



Wind Turbine Noise & Shale Gas Extraction

Towards a Robust Regulatory Roadmap?

by

David Unwin

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Executive Summary

This paper compares and contrasts the regulatory framework in place for onshore wind turbines with those for shale gas extraction and minerals working. A central feature of the current roadmap for building and operating onshore wind farms in England is the absence of an effective regulatory roadmap of the type that is commonly imposed on other large industrial developments in essentially rural areas.

It is concluded that the current regulatory regime for onshore wind is too light, unable to inspire the confidence of communities close to operating wind farms that is essential to any further developments. It would benefit from any or all of the following additions:

- national oversight of development proposals;
- replacement of the discredited ETSU-R-97 with a noise assessment based on the principals of BS4142 as the basis for the noise assessment;
- better supervision during construction to ensure compliance with relevant planning conditions;
- immediate post-construction forensic testing for compliance with agreed planning noise conditions;
- continued post-construction monitoring to ensure that this compliance is maintained;
- establishment of local liaison committees together with a licensing scheme to monitor operation for the lifetime of any WTF project.

List of Abbreviations Used

CSG	Commissioner for Shale Gas
DBEIS	Department for Business, Energy and Industrial Strategy
DEFRA	Department for Environment, Food & Rural Affairs
EA	Environment Agency
EAM	Excess amplitude modulation
EH	Environmental Health
EHO	Environmental Health Officer
EIS	Environmental Impact Statement
GPG	<i>A Good Practice Guide to the Application of ETSU-R-97 for the Assessment of Wind Turbine Noise</i>
HF	Hydraulic Fracture
HFC	Hydraulic Fracturing Consent
HFP	Hydraulic Fracture Plan
HSE	Health and Safety Executive
IoA	Institute of Acoustics
LPA	Local Planning Authority
MHCLG	Ministry of Housing Communities and Local Government
OGA	Oil and Gas Authority
PEDL	Petroleum Exploration & Development License
PINS	Planning Inspectorate
PPG	Planning Practice Guidance
SCADA	Supervisory Control and Data Acquisition
SERG	Shale Environmental Regulatory Group
SGE	Shale gas extraction
SN	Statutory Nuisance (SN)
SoS	Secretary of State
WTF	Onshore wind turbine farm

The author

David Unwin is now retired and writes in a private capacity. He is Emeritus Chair in Geography at Birkbeck, University of London. He was a founder member of the INWG and has published papers in which he examines the statistical methods mandated by the ETSU-R-97 protocol to analyse noise survey data in developer Environmental Impact Statements. In this work, he has examined numerous developer noise assessments. In addition, from his background in climatology and meteorology (he was FRMetS from 1965 to retirement in 2002), he has used anemometer tower data from several sites in Northamptonshire to test developer wind harvest claims. This is his first attempt to address regulatory issues related to onshore wind.

From Hansard December 2018

Wind Power: Noise: Written question – 198310

Q Asked by [Heidi Allen](#) (South Cambridgeshire)

Asked on: 03 December 2018

Department for Business, Energy and Industrial Strategy

Wind Power: Noise

198310

To ask the Secretary of State for Business, Energy and Industrial Strategy, whether he is taking steps to ensure that the level of regulation applied to fracking sites on the permanent monitoring of noise emissions applies also to (a) the wind industry, (b) wind turbines and (c) all wind farm sites; and if he will make a statement.

Answered by: [Claire Perry](#)

Answered on: 27 December 2018

Planning authorities are responsible for applying and enforcing any conditions attached to the planning permission for a fracking or wind turbine development, and this must be assessed on a case-by-case basis. This may include monitoring of noise levels.

1 Introduction

1.1 This paper examines the regime in place in England for the assessment and regulation of wind turbine/wind farm noise. Following similar usage by the Department for Business, Energy and Industrial Strategy (DBEIS), this entire process is referred to as a *Regulatory Roadmap*.

2 Regulation of WTF noise in outline

2.1 Although in this note we concentrate on proposals for new onshore wind turbine farms (WTF), the arguments presented apply possibly with more force to proposals for *repowering* extant WTF with new hardware. Whether or not these same arguments should be deployed in relation to existing, operational, WTF is moot. Currently, permission to build, operate, or repower and operate, a WTF is entirely within the standard planning system in which a developer applies to the relevant *Local Planning Authority* (LPA) for permission to develop. Typically, the process starts with a submission by the developer of an outline proposal in order to obtain a *scoping opinion*. At this stage affected communities are unlikely to hear of the planned application and the scoping will not formally consider their possible reactions. At the request of the LPA, applications for larger projects are normally accompanied by a justification and a detailed *Environmental Impact Statement* (EIS) developed at the proposer's expense to address environmental concerns, including noise.

2.2 WTF noise has been a cause for concern for many years. Currently, WTF noise potential is assessed using a protocol called ETSU-R-97 devised in 1996 at the behest of the then *Department of Trade and Industry* by a committee comprising government officials and wind industry acoustics consultants at a time when it was considered anti-social to criticize wind turbines. At that time, it was considered that the existing guidance for controlling industrial noise such as BS4142:1990 would inhibit wind energy development, with various technical arguments being advanced regarding the alleged difficulty of applying it to turbine noise. After almost two decades of use, and following legitimate concern from both environmental noise consultants and in the main resident groups affected by WTF developments, in 2013 the noise consultant's trade association, the *Institute of Acoustics* (IoA) published *A Good Practice Guide to the Application of ETSU-R-97 for the Assessment of Wind Turbine Noise* (GPG, IoA 2013). This outlines the processes that are supposed to be followed by (typically) noise consulting companies acting for the developer and/or opposition groups. It is this version of ETSU-R-97 that remains policy.

2.3 ETSU-R-97 is a two-stage process. Initially, it uses standard noise propagation software and turbine manufacturer noise output data, warranted or otherwise, to predict the noise climate over the area surrounding the development, setting a threshold of 35dB using the weighted measure of sound known as L_{A90} . This is the level of noise exceeded 90% of the time adjusted to the average hearing response of the human ear. Should there be potential *receptors* (residences) inside a 35dB noise contour there follows a second more complex process in which properties are identified as being at risk and a measurement survey undertaken. This results in a plot of the baseline background noise (measured as L_{A90} averages over ten minutes) at a selection of representative receptors as a function of the wind speed at 10m above ground as inferred from on-site anemometry. A generalizing polynomial curve of unspecified and seemingly arbitrary order is then fitted through these data using ordinary least squares regression and used to provide a representative value for the background at each whole number wind speed. These values are used to establish an appropriate planning condition for the WTF should it be granted planning consent. Underlying this process is the notion that any WTF related noise can be swamped when added to the existing noise climate and will therefore not present a significant additional loss in amenity.

2.4 The arguments and data presented in the developer's EIS are tested locally in the usual planning process through which, after consultations with various statutory bodies and the public, a salaried planning officer makes a recommendation to the relevant LPA which may or may not accept it. At this stage most LPA Environmental Health Officers (EHO) are ill-equipped to scrutinize the developer noise assessment in the EIS which is likely to be accepted without such scrutiny. Arguments for and against the entire development take the form of written submissions to the LPA and what is normally a limited number of three-minute presentations during a routine meeting of the LPA. Should the LPA decide to allow the development, planning conditions, with which the development must comply, are drafted and appended to the permission. Appropriate conditions for noise nuisance are virtually standard and appear cut and paste into most granted permissions. A copy of the current IoA (IoA, 2013) suggested conditions that are almost always used are attached as an *Annex* to this note. There is no extant statutory agency that at this stage might be called upon to comment on the developer's noise assessment; whether or not it is tested relies entirely on whether or not either local members of the public or the elected members of the LPA and their salaried officers see fit.

2.5 Many large onshore WTF proposals are not consented by the relevant LPA, which frequently responds to local concerns and, usually for reasons of visual or cultural heritage impact, declines permission. In such

circumstances the developer has the option of appeal to the *Secretary of State* (SoS) who in turn empowers the *Planning Inspectorate* (PINS) to determine the outcome, frequently through the medium of a formal public inquiry at which the entire proposal is tested, and a recommendation is made to the SoS by the inspectorate. Usually, this decision is made by the PINS Inspector: it is only if the application is *called in* that the appeal is determined directly by the SoS. For the noise assessment, developers often employ specialist noise consultants to defend the EIS, but whether or not their arguments are tested is a matter of chance. In practice, very few communities have either the knowledge or resources to address the scientific complexities of sound propagation in varied meteorological conditions and, whatever the truth of the matter, it is very unlikely that any inspector would feel able to challenge the developer's consultant-driven noise assessment. In consequence, it is rare for potential noise nuisance to be cited as a reason for refusing permission unless a fully independent acoustics consultant has been employed by either the LPA or an opposition group (Cox, Unwin and Sherman, 2012). Despite this, the evidence is that where suitably qualified testing of a noise assessment is employed the developer's noise impact assessment is often found wanting. Note that, although the noise assessment may have been subject to greater scrutiny than is the case of approval at the LPA stage, whether or not this occurs at a public inquiry is a matter of happenstance. If the recommendation is for approval, a set of planning conditions negotiated by interested parties at the conclusion of the inquiry will be attached to the decision letter. Again, with respect to noise, these will usually follow the IoA model as detailed in the *Annex*.

2.6 Other than the use of the ETSU-R-97 protocol to assess the potential noise nuisance from onshore WTF, there is nothing in this description so far describing the planning part of the Regulatory Roadmap that differs substantially from the local planning process for *any* large development. Not only is there no provision for explicit and strictly disinterested testing of the noise assessment, it should be apparent that it also relies heavily on the robustness of ETSU-R-97 process, the validity and representativeness of any turbine and noise climate survey data, and the impartiality of its processing and presentation. This is not an appropriate forum at which to expand on the merits or otherwise of ETSU-R-97. Suffice it to record that there is a substantial literature that casts doubt on its understanding of noise generation and propagation in complex atmospheric conditions, its mandated sampling in space and time of any local pre-existing noise climate, its (mis) use of statistical regression analysis, its implications for human hearing, its failure properly to address the character as well as the volume of noise, its neglect of transmitted energy at frequencies outside the range of human hearing, and its failure to incorporate any margins for any of the

many possible uncertainties in the assessment (see for example Bowdler, 2012; Cowen, 2015; Greenough and Unwin, 2013; Unwin and Cox, 2013). In review, these uncertainties have been estimated as being of the order of up to +/-8 to 10dB in the background values used as benchmarks (Cox, Unwin and Sherman, 2012). An uncertainty of +/- 10dB represents a doubling or a halving of the measured noise. This uncertainty in the process, about which ETSU-R-97 is utterly silent, carries with it the danger that a consented and operational WTF can justifiably claim compliance with ETSU-R-97 based planning conditions, but when operational will exceed the defined limits or otherwise cause a noise nuisance. It is clear that ETSU-R-97 process provides a great deal of flexibility for the wind turbine developer's acoustician to demonstrate that the wind turbine complies with noise limits. As illustrated by the long-running issues at Den Brook WTF, any features of the WTF generated noise not anticipated by ETSU-R-97, such as the phenomenon of *excess amplitude modulation* (EAM), will be subject to legal uncertainty, with or without, conditions additional to the IoA set (see Cowen, 2015 for a discussion), making whether or not the development is compliant moot. Based on his experience at Cotton Farm WTF, Gray (2015) outlines the numerous difficulties experienced by a local community group when attempting to use formal legislation related to *Statutory Nuisance* (SN) to mitigate noise in excess of the ETSU-R-97 set limits or EAM.

2.7 It is difficult to reconcile the confidence shown by the acoustics consulting industry acting on behalf of wind turbine developers in its assessment of WTF noise with the results reported by Sherman (2015), at least in respect of EAM. In England, of the 203 responses to his survey, 54 LPAs had received complaints about WTF noise. This should not be interpreted as 27% of wind farms giving rise to noise complaints; many of the LPAs that reported no complaints may well have no operating wind farms in close proximity to housing. Of these 54 LPAs, 17 had investigated complaints about EAM. Over 600 individual complaints had been received, with the majority in the five-year period from 2010 to 2014. Perhaps reflecting the geographical distribution of operating WTF, the main clusters of complaints were in the East of England, East and West Midlands, North West and South West, with less in the South East, and at the time of writing just one in Yorkshire and the Humberside, and one in the North East.

2.8 When operative, any WTF is subject to a regulatory regime defined by the conditions attached to its specific permission. As noted above for noise these are typically a copy of those suggested by the IoA listed in the *Annex* as clarified by their accompanying *Guidance Notes 1 – 4*. Although the operator must monitor the power station output, wind speed and direction, there is no provision for routine monitoring of the noise output unless noise complaints

are received, in which case the LPA must initiate a course of action that in essence replicates the original ETSU-R-97 protocol, possibly even using the same supposedly independent acoustics consultants that were employed by the developer during the planning permission process. From a strictly legal viewpoint, the issue is simply that of the operating WTF's compliance with the conditions listed in the Planning Certificate.

2.9 The crux of the difficulty here lies in both the establishment and the enforcement of planning conditions (see MHCLG, 1995 *Circular 11/95*). Experience suggests that these are often drafted at the end of a long and arduous public inquiry and treated far more trivially than they should be. If community groups are registered as *Rule 6* parties, they will be consulted about any planning conditions, but with regard to noise, anything that changes the IoA standard set is unlikely to be included. To be valid, a formal planning condition must meet six tests related to its being necessary, relevant to planning, relevant to the development to be permitted, enforceable, precise, and reasonable in all other respects. The acoustics consulting industry argues that the IoA set not only meets these tests but, when coupled with the option for the LPA to use SN legislation, are in themselves sufficient. Opponents argue otherwise, particularly in respect of EAM, suggesting the imposition of conditions similar to those in operation at Den Brook WTF. In *Noise nuisances: how councils deal with complaints*, the Department for Environment, Food & Rural Affairs (DEFRA, 2015) makes it clear that in England when noise-related complaints are received councils can investigate using legislation related to SN, setting limits based on the absolute weighted sound level of 34 dBA if the underlying level of noise is no more than 24 dBA or 10 dBA above the underlying level of noise if it is more than 24 dBA. Whether or not these protections ever can be effective in the case of WTF noise is moot. Cowen (2015) examines whether or not it is reasonable to impose noise related planning conditions in addition to those in the IoA set (he concludes that it is), whether in practice SN is an effective recourse (he argues that it is not) and whether or not wider human rights legislation might be employed (he argues that this is unlikely).

2.10 First, any sound pressure features outside the audible part of the spectrum are not dealt with in the ETSU-R-97 protocol and are therefore not considered. Transient effects, such as EAM, lost in the data averaging process that might well give rise to complaints are easily missed. Large and Stigwood (2014) document four cases (including Swaffham, Kessingland and Cotton Farm WTFs) where a WTF that is technically compliant with ETSU-R-97 guidelines from time to time generates noise whose character makes it subject to numerous complaints.

2.11 Second, the onus to take action lies with the LPA. Since the aim of any worthwhile noise assessment is to prevent reasonable complaint their first reaction is likely to be to test for compliance with planning conditions as suggested by DEFRA (2011) in *Wind Farm Noise Statutory Nuisance Complaint Methodology* (page 89):

Ideally local authorities should utilise planning controls to manage noise from proposed wind farms as a first line of defence. Because, in general, and in line with most other forms of noise generating development, effective use of the planning system should prevent noise Statutory Nuisances from being emitted from wind farms.

There are three problems with this approach. First, as already suggested, LPAs may not have the resources or expertise adequately to test for compliance in the absence of any shared noise monitoring. Although short term testing has been undertaken at a number of WTFs (notably by *MAS Environmental*, Cambridge), the community monitor at Cotton Farm described by Gray and Tossell (2015) and Large, Stigwood and Stigwood (2017) remains the only example known to the author of a long-term community noise monitoring project. That it provides convincing evidence of noise nuisance at what in the relevant public inquiry was asserted to be an ETSU-R-97 compliant site should perhaps give cause for considerable concern about the effectiveness of this protocol. Second, in practice compliance is taking years to assess, leaving complaints unresolved. Third, compliance may well not alleviate SN. Two recent cases illustrate the use of SN rather than planning condition compliance to address complaints.

2.12 First, in a recent and possibly extreme case of a single 50kW turbine built very close (209m) to its nearest receptor in Kirklees District, action taken by the Council using SN as its basis rather than non-compliance with ETSU-R-97 has resulted in a substantial fine to the operator. The evidential base for the legal judgment was simply that on the eight occasions when EHOs listened to the noise immission they agreed that the turbine created a nuisance that could not be mitigated. Importantly, for WTF noise to be accepted as a nuisance the judgement concludes that it

... would have to interfere to an unreasonable degree with the personal comfort of, or injure the health of, the reasonable person's use and enjoyment of their land – having regard to the ordinary comforts of human existence in the particular location

with the addition that

... this is an infinitely variable test. Every case is fact specific

(*Noise Bulletin*, March 2018).

2.13 Second, SN has also been invoked in a case at West Knock Farm, Aberdeenshire, involving at least one (of three) 80m turbine some 436m

from the nearest receptor that at planning was also asserted to be ETSU-R-97 compliant (Noise Bulletin, 2019). Here, since the LPA either could not or would not take action, a successful action against the turbine operator was brought in the Sherriff's Court by the house owners (Sheriff Court Of Grampian, Highland and Islands at Aberdeen, 2018). Four features of the judgment stand out:

- The Sherriff accepted that no medical harm needed to be shown, the fact of agreed annoying and excessive noise in itself was sufficient to define a nuisance. In this, the Sherriff's focus on the complainant's experience is consistent with the UK basis for assessing SN as described in the *Planning Practice Guidance* (PPG) on noise (MHCLG, 2014a);
- At the same time, although two of UK's best-known wind turbine noise acoustics consultants gave evidence, he opined that "*the non-technical evidence given by the witnesses of fact is of greater significance in the context of these proceedings and (that) the case ultimately turns on the non-technical evidence*";
- Although the turbine may well have not exceeded the volume limits set in the original planning conditions, it was recognized that it was other features of the noise, including EAM, that set it apart;
- Finally, compromise mitigation was proposed in which the operators were required to adjust the turbine blades and reduce output in a strictly defined range of wind directions and speeds. Time alone will tell if such mitigation succeeds.

2.14 Summary: In relation to possible noise nuisance, The *Regulatory Roadmap for Onshore Wind* is very short and ineffective. Key features to note are:

- The evaluation of the environmental harm due to noise is done locally, within the normal planning system without any national checks and potentially only a cursory consideration of other local WTF projects;
- The developer assertions with respect to noise nuisance are only seldom tested by an approved and suitably resourced, disinterested external agency;
- The planning decision relies on a dated and disputed protocol (ETSU-R-97) developed by acoustics consultants. Cox (2017) points out that individuals employed by acoustics consulting companies often used by WTF developers were heavily involved in the development and establishment of the IoA GPG;
- There is no provision for routine monitoring of WTF noise immissions post construction;

- Individual complaints related to non-compliance are routed through the relevant LPA, which may or may not attempt to rectify any problems, but is unlikely to be able to access the necessary resources adequately to test the WTF for compliance. LPAs might be reluctant to challenge the operator of a large wind turbine installation through possible legal cost implications and /or loss of tax revenue. The only known cases in England known to the author where a turbine has been shut down or had operation curtailed by the LPA have involved small, typically 50kW, turbines;
- For most ordinary citizens if the LPA does not act this will be the end of the road. Any further action would have to involve a Court Challenge on the validity of the process or recourse to more general human rights legislation.

3 The Regulatory Roadmap for Shale Gas Extraction

3.1 It is instructive to compare the roadmap for onshore wind with other, similar industries that involve the imposition onto a rural community of a development seen to be in the national interest but that carries with it potential to cause significant environmental harm and loss of amenity. Shale gas extraction (SGE), otherwise known as *fracking*, is an obvious and topical example. The point here is simply that, although subject to the same local planning process as onshore wind, there is a number of additional safeguards in its regulatory roadmap. Although the LPA can only consider SGE applications on their specific planning merits (such as appearance of the equipment in the landscape, noise, traffic, and effects on cultural heritage), what goes on under the ground is subject to rules laid down by the *Environment Agency* (EA) and DBEIS and are not open to debate as part of the planning process.

3.2 For the planning phase of any SGE project, DBEIS defines a very detailed regulatory roadmap that operators must follow when seeking to drill for any form of onshore oil and gas in the UK. This is summarised in the figure below:



Source: DBEIS (2018)

SGE is regulated under the terms of the *Infrastructure Act* (2015) that

simplifies the procedure for obtaining the right to use underground land 300 meters and below for the purpose of exploiting oil and gas (petroleum) and deep geothermal energy, whilst ensuring that communities benefit and that the UK has a robust regulatory regime

Section 49 of the Act requires the SoS at DBEIS *regularly* (my emphasis) to seek and publish advice from the *Committee on Climate Change* on the impact of emissions from the onshore oil and gas sector and on the ability of the UK

to meet the carbon limits set by the *Climate Change Act 2005*. In Section 50 it introduces a range of safeguards, such as requiring independent well inspections, monitoring of groundwater, and restoration conditions. It also bans SGE in protected areas to ensure that it can only take place below 1200m depth in specified groundwater areas, National Parks, Areas of Outstanding Natural Beauty and World Heritage Sites.

3.3 SGE projects follow exactly the same local planning process as onshore wind in which the relevant LPA must grant planning permission. The operator needs the landowner's permission and planning permission, which may require an EIS. However, in the case of SGE additional oversight of any project is provided by no less than a further seven agencies:

- The *Oil and Gas Authority* (OGA) issues well consents, development programme approvals, completion of work programme approvals, and production consents. Before a company can carry out onshore exploration it must have a *Petroleum Exploration & Development License* (PEDL). OGA has stringent controls in place to ensure that operators manage the risk of induced seismicity from such operations using as its instrument a *Hydraulic Fracture Plan* (HFP). This sets out the steps that the operator has taken to minimize seismic risks and the ways in which the operator will monitor and control the hydraulic fracturing process. It must include detailed geological studies and then must be approved independently both by the OGA and the EA, with the *Health and Safety Executive* (HSE) also having had the opportunity to comment;
- The EA or its equivalent in England, Wales, Scotland, and Northern Ireland must ensure that any shale gas operations are conducted in a way that protects people and the environment. The EA is also a statutory consultee in the planning process and provides local mineral planning authorities (normally the county or unitary local authority) with advice on the potential risks to the environment;
- The HSE must be notified of the well design and operational plans at least 21 days before drilling starts. The HSE then inspects the plan for the well design, its construction, and maintenance to ensure that the operator has put measures in place to ensure that health and safety risks are effectively managed throughout the life cycle of the well. The HSE and EA are further required to share relevant site information and to ensure that there are no material gaps between safety and environmental protection and that all material concerns are addressed;
- DBEIS itself must issue a *Hydraulic Fracturing Consent* (HFC), which

... will not be issued unless 13 conditions are met and (D)BEIS is otherwise satisfied that it is appropriate. The conditions relate to a variety of environmental and social factors including emissions and community benefits. The operator must also demonstrate its financial resilience prior to HFC being granted. The operator then seeks final well consent from the OGA

- The *Commissioner for Shale Gas* (CSG) acts as a point of contact for members of the public, pointing them directly to clear, factual guidance on shale gas regulation and developments. This agency will also feedback comments to industry and regulators on their engagement with the public and will work closely with the *Shale Environmental Regulator Group* as well as the new *Planning Brokerage Service* to ensure accurate and timely information is available to residents;
- Finally, in view of this regulatory complexity, in October 2018 it was announced that a *Shale Environmental Regulatory Group* (SERG) is to be established to

act as a single entry point for information related to the environmental regulation of the shale gas industry and bring regulators together to act as one coherent single face for operators, the mineral planning authorities and the public

but each regulator will continue to retain its own independent regulatory functions, duties and enforcement powers as set out in law.

3.4 The main environmental concerns related to SGE relate to seismic shocks (earth tremors) during and after hydraulic fracturing of the shale rock, noise during drilling operations, surface and groundwater pollution from the escape of the fluids used, and traffic. Baseline environmental data for all have to be collected prior to work commencing to provide comparison with what occurs during working. During construction, the equipment used is standard (excavators, dump trucks etc.) but during operation the main noise source is a vertical drilling rig with associated compressors, pumps, and the like. Although the noise pollution from this is relatively well understood, like WTF noise it will almost always intrude into quiet rural areas and be present during both day and night.

3.5 For operational noise in SGE, a well-known acoustics consulting company (Hayes McKenzie, 2015) summarise the regulations thus:

The noise emissions section defines separate limits on noise for day-time (0700-1900), evening (1900-2200) and night-time (2200-0700) periods. The day-time limit is set at 10 dB above the $L_{A90,1hr}$ background noise level although how this background level is set, bearing in mind typical variation in background noise level, is not defined. Some variation is allowed to avoid imposing unreasonable burdens on the mineral operation but the limit should be as close to this as possible and should not exceed 55 dB L_{Aeq} . The evening limit is similar but there is no variation allowed for a perceived 'unreasonable burden'. At night the limit should be set 'to reduce to a minimum any adverse impacts, without imposing unreasonable burdens on the mineral operator, subject to a maximum of 42 dB L_{Aeq} '

They go on to note that this last item can be particularly challenging in the case of SGE drilling if inappropriate sites are selected for development, due to the requirement for the 24-hour drilling operation and that the regulation

leaves open the question of what might be regarded as an unreasonable burden. It is worth noting here that for SGE the noise limits are lower at night whereas for wind turbines the noise limits are higher. It is unclear which of the possible noise regulations might be used with the choice of either BS 5228 aimed at regulating construction work of relatively short duration or BS 4142 as would be employed for minerals extraction over a longer period of time. They conclude:

There is clearly a requirement for detailed noise assessments to be carried out on sites identified for shale gas exploration and extraction. This is likely to increase following the recent planning consent by North Yorkshire County Council and due to the unequivocal support by the current UK Government. Careful attention needs to be paid to the noise limits to be applied, particularly at night due to the necessity for continuous 24-hour drilling for long periods but also during the day when background noise levels can be low in rural areas and when the noisier fracking operations are carried out

Interestingly, they state that in the case of SGE:

The crux of the sleep disturbance discussions appears to be not the level of disturbance to a sleeping person from noise from transportation, on which the majority of sleep effects research is based, but the effect on individuals who may be awoken by other sources, and their ability to be able to return to sleep in the face of an audible noise which they may have significant objection to. The Inspector in this case, and the Secretary of State to whom she will make her report will need to consider this carefully

A further requirement they do not address is that background values for all these environmental risks (noise, seismicity, and groundwater) for input into any EIS must be established on the basis of a full year's monitoring. Again, this contrasts with the ETSU-R-97 approach in which a two to three-week survey is considered adequate.

3.6 Significant additions to the regulations relating to SGE are requirements for operator funded continuous monitoring:

- Of the danger during fracking operations from seismic disturbances that might be triggered by the operations. Currently, the regulations specify that if a seismic event above magnitude 0.5 on the Richter scale is detected, the operator must pause injection operations and reduce well pressure, monitor seismicity and ground motion to determine the cause of the event and whether or not it is in line with the HFP. If the event is not in line with what is anticipated, the OGA will require further analysis of the cause of the seismic activity before considering whether injection operations can resume;
- Throughout the lifetime of any project of groundwater conditions to ensure that there is no escape of the liquids used in the fracking operations.

3.7 Further notifications are required from the operator for a range of other possible changes to the HF process and the operator must also provide a weekly report giving details of all work that has taken place since the previous report which is intended to provide HSE with assurance that the operator is constructing and operating the well as described in the notification.

3.8 Summary. This regulatory roadmap implies a substantial national infrastructure to regulate the industry and protect those affected by it from any environmental harm or loss of amenity. Writing in April 2019, it should be added that the SGE industry argues that aspects of this roadmap are too stringent. For example, it has been reported that in 2017-8 seven out of eight applications were rejected at the LPA level and, further, despite advice from the *British Geological Survey* that a safe seismic limit could be of the order of 1.5 on the Richter Scale, at the working site at Preston New Road, repeated pauses to operations triggered by earth tremors above the current 0.5 limit have led to only 5% of the well being developed. In addition, the SGE industry is reported to be antagonistic towards the roadmap's reporting and monitoring requirements.

3.9 Comparing the Regulatory Roadmaps for onshore wind and SGE, leads to a conclusion that *neither* is appropriate for the task in hand. On the one hand, there is an industry, SGE, that, whatever the national need for energy and gas as an industrial raw material, is at the time of writing so regulated as to be unable to establish itself. There is little doubt that the Environmental Permits issued by the EA are an effective sanction and that LPAs have neither the expertise nor the sanctions after the event to impose standards. The threat of losing the Environmental Permit is strong and real. Despite this, it would seem that the industry in general accepts that it is their interests to demonstrate environmental responsibility and it is used to regulation in all its forms. On the other hand, there is an industry, onshore wind, that is far too lightly regulated to the extent that, again whatever the national need, permissions have been obtained in sub-optimal locations, with minimum protection for wind farm neighbours in affected rural communities, and an almost total lack of accountability post-construction.

4 Other industrial developments in rural areas

4.1 A third, similar, industrial development imposed on rural areas is quarrying and minerals extraction. The regulatory roadmap for minerals extraction is in many respects similar to that outlined above for SGE.

4.2 It is sufficient here to draw attention to four provisions:

- First, minerals extraction may only take place if the operator has obtained both planning permission and any other permits and approvals. These latter include permits from bodies such as the EA, and licenses from *Natural England* and, in relation to coal resources, the *Coal Authority*;
- Second, minerals extraction noise is regulated in accordance with BS 5228 (BSI 2014a) and BS 4142 (BSI 2014b). Operators and the planning system see no need for any special arrangements of the sort developed for wind in ETSU-R-97;
- Third, there is a provision for monitoring of operations as a matter of routine. In this, the minerals working roadmap is quite specific (MHCLG, 2014b):

... Since extraction of minerals is a continuous process of development, there is a requirement for routine monitoring, and if necessary, enforcement to secure compliance with conditions that are necessary to mitigate impacts of minerals working operations

- Finally, there is provision for periodic review to ensure compliance with any original planning conditions. Here, the same source argues:

... Since some minerals permissions last for many years, there may be a need to carry out periodic reviews of the planning conditions attached to that permission to help ensure that the sites operate to continuously high working and environmental standards. Section 97 of Part II of Schedule 5 and Schedule 9 to the Town and Country Planning Act 1990 establishes a range of orders for mineral planning authorities to control minerals development.

4.3 Summary. Note that, as with SGE, in addition to the provisions of the normal local planning system, minerals extraction has a roadmap that includes a measure of national oversight at the planning stage, the use of tried, tested and trusted protocols for the regulation of noise and other environmental effects, and mandated post-construction monitoring of operations with some form of licensing based on periodic review.

5 A Roadmap for Onshore Wind?

5.1 In the late 1990s, there may well have been a case not only to incentivize investment in onshore wind but also to back this up with a light touch regulatory roadmap. We now have a mature technology that assures us it is the cheapest source of renewable energy but are left with an industry that, relative to others of a similar nature, is under-regulated. It may well be that, rather than being just a so-called *NIMBY* reaction, experienced local

challenge to WTF projects reflects a clear appreciation of the lack of testing and accountability in the WTF regulatory roadmap.

5.2 In conclusion, which provisions of the SGE and minerals extraction roadmaps might enhance that for onshore wind and in so doing alleviate some of the fears that lead to opposition in planning by affected communities? Seven additions are suggested:

- In planning, there is a need for *national oversight* of projects in relation to the perceived national need. This would prevent capital being invested in unsuitable sites such as the *Daventry cluster* of around 40 turbines located in a few square kilometres around the M1/M6 junction which is precisely the area of England that has some of the lowest mean winds. This implies the setting up of an agency for onshore wind with a mandate similar to that of the OGA or MPA, or the current EA accepting such a role as part of its mandate;
- There is a clear need for LPA/PINS to introduce effective *planning conditions* that would protect windfarm neighbours in the event of a constructed WTF seen to be noisy. Almost all parties agree that ETSU-R-97, developed over twenty years ago for much smaller turbines than those of today on the basis of some very simple experiments, should no longer be used. Using BS4142 or a methodology based on it, as a substitute would bring new WTFs into line with other legislation and local EHO experience;
- The responsibility of overseeing the *construction* of wind farms historically has been left to be the responsibility of the Local Authorities (LA) that almost by definition cover rural areas. The officers in most do not have the knowledge, experience, or resources to supervise such civil engineering projects leading to near unregulated WTF farm construction. As with the above, this is a matter for more careful drafting of the planning conditions;
- There is a clear need for *compliance testing* of WTF against their planning approval document and other applicable regulations, under the full range of anticipated meteorological conditions, and over the complete range of audible and inaudible noise, with defined mitigation to be employed in the case of failure. Again, this could be addressed by the imposition of properly tested planning conditions;
- As part of an application, there should be a defined process for *post-construction monitoring* the WTF noise at the operator's expense at an agreed number of sites and over at least a year of operation. In the event of complaints, this should provide LA and other interested party access to any relevant Supervisory Control And Data Acquisition (SCADA), meteorological, and audio data. Noise complaints received by the local authorities should be logged and

immediately responded to by the Environmental Health (EH) department.

- Post-construction, consideration should be given to the establishment of *Liaison Committees* comprising the council, operators and affected residents tasked to monitor post-construction noise;
- Also, post-construction, consideration should be given to *licensing* WTF to operate using a mechanism similar to that adopted by the OGA, with an annual license to generate that is contingent on the absence of verified complaints in relation to noise and other loss of amenity. The HSE is the agency that should be overseeing the safety aspects of wind turbines, at the planning stage and during operation.

5.3 Imposing planning conditions along the lines suggested in 5.2 above would almost certainly be opposed by the on-shore wind industry arguing that such conditions would not pass the six tests laid out in Circular 11/95 (MHCLG, 1995). As noted above (see Section 2.9), these state that to be valid conditions must be:

- necessary;
- relevant to planning;
- relevant to the development to be permitted;
- enforceable;
- precise; and
- reasonable in all other respects.

In response to a Parliamentary question made by Heidi Allen (MP, South Cambs., Allen 2018) on 3rd December 2018, Government replied that:

... Planning authorities are responsible for applying and enforcing any conditions attached to the planning permission for a fracking or wind turbine development, and this must be assessed on a case-by-case basis. This may include monitoring of noise levels.

Routine monitoring of WTF noise is undeniably relevant to planning, relevant to any planned development, enforceable and, potentially at least, precise. Whatever one makes of the word *may* in the Ministerial reply, it implies that such a condition would be *reasonable*. This just leaves the issue of *necessity*. The evidence of noise nuisance at numerous constructed WTF in a variety of settings seems to imply that such conditions are very necessary.

5.4 Mandatory Liaison Committees, might well be accepted and incorporated into the standard local democratic process at no great cost and would provide a possible forum for noise-related complaints.

5.5 Perhaps the most controversial of these suggestions is the final one, the notion that by their very nature and longevity WTF projects should be subject to a licensing regime. This would almost certainly be opposed by the wind industry but would bring WTF into line with the roadmaps in place for both SGE and minerals extraction.

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Annex

This is taken *verbatim* from: Institute of Acoustics (2013) *Example Planning Condition*, Annex B, pages 34-40 of *A Good Practice Guide to the Application of ETSY-R-97 for the Assessment and Rating of Wind Turbine Noise*

Example Planning Condition

N.B. the following is an example condition, with attached guidance notes, the form of which has been the basis for the control of noise for several larger-scale UK wind farm developments, for example at recent planning appeals. More concise conditions may be acceptable, particularly for smaller-scale developments, and it is recommended that legal advice is sought.

The condition below assumes noise limits were referenced to standardized 10 meters height wind speed (derived from hub height). If considering noise limits referenced to measured 10 meters height, the condition should be modified appropriately: see in particular the Tables and Guidance Note 1 (d).

The rating level of noise immissions from the combined effects of the wind turbines (including the application of any tonal penalty) when determined in accordance with the attached Guidance Notes (to this condition), shall not exceed the values for the relevant integer wind speed set out in, or derived from, the tables attached to these conditions at any dwelling which is lawfully existing or has planning permission at the date of this permission and:

- a) The wind farm operator shall continuously log power production, wind speed and wind direction, all in accordance with Guidance Note 1(d). These data shall be retained for a period of not less than 24 months. The wind farm operator shall provide this information in the format set out in Guidance Note 1(e) to the Local Planning Authority on its request, within 14 days of receipt in writing of such a request.
- b) No electricity shall be exported until the wind farm operator has submitted to the Local Planning Authority for written approval a list of proposed independent consultants who may undertake compliance measurements in accordance with this condition. Amendments to the list of approved consultants shall be made only with the prior written approval of the Local Planning Authority.
- c) Within 21 days from receipt of a written request from the Local Planning Authority following a complaint to it from an occupant of a dwelling alleging noise disturbance at that dwelling, the wind farm operator shall, at its expense, employ a consultant approved by the Local Planning Authority to assess the level of noise immissions from the wind farm at the complainant's property in accordance with

the procedures described in the attached Guidance Notes. The written request from the Local Planning Authority shall set out at least the date, time and location that the complaint relates to and any identified atmospheric conditions, including wind direction, and include a statement as to whether, in the opinion of the Local Planning Authority, the noise giving rise to the complaint contains or is likely to contain a tonal component.

