



Independent Noise Working Group

## Wind Turbine Amplitude Modulation & Planning Control Study

### Work Package 8.1

### **Review of WSP/Parsons Brinckerhoff and Institute of Acoustics Amplitude Modulation Studies**

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## Objective:

To review the wind turbine amplitude modulation reports of WSP/Parsons Brinckerhoff and the Institute of Acoustics amplitude modulation working group and then to make appropriate recommendations to government.

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## Abbreviations

AM	Amplitude Modulation (of ‘sound’ pressure waves)
AMWG	(Wind turbine noise) Amplitude Modulation Working Group of the IoA
BSI	British Standards Institute
DECC	Department of Energy and Climate Change
DBEIS	Department for Business, Energy and Industrial Strategy
EHO	Environmental Health Officer (usually working for a local authority)
ETSU-R-97	The Assessment and Rating of Noise from Wind Farms, The Working Group on Noise from Wind Turbines, September 1996
ETSU	as above
EAM	Excess amplitude modulation
GPG	Good Practice Guide (IoA update of ETSU-R-97)
INWG	Independent Noise working Group
IoA	Institute of Acoustics (UK)
NWG	(Wind Turbine) Noise Working Group of IoA
ReUK	RenewableUK, wind industry trade association
WSP/PB	WSP / Parsons Brinckerhoff
WTN	Wind turbine noise

## 1 Executive Summary

The Independent Noise Working Group (INWG) was formed during late August 2014 in response to the Institute of Acoustics (IoA) announcement of the formation of their Amplitude Modulation Working Group (AMWG). The INWG consists of a diverse group of experts and non-experts having independence from the wind industry supply chain. The primary objective of the INWG being to conduct an independent study into Amplitude Modulation (AM) that could credibly scrutinise the findings of the IoA sponsored study.

The subsequent INWG study looking at all aspects of wind turbine noise and its effects was carried out over the following year with individual work packages released during the summer and autumn of 2015. A presentation of the INWG findings and recommendations was made to the Government (DECC) Energy Minister on 13 October 2015. Reports from the INWG AM study are available at: <https://www.heatonharris.com/reports-publications>.

Since the release of the IoA and WSP/PB reports during August and October 2016, the INWG has reviewed them as presented below. This review includes some preliminary testing of the AMWG proposed AM measurement metric. Additionally it is intended that the INWG will carry out further testing of the combined AMWG measurement metric and WSP/PB proposed AM control scheme using real turbine noise data and to be described later. The INWG initial concerns with these two reports and the lack of independence of the IoA were also outlined in a press release dated 5 October 2016 (Appendix E). These concerns include:

- The latest proposals deal only with new wind turbine planning applications leaving residents living near existing turbines unprotected and effectively abandoned.
- A failure to investigate the extent of the turbine noise problem and to continue to downplay the significance of the AM problem. INWG work package 3.1 thus remains as the most comprehensive survey data available.
- The untested and unproven nature of the proposed AM measurement and control scheme.
- The lack of independence of the report authors

The INWG reviews of these latest AMWG and WSP/PB AM studies show that their proposals are basically reworked versions of the heavily criticised 2013 ReUK AM study proposals with some of the same authors involved. However, the following important admissions are made within these latest two reports after many years of denial:

- That modulating WTN-like sounds are more annoying than similar noise levels without significant modulation.
- The threshold of perception of AM is around 2dB and increasing modulation depth is associated with increased annoyance. That where there are high levels of AM, the adverse effects could be significant and on this basis a control for AM is required
- That wind turbine related noise annoyance is associated with increased risk of sleep disturbance and stress. Additionally, the annoyance increases during normal resting periods during the late evening, night-time and early morning. However, the potential impacts on health are still not accepted by WSP/PB and other reports which do suggest a causal link are heavily criticised.

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- That AM cannot be predicted at the planning stage so the likely default position for a planning decision maker should be to apply an AM planning condition unless there is good reason not to.

The IoA AMWG report scope is limited to establishing an AM measurement metric and is critiqued in detail below and at Appendices A and D. The resulting AM measurement metric being proposed by the IoA takes the form a ‘black box’ containing a complex and opaque process that when tested is shown to under record actual peak to trough levels of AM and has been shown to fail to identify intermittent bursts of AM. The IoA metric is presented as an untested and unproven solution.

The WSP/PB report to DBEIS critiqued below and at Appendices B and C is superficially professional in approach with some good work evident particularly in the earlier sections. However, throughout the report the INWG has identified a common thread of selective use and misinterpretation of evidence that then leads conveniently to the justification of the AM control scheme being proposed by WSP/PB. This proposed AM control scheme based on the ReUK scheme from 2013 applies a small dB penalty to the existing ETSU noise assessment dB (loudness) limits in the event of AM exceeding a defined limit. However, since the most intrusive AM usually occurs when overall dB levels (loudness) are well below the ETSU limits, it is considered that like the similar ReUK methodology to be most unlikely to protect against even the most severe periods of AM.

We are concerned about the criticisms made of Dr Hanning’s INWG WP3.2 report by WSP/PB. Dr Hanning is an acknowledged sleep expert and we believe that his conclusions supported by the recent paper by Smith et al (September 2016) Physiological effects of wind turbine noise on sleep (22<sup>nd</sup> International Congress on Acoustics) clearly demonstrates the health impacts of wind turbine noise at the levels permitted by ETSU-R-97.

We are also concerned regarding the unproven theory underpinning the AM control scheme advocated by WSP/PB. This relies on the assumption that simply reducing the overall noise level will alleviate the impact associated with AM. As with the IoA metric, the WSP/PB AM control scheme is presented as an untested and unproven solution.

Additionally, it is considered by the INWG to be unlikely that the wind industry via its acousticians making these proposals would allow a control scheme to be promoted that would control AM effectively as that would require reductions in turbine generation and hence reductions in operational revenue.

### Recommendations to Government Ministers

- **The AMWG and WSP/PB untested and unproven proposals for the measurement and control of AM should be rejected by government unless proven to be a reliable and effective solution to protect wind turbine neighbours.** These proposed methodologies have not been tested with real wind turbine noise data and shown to be able to control AM in an accurate and reliable way. Thorough independent testing is required to prove or disprove the proposed scheme. Initial testing, by the

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INWG, of the IoA AMWG AM measurement metric **demonstrates the need for credible independent testing.**

- **That Government introduces regulation to the wind industry requiring licencing of individual wind turbine or wind farm sites in a similar manner to other polluting industries.** This being the only means to effectively control noise nuisance and the related health effects from existing wind turbines and so provide a reasonable and workable resolution for wind turbine neighbours. The applicability of these latest proposals to new wind turbine planning applications only would still leave people living near existing wind turbines unprotected other than by taking legal action for nuisance or relying on their Local Authority to pursue a statutory nuisance action. Since the wind industry has shown itself consistently to be unable or incapable of self-regulation on noise issues, Government intervention is required.

Additionally, the INWG key recommendations from the AM study detailed at INWG WP10 dated November 2015 are still valid today and are repeated below:

- Based on the findings at WP2.1, WP3.2 and WP5, a key step towards protecting communities from wind turbine noise amplitude modulation would be to replace the use of ETSU as recommended by the Northern Ireland Assembly report, January 2015. **ETSU should be replaced with a procedure based on the principles of BS4142: 2014.** This will bring wind turbine noise assessment into line with other industrial noise controls. New guidance of this type should be formulated in a Code of Practice that sets out a BS4142: 2014 type methodology that reflects noise character and relates impact and the effects on people and not an averaged dB limit as at present.
- Based on the findings in the legal review at WP6.1, experience at Cotton Farm described at WP6.2 and elsewhere it is recommended that **an effective AM planning condition should be part of every wind turbine planning approval,** unless there is clear evidence it is not needed.
- **Continuous noise monitoring of wind turbines should become a standard planning condition for all wind turbine planning approvals** as recommended in the Northern Ireland Assembly report, January 2015. This should be funded by the wind turbine operator, but controlled by the LPA with the noise data made openly available to ensure transparency. The Cotton Farm community noise monitor described at WP9 provides an example of how this can be achieved.
- **There is a need to commission independent research to measure and determine the impact of low-frequency noise on those residents living in close proximity to individual turbines and wind farms** as recommended in the Northern Ireland Assembly report, January 2015.
- **Conflict of interest concerns must be properly addressed and, if established, appropriate action taken to remedy the situation and provide full transparency.**

## 2 Preamble

After more than a *'decade of denial'* by the wind industry and its acousticians that wind turbine noise and specifically the thumping noise known as amplitude modulation (AM) was anything other than a rare and infrequent occurrence, there was finally a reluctant acknowledgement by 2010 that AM could not be ignored any longer. In an attempt to head off complaints, the UK wind industry trade and lobby organisation, RenewableUK (ReUK) conducted their own study into AM starting during 2010 with the report finally being released during December 2013. This report included a methodology for defining and measuring AM and a proposal for an AM control method that could be included as a planning condition for new wind turbine developments.

The ReUK report and proposed AM control methodology was subsequently heavily criticised by third parties, both for the misleading science behind the study and the failure of the proposed control methodology when independently tested to control and protect against even the worst cases of AM. The general view of these critics was that the ReUK report recommendations, accompanied by intense political lobbying offered only an illusion of AM control and was an attempt to silence those complaining of wind turbine noise AM. Since the only AM mitