panels.

For each agenda item the developers will open with their comments based on their published proposals. The licensees will respond, providing updates as appropriate. Each item will close by summarising the points of agreement, disagreement and further actions.

- 9:00 Introduction by Ofgem
- 9:10 Review of actions from 24/5 Forum**
- 9:30 Fault ride-through**
The issue of compliance will be addressed under this item
- 10:45 Frequency range**
- 11:15 Frequency control**
- 12:15 Lunch
- 12:45 Reactive range and Voltage Control**
- 14:00 Negative phase sequence**
- 15:15 Any other business**
- 15:45 Close

Forum Opening

Gareth Evans, the Ofgem Project Manager, welcomed the representatives who went on to introduce themselves. Ofgem explained that following the Forum that took place on 24/25 March 2004, BWEA, NGC and SPT/S&SE have produced revised proposals. The purpose of this 2nd Forum was to review the revised proposals and to agree as far as possible the content of the revised grid codes that would go forward to the next stage of the development process. For both NGC and SPT/S&SE this would involve the submission of papers to the respective Grid Code Review Panels in mid May 2004. (see Item 7 of these minutes)

Review of actions from 24/5 March Forum

The status of actions resulting from the 24/25 March 2004 Forum was established as set out in the table below.

	Action	Status
1.	NGC to consider the public domain release of the three slides relating to the economics of the 1320MW generation loss limit.	Done
2.	Licensees to consider making public further studies to justify Code revision as in Irish Grid Code.	Studies have been made public either at the GPWG, the Scottish Panels, IEE presentations and both Forums + additional studies to be provided separately
3.	Ofgem to consider issue of license exempt medium power stations.	Ongoing debate outside of this Forum
4.	CC6.3.3 – Licensees to consider the requirement in the light of current proposals going through the review process.	NGC see no further action – BWEA want issue left open
5.	Scottish Licensees to remove phrase “If agreed by company” from 4.3.2(c).	Done
6.	Licensees to perform analysis of propagation of 2-phase faults and consider location of NPS requirement in CCs.	Done – location of NPS requirements moved within Connection Conditions.
7.	Licensees to consider defining Transmission unbalanced faults n Ride Through clauses.	Done
8.	Ofgem to consider modified connection approval process.	Ongoing debate outside of this Forum
9.	Licensees to confirm operational costs associated with proposed requirements with manufacturers.	To be discussed at this Forum
10.	Licensees to consider SKM’s suggestion that compliance is on best endeavours or with derogations.	To be discussed at this Forum
11.	Scottish Licensees to clarify and redraft clauses 4.3.1 (g) (i), (ii), (iii) and (iv).	Done

12.	Responses to be submitted by 22 April.	Done
13.	Ofgem to arrange Forum to meet by end of April.	Done
14.	Licensees to consider including a dynamic model description in the Planning Code.	Done
15.	OFGEM to consider review of 1320MW loss.	Out of scope for the Forum
16.	Frequency response market to develop.	Out of scope for the Forum
17.	Application of GC requirements for Licence exempt power plant.	Ongoing debate outside of this Forum
18.	Round two discussions on Grid Code issues should be initiated soon.	No action required
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.	Done
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)?	To be discussed at this Forum
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.	To be discussed at this Forum

1. Fault Ride Through (FRT)

Discussion Points

BWEA briefly presented their latest proposals with respect to FRT and summarised them as:

- the FRT threshold to be set 100MW
- the retained voltage profile to set as per EON i.e. 15%

Ofgem suggested that a "one size fits all" approach may not be appropriate and that different criteria could be applied to different voltage levels. There is a difference in views between SOs and developers with the SOs having undertaken studies to demonstrate fault propagation within the network.

NGC considered that having the same retained voltage at all voltage levels has no logic and quoted a number of world wide utilities (Canada, Australia, and France) where a retained voltage of 0% is required. EDF has proposed 0% at 400kV and 225 kV for 110 ms (and 15% at 132kV). *(post meeting NGC note – Based on the latest information we have to date wind farms in France are required to remain connected for 0% volts for 250ms on the 63 and 90 kV networks)*. Also the conditions placed around the ESBNG FRT provisions (which are similar to EON) that allow for ESBNG to require an enhanced FRT may not be workable. NGC pointed out that a 15% retained voltage is not an industry standard and considered this to be the minimum voltage seen at the terminals of individual generating units at which DFIG converters can continue to function according to manufacturers

NGC stated that the Generation Connection Criteria in the Security and Quality of Supply Standard includes a customer choice element which allows a customer to request variations from the standard design provided that the variation criteria are met. These criteria deal with security of the main system, any additional system investment and / or operational cost, and future changes. From analysis studies NGC could negotiate different standards for different parts of the network. The "Customer Choice" route would require NGC and the customer to have a derogation from the Grid Code which may have to be called in sometime in future if system conditions change. RWE stated that derogations are not the preferred route and that the grid codes should be definitive.

BWEA stated that they would like to see fault statistics that show the distribution of 3-phase faults pointing out that the NGC system has recently been subject to a 3-phase fault. NGC stated that the deterministic security criteria in the Security and Quality of Supply Standard had been established from probabilistic studies undertaken during the 1990s and approved by Ofgem. Changing the criteria was not considered to be a subject for discussion at this forum.

NGC stated that the manufacturers had indicated that they were able to deliver FRT according to the proposed grid code provisions. Ofgem proposed that, as the final proposals are likely to be different to those previously presented to the manufacturers, they should be fed back to them for further comment and impact assessment as part of the consultation process.

Ofgem asked BWEA why they did not consider a 3-phase fault with 0% retained voltage to be a credible event. BWEA maintained that evidence had not been tabled to substantiate this position.

RWE stated that an impact assessment of FRT at different retained voltages should be undertaken to establish costs and benefits.

RWE questioned why conventional plant had now been caught by FRT provisions. NGC stated that the proposed changes had been subject to a wide consultation involving synchronous plant operators and this was supported by SPT/S&SE who additionally noted that their proposals had always included synchronous plant being subject to fault ride through proposals.

Ofgem asked BWEA what retained voltage should be used and BWEA restated their preferred use of the EON standard of 15% but no evidence or justification was provided

NGC went on to explain the rationale behind the proposed FRT curve and Powergen questioned how the curve would be applied to network models to demonstrate compliance. RWE expressed concern regarding compliance monitoring during actual operation and did not want to see the need for complicated monitoring systems.

NGC indicated that the FRT curve was not a continuous voltage/time response to be imposed on the network model but that it was a voltage / duration curve which represented a set of retained voltages associated with different time durations. The envelope had been developed taking into account the most onerous credible faults. NGC reiterated that the curve was not a continuous voltage/time plot as some attendees had assumed.

NGC went on to present their compliance process and tabled the diagram shown on Attachment 1 including the objectives developed from all parties. NGC explained that they had arranged a meeting with the Federation of German Windpower (www.wind-fgw.de) and that this organisation was a valuable source of generic initial information on wind turbine generators. RWE pointed out the importance of modelling actual control systems and questioned the usefulness of generic models.

NGC stressed the importance of developers entering into discussions with NGC at an early stage so that requirements can be established early in the connection / compliance process.

BWEA questioned whether demonstrating compliance as part of the connection process would be the end of the matter. NGC stated that compliance would be monitored under OC5 (as with conventional generators) and that NGC is reasonable in its monitoring practice taking into account the practicalities of monitoring wind farms. SKM pointed out that FRT is not commercially driven (i.e. it is not an ancillary service for which payment is made) and that monitoring principles should recognise this. This process also applies to conventional generators.

NGC referred to two documents which dealt with compliance issues for both conventional generation and wind farms. These are available on the NGC website and available from the attached link.

http://www.nationalgrid.com/uk/indinfo/grid_code/pdfs/Compliance_Report_November_2001_issue_10.pdf

http://www.nationalgrid.com/uk/indinfo/grid_code/pdfs/AddendumtoGuidanceNotesforGeneratorsD31.pdf

NGC advised that these documents were constantly under review as the technology developed. NGC advised that they would be happy to receive any comments on these documents or the process diagram in Attachment 1. ABB stated that they were encouraged by the NGC compliance process.

RWE asked whether NGC would approve manufacturers' products. NGC stated that it would not undertake type approvals but would register the characteristics of products so that repeat requirements with the same product on different projects could be smoothly processed.

NGC stated that FWG models (in German) are available to members. NGC encourages type testing but also has to deal with project specifics using various information including data from type testing. Formal type approval is not followed in order to maximise the design options to the developers at the turbine level.

At this point it was decided to move on to other agenda items and return to FRT later in the proceedings.

2. Frequency range

Discussion Points

RES stated that operation at the proposed high frequency limits is acceptable but that operation at the low limit was problematic. Regarding continuous operation at 47.5Hz NGC stated that they would look at this but indicated that a significant amount of work would be required to set new frequency and time bands. SKM questioned the extent of the work required in this area and considered that the task would be relatively straightforward. NGC stated that the time taken to undertake manual actions could determine the timescales involved.

NGC indicated that, based on the data they had collected, the overall frequency range is not an issue for manufacturers and that the required endurance (in minutes) in the frequency bands would be subject of a forthcoming review..

BWEA pointed out that the endurance at the extremes of the frequency range should take into account the thermal limits of plant and equipment.

Actions

It was agreed that this issue could be closed and that no further action was required.

3. Frequency Control (FC)

Discussion Points

Ofgem opened the discussion by summarising the overall conclusion of the 1st Forum meeting: no technical barriers to the provision of frequency control (FC) have been identified. Not all manufacturers have commercial solutions available at present but expect to in the near future. There is no dispute about the system need for frequency responsive plant. The issues remaining are when should frequency control be required under the grid codes and should it be required for all plant sizes.

BWEA considered that constraining wind off at times of low demand is the way forward until such a time that it can be demonstrated absolutely that it is required from wind generation.

SPT/S&SE stated that they were prepared to relax their previous proposals on FC so that the Scottish Grid Code (SGC) would now require all plant commissioning from now to be capable of FC in 2 years time (2006), at which time the GB market is planned to be in operation. SPT/S&SE further stated that if wind generation had to be constrained off because it did not have a FC capability then it should be without compensation.

NGC pointed out that there now existed market opportunities (at times of £60/MWh for deloading) for FC and that generators would be denying themselves the opportunity to participate in this market if they did not have a FC capability. Manufacturers had indicated that this capability could be provided at negligible cost. RWE took the position that the economic case for the provision of FC from wind generation was not proven.

BWEA made the point that there was an issue regarding the determination of lost energy from wind generation when providing FC as the variability of the resource would make this difficult to predict accurately.

NGC stated that the present Grid Code arrangements for the provision of FC capability are mandatory. For wind generation the grid code requirements have been delayed by 2 years which gives 1 year to prove the capability given that this is expected to be available for delivery from most manufacturers in early 2005.

SPT/S&SE considered that plant connected to 132kV and above will require FC capability but pointed out that most wind farms are below 100MW and that there was an issue regarding the volume connected below 100MW.

BWEA expressed concern about compliance and questioned how NGC propose to verify that the service has been delivered. NGC stated that they have a methodology to monitor compliance and have the tools to determine when and where FC is needed taking into account the variability and diversity of wind generation. Existing frequency response monitoring tools could verify if the service had been delivered.

Powergen questioned whether there was a route to market for FC below 100MW. NGC responded by stating that they consider the market rules require changing to 50MW because of the increasing volumes of wind generation that are foreseen. NGC also expressed concern that the retrofitting of FC capability could be problematic in respect of warranties and other retrospective contractual issues with suppliers.

NGC took the opportunity to clarify statements on reserve made in the Seven Year Statement regarding wind generation. The statement was in connection with long term reserve to cover wind generation intermittency and variability in output across the country taking into account geographical diversity. It concluded that adequate conventional generation was available to manage wind power intermittency assuming that Grid Code requirements for fault ride through are met.

In response to a question from RWE on the number of 1000 MW losses, NGC referred to the diagram showing the number of generation infeed losses and the associated costs of reserve and lost load. NGC explained that their primary concern was the loss of 1320 MW of generation. RWE said they were not convinced that the results substantiated the economic case for setting the levels of spinning reserve. NGC stated that this methodology was used by NGC a few years ago during the review of the Security and Quality of Supply Standards approved by Ofgem.

Ofgem summarised the remaining issues on frequency control as being when and what threshold should be applicable to wind generation.

Actions

NGC to refer the need for a route to market for 50MW to appropriate body.

4. Reactive range and voltage control

Discussion Points

Ofgem opened the discussion by summarising the position reached at the previous Forum meeting: there are no technical barriers to achieving the reactive range and voltage control requirements proposed (at the PCC). The remaining issues relate to actual application at different voltage levels and cost.

BWEA outlined their latest proposals for reactive range which related to relaxing the lagging power factor requirements at the high voltage extremes and relaxing the leading power factor requirements at the low voltage extremes. SPT/S&SE considered the proposed requirements to be reasonable at 33kV and below but considered them unnecessary above 33kV as the tap changers on step-down transformers would cover the requirements. NGC stated that a standard tap-changer range would cover the requirements.

BWEA made the point that compliance with the reactive power range within voltage limits should be a "shallow" connection charging issue and that the cost of any "deep" reinforcements required for compliance should not fall upon the generator.

SPT/S&SE stated that they preferred to stay with the requirements as set out in CC.4.3.1 (c). Powergen questioned why a similar diagram was not included in the NGC Grid Code and NGC undertook to consider including a diagram.

SPT/S&SE stated that they expected wind farms to be benign or to contribute to reactive power demands so that a voltage control range is required. BWEA commented that there was a relationship between reactive power capabilities between steady-state, dynamic and FRT. SPT/S&SE considered that they require a dynamic lagging and leading reactive power capability and undertook to review the Grid Code wording so that the steady-state and dynamic requirements are clearly set out. AMEC considered that steady-state and dynamic reactive power requirements should be separated.

SPT/S&SE took the view that the provision of dynamic reactive power was the responsibility of the developer in order to meet FRT. SKM considered that the FRT reactive power provisions need to be tightened up as the use of different WTG technology could have a different impact on the network.

The discussion moved on to Figure X in the BWEA submission and NGC considered that the tapered requirement below 50% active power was unnecessary. Also the NGC Grid Code allowed for a pro-rata reduction in capability with the amount of plant in service. Also NGC considered that the 10% active power limit for minimum generation was also unnecessary because the NGC Grid Code allowed this limit to be quantified as the Designed Minimum Operating Level (DMOL).

NGC agreed with the green shaded area on Figure X (i.e. a tolerance around zero below the Designed Minimum Operating Level) to cover the uncertainties associated with start-up and shut-down. SPT/S&SE suggested that there should be some hysteresis between the zones demarcated by the Minimum Operating Level where reactive power above the line is despatched by the SO and below the line despatched by the generator.

NGC and SPT/S&SE agreed that a capability chart along the lines of a modified Figure X was the way forward and BWEA undertook to refine their proposal.

RWE questioned why reference to performance requirements and a Bilateral Agreement had been added to CC.6.3.8.(b). NGC explained that this requirement covered the settings associated with voltage controller gains, limits, time constants etc that were specific to the connected plant as is current practice with synchronous plant

Actions

NGC to consider the inclusion of a reactive power vs. voltage chart in the Grid Code.

BWEA to revise reactive power capability chart (Figure X) and NGC and SPT/S&SE to consider inclusion in the Grid Code.

NGC and SPT/S&SE to review dynamic reactive power requirements.

5. Negative phase sequence

Discussion Points

BWEA outlined the issues in the light of the clarification on the FRT curve being an envelope of retained voltages associated with different time durations and considered that there could still be problems with converter crowbar operation. NGC stated that most manufacturers had advised that NPS was not a problem.

Actions

It was agreed that this issue could be closed and that no further action was required.

6. Ramp Rates

Discussion Points

SPT/S&SE stated that they have problems in balancing the power exchange between their areas and with NGC and that the ramp rates stated in the SGC are consistent with load following thermal plant. The ramps rates are applicable pre-BETTA and would need to be revised when BETTA comes into effect.

BWEA considered that ramp rates could be delivered during start-up but that there could be difficulties during normal operation due to wind variability. Also there would be a commercial impact if ramp rates have to be limited below what could be derived from prevailing wind conditions. BWEA considered that some short term measures could be put in place to comply with requirements.

Actions

Ofgem summarised the position on ramp rates as follows:

- the NGC ramp rates do not present a problem.

- the SPT/S&SE ramps rates are a problem for wind generation and Ofgem will refer the issue to the BETTA team for guidance.

7. Next steps

Ofgem stated that it would not be necessary for the entire group to meet again as all parties have had the opportunity to express views. Ofgem expressed disappointment on the lack of consensus on FRT, the major outstanding issue. Ofgem would like to achieve consensus but if this is not possible then Ofgem will have to make a determination on the content of the grid codes with respect to FRT. Ofgem could make such a proposal for FRT using its consultants and feed this back for comment. However legal advice would need to be taken as to whether Ofgem would be able to take this course of action. Ofgem advised that it is very likely that they will be required to produce a Regulatory Impact Assessment.

NGC advised that a paper on grid code change proposals would be submitted to their GCRP on 20 May 2004 and would take into account the Forum discussions. A full public consultation would follow.

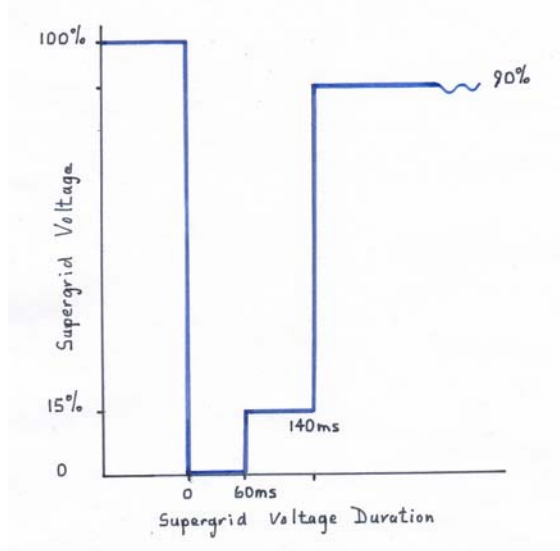
SPT/S&SE advised that a paper on grid code change proposals would be submitted to their GCRP on 13 May 2004 and would take into account the forum discussions. As a matter of procedure the initial grid code change proposals may have to be formally withdrawn.

Ofgem stated that the NGC and SPT/S&SE consultation process should proceed concurrently by the end of May 2004. The SOs should be in a position to report back by the end of July 2004.

8. FRT (revisited)

Discussion

SPT/S&SE stated that the 15% retained voltage as proposed by BWEA is a compromise that does not appear to be based on any rationale. BWEA suggested curves for a 3-phase fault resulting in 0% voltage at the Supergrid.



(Post-meeting comment – the times shown in this diagram are illustrative and relate to fault clearance circuit breaker operations close to and remote from the fault location.)

Ofgem raised the issue of the need for FRT in a situation where no credible fault could cause more than 1320MW of plant to be disconnected. NGC stated that although some relaxation could be given at the time of connection if the customer requests it, there may be a requirement to enhance the requirements at a later date. The option could be requested by the customer 'Customer Choice' SPT/S&SE were not fully in favour of the customer choice proposal as a GB standard was preferred to a patchwork of customer arrangements and sterilised areas.

Ofgem asked what voltage is likely to be retained at the generating unit terminals under for a zero impedance supergrid fault. NGC stated that they would not expect it to be less than 15% taking into account typical machine and transformer impedances.

BWEA raised concerns about the risk of non-compliance and also about the bankability of projects using new technology. RWE suggested that some of the risk could be transferred away from the generators if the penalties associated with non-compliance could be waived for new and evolving technology.

BWEA stated that they would like to reconsider their position on reactive power capability during FRT in view of the clarification of the FRT curve as an envelope. SKM pointed out that the requirements of CC.6.3.2 as set out in the NGC Grid Code are not reflected in the SPT/S&SE Grid Code.

BWEA suggested that there should be a tolerance on FRT with a best endeavours approach to design and if things do not work fully in practice then some reasonable relaxation. SPT/S&SE and NGC stated that this issue is already covered under OC5 and the CUSC.

Ofgem stated that it would be necessary to keep manufacturers involved through the further consultation processes. However, it was stressed that system need must be the primary driver for the grid code requirements rather than the capabilities of manufacturers' equipment.

ABB made the point that cost has to have an influence on capabilities and Ofgem stated that manufacturers had indicated an additional cost of several percent for the provision of FRT capability.

NGC stated that 5 developers have already stated that they can comply with FRT (as per the proposed Grid Code) and set out in bilateral agreements and that the developers were comfortable with the compliance process for FRT.

Ofgem undertook to look into what would be needed for a Regulatory Impact Assessment on FRT.

Actions

BWEA to review position on FRT in light of the clarification of the FRT curve as an envelope

9. Forum close

Ofgem summarised the discussion by saying that FRT is the only issue where substantial differences in views remain. This view was supported by the meeting.

It was agreed that a further meeting of the Forum is unlikely to be required although further discussion between the parties will continue.

Ofgem stated that they would circulate notes of the forum as soon as possible.

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.

The forum closed at 16:15.

New Generation Technologies and the Grid Codes

NGC Compliance Process (the following notes were provided by NGC after the meeting)

Objectives of process for main parties involved:

For System Operator:

- ◆ Establish compliance with technical requirements, confirming contribution to system security
- ◆ Define wind farm characteristics, the basis for contracting Balancing Services
- ◆ Establish and validate models and associated data for the wind farm, for use in evaluating system security in design of the Power System (dealing with other applications) and in System Operation.

For Project Developer & Owner:

- ◆ Obtain Operational Notification (ON) to allow commercial operation ASAP
- ◆ Certainty of outcome of compliance prior to project commitment - minimise project risk
- ◆ Define plant capability ready for contracting – maximise commercial opportunities

For Wind Turbine Generator Manufacturer:

- ◆ Ability to give confidence to Developers/Investors of low risk while minimising own risk exposure
- ◆ Deliver practical compliance at least cost
- ◆ Maximise activity in factory, minimise site activity
- ◆ Streamline process to maximise reuse of approach from project to project
- ◆ Provide effective performance feedback to design / product development

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NGC Compliance Process