d) The assessment of the rating level of noise immissions shall be undertaken in accordance with an assessment protocol that shall previously have been submitted to and approved in writing by the Local Planning Authority. The protocol shall include the proposed measurement location identified in accordance with the Guidance Notes where measurements for compliance checking purposes shall be undertaken, whether noise giving rise to the complaint contains or is likely to contain a tonal component, and also the range of meteorological and operational conditions (which shall include the range of wind speeds, wind directions, power generation and times of day) to determine the assessment of rating level of noise immissions. The proposed range of conditions shall be those which prevailed during times when the complainant alleges there was disturbance due to noise, having regard to the written request of the Local Planning Authority under paragraph (c), and such others as the independent consultant considers likely to result in a breach of the noise limits.

e) Where a dwelling to which a complaint is related is not listed in the tables attached to these conditions, the wind farm operator shall submit to the Local Planning Authority for written approval proposed noise limits selected from those listed in the Tables to be adopted at the complainant's dwelling for compliance checking purposes. The proposed noise limits are to be those limits selected from the Tables specified for a listed location which the independent consultant considers as being likely to experience the most similar background noise environment to that experienced at the complainant's dwelling. The rating level of noise immissions resulting from the combined effects of the wind turbines when determined in accordance with the attached Guidance Notes shall not exceed the noise limits approved in writing by the Local Planning Authority for the complainant's dwelling.

f) The wind farm operator shall provide to the Local Planning Authority the independent consultant's assessment of the rating level of noise immissions undertaken in accordance with the Guidance Notes within 2 months of the date of the written request of the Local Planning Authority for compliance measurements to be made under paragraph (c), unless the time limit is extended in writing by the Local Planning Authority. The assessment shall include all data collected for the purposes of undertaking the compliance measurements, such data to be provided in the format set out in Guidance Note 1(e) of the Guidance Notes. The instrumentation used to undertake the measurements shall be calibrated in accordance with Guidance Note 1(a) and certificates of calibration shall be submitted to the Local Planning Authority with the independent consultant's assessment of the rating level of noise immissions.

g) Where a further assessment of the rating level of noise immissions from the wind farm is required pursuant to Guidance Note 4(c), the wind farm operator shall submit a copy of the further assessment within 21 days of submission of the independent consultant's assessment pursuant to paragraph (d) above unless the time limit has been extended in writing by the Local Planning Authority.

Table 1 – Between 07:00 and 23:00 – Noise limits expressed in dB LA90,10 minute as a function of the standardized wind speed (m/s) at 10 meter height as determined within the site averaged over 10 minute periods.

Location	Standardised wind speed at 10 meter height (m/s) within the site averaged over 10-minute periods											
	1	2	3	4	5	6	7	8	9	10	11	12

Table 2 – Between 23:00 and 07:00 – Noise limits expressed in dB LA90,10-minute as a function of the standardized wind speed (m/s) at 10 meter height as determined within the site averaged over 10 minute periods.

Location	Standardised wind speed at 10 meter height (m/s) within the site averaged over 10-minute periods											
	1	2	3	4	5	6	7	8	9	10	11	12

Table 3: Coordinate locations of the properties listed in Tables 1 and 2.

Property	Easting	Northing

Note to Table 3: The geographical coordinate references are provided for the purpose of identifying the general location of dwellings to which a given set of noise limits applies.

Guidance Notes for Noise Conditions

These notes are to be read with and form part of the noise condition. They further explain the condition and specify the methods to be employed in the assessment of complaints about noise immissions from the wind farm. The rating level at each integer wind speed is the arithmetic sum of the wind farm noise level as determined from the best-fit curve described in Guidance Note 2 of these Guidance Notes and any tonal penalty applied in accordance with Guidance Note 3. Reference to ETSU-R-97 refers to the publication entitled "The Assessment and Rating of Noise from Wind Farms" (1997) published by the Energy Technology Support Unit (ETSU) for the Department of Trade and Industry (DTI).

Guidance Note 1

(a) Values of the LA90,10 minute noise statistic should be measured at the complainant's property, using a sound level meter of EN 60651/BS EN 60804 Type 1, or BS EN 61672 Class 1 quality (or the equivalent UK adopted standard in force at the time of the measurements) set to measure using the fast time-weighted response as specified in BS EN 60651/BS EN 60804 or BS EN 61672-1 (or the equivalent UK adopted standard in force at the time of the measurements). This should be calibrated in accordance with the procedure specified in BS 4142: 1997 (or the equivalent UK adopted standard in force at the time of the measurements). Measurements shall be undertaken in such a manner to enable a tonal penalty to be applied in accordance with Guidance Note 3.

(b) The microphone should be mounted at 1.2 – 1.5 metres above ground level, fitted with a two-layer windshield or suitable equivalent approved in writing by the Local Planning Authority, and placed outside the complainant's dwelling. Measurements should be made in "free field" conditions. To achieve this, the microphone should be placed at least 3.5 metres away from the building facade or any reflecting surface except the ground at the approved measurement location. In the event that the consent of the complainant for access to his or her property to undertake compliance measurements is withheld, the wind farm operator shall submit for the written approval of the Local Planning Authority details of the proposed alternative representative measurement location prior to the commencement of measurements and the measurements shall be undertaken at the approved alternative representative measurement location.

(c) The LA90,10 minute measurements should be synchronised with measurements of the 10-minute arithmetic mean wind and operational data logged in accordance with Guidance Note 1(d), including the power generation data from the turbine control systems of the wind farm.

(d) To enable compliance with the conditions to be evaluated, the wind farm operator shall continuously log arithmetic mean wind speed in metres per second and wind direction in degrees from north at hub height for each turbine and arithmetic mean power generated by each turbine, all in successive 10-minute periods. Unless an alternative procedure is previously agreed in writing with the Planning Authority, this hub height wind speed, averaged across all operating wind turbines, shall be used as the basis for the analysis. All 10 minute arithmetic average

mean wind speed data measured at hub height shall be 'standardised' to a reference height of 10 metres as described in ETSU-R-97 at page 120 using a reference roughness length of 0.05 metres. It is this standardised 10 metre height wind speed data, which is correlated with the noise measurements determined as valid in accordance with Guidance Note 2, such correlation to be undertaken in the manner described in Guidance Note 2. All 10-minute periods shall commence on the hour and in 10- minute increments thereafter.

(e) Data provided to the Local Planning Authority in accordance with the noise condition shall be provided in comma separated values in electronic format.

(f) A data logging rain gauge shall be installed in the course of the assessment of the levels of noise immissions. The gauge shall record over successive 10-minute periods synchronised with the periods of data recorded in accordance with Note 1(d).

Guidance Note 2

(a) The noise measurements shall be made so as to provide not less than 20 valid data points as defined in Guidance Note 2 (b)

(b) Valid data points are those measured in the conditions specified in the agreed written protocol under paragraph (d) of the noise condition, but excluding any periods of rainfall measured in the vicinity of the sound level meter. Rainfall shall be assessed by use of a rain gauge that shall log the occurrence of rainfall in each 10 minute period concurrent with the measurement periods set out in Guidance Note 1. In specifying such conditions the Local Planning Authority shall have regard to those conditions which prevailed during times when the complainant alleges there was disturbance due to noise or which are considered likely to result in a breach of the limits.

(c) For those data points considered valid in accordance with Guidance Note 2(b), values of the LA90,10 minute noise measurements and corresponding values of the 10- minute wind speed, as derived from the standardised ten metre height wind speed averaged across all operating wind turbines using the procedure specified in Guidance Note 1(d), shall be plotted on an XY chart with noise level on the Y-axis and the standardised mean wind speed on the X-axis. A least squares, "best fit" curve of an order deemed appropriate by the independent consultant (but which may not be higher than a fourth order) should be fitted to the data points and define the wind farm noise level at each integer speed.

Guidance Note 3

(a) Where, in accordance with the approved assessment protocol under paragraph (d) of the noise condition, noise immissions at the location or locations where compliance measurements are being undertaken contain or are likely to contain a tonal component, a tonal penalty is to be calculated and applied using the following rating procedure.

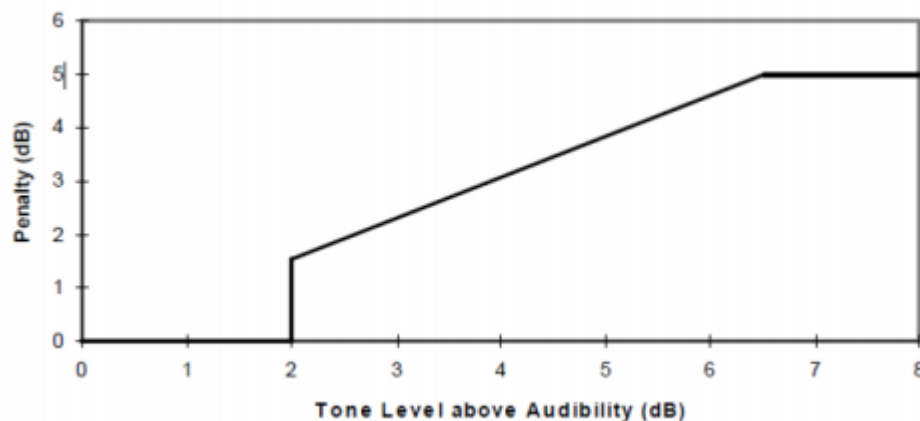
(b) For each 10 minute interval for which LA90,10 minute data have been determined as valid in accordance with Guidance Note 2 a tonal assessment shall be performed on noise immissions during 2 minutes of each 10 minute period. The 2 minute periods should be spaced at 10 minute intervals provided that uninterrupted uncorrupted data are available (“the standard procedure”). Where uncorrupted data are not available, the first available uninterrupted clean 2 minute period out of the affected overall 10 minute period shall be selected. Any such deviations from the standard procedure, as described in Section 2.1 on pages 104-109 of ETSU-R-97, shall be reported.

(c) For each of the 2 minute samples the tone level above or below audibility shall be calculated by comparison with the audibility criterion given in Section 2.1 on pages 104-109 of ETSU-R-97.

(d) The tone level above audibility shall be plotted against wind speed for each of the 2 minute samples. Samples for which the tones were below the audibility criterion or no tone was identified, a value of zero audibility shall be used.

(e) A least squares “best fit” linear regression line shall then be performed to establish the average tone level above audibility for each integer wind speed derived from the value of the “best fit” line at each integer wind speed. If there is no apparent trend with wind speed then a simple arithmetic mean shall be used. This process shall be repeated for each integer wind speed for which there is an assessment of overall levels in Guidance Note 2.

(f) The tonal penalty is derived from the margin above audibility of the tone according to the figure below.



Guidance Note 4

(a) If a tonal penalty is to be applied in accordance with Guidance Note 3 the rating level of the turbine noise at each wind speed is the arithmetic sum of the measured noise level as determined from the best fit curve described in Guidance Note 2 and the penalty for tonal noise as derived in accordance with Guidance Note 3 at each integer wind speed within the range specified by the Local Planning Authority in its written protocol under paragraph (d) of the noise condition.

(b) If no tonal penalty is to be applied then the rating level of the turbine noise at each wind speed is equal to the measured noise level as determined from the best fit curve described in Guidance Note 2.

(c) In the event that the rating level is above the limit(s) set out in the Tables attached to the noise conditions or the noise limits for a complainant's dwelling approved in accordance with paragraph (e) of the noise condition, the independent consultant shall undertake a further assessment of the rating level to correct for background noise so that the rating level relates to wind turbine noise immission only.

(d) The wind farm operator shall ensure that all the wind turbines in the development are turned off for such period as the independent consultant requires to undertake the further assessment. The further assessment shall be undertaken in accordance with the following steps:

(e). Repeating the steps in Guidance Note 2, with the wind farm switched off, and determining the background noise (L3) at each integer wind speed within the range requested by the Local Planning Authority in its written request under paragraph (c) and the approved protocol under paragraph (d) of the noise condition. (f) The wind farm noise (L1) at this speed shall then be calculated as follows where L2 is the measured level with turbines running but without the addition of any tonal penalty:

$$L_1 = 10 \log \left[10^{L_2/10} - 10^{L_3/10} \right]$$

(g) The rating level shall be re-calculated by adding arithmetically the tonal penalty (if any is applied in accordance with Note 3) to the derived wind farm noise L1 at that integer wind speed.

(h) If the rating level after adjustment for background noise contribution and adjustment for tonal penalty (if required in accordance with note 3 above) at any integer wind speed lies at or below the values set out in the Tables attached to the conditions or at or below the noise limits approved by the Local Planning Authority for a complainant's dwelling in accordance with paragraph (e) of the noise condition then no further action is necessary. If the rating level at any integer wind speed exceeds the values set out in the Tables attached to the conditions or the noise limits approved by the Local Planning Authority for a complainant's dwelling in accordance with paragraph (e) of the noise condition then the development fails to comply with the conditions.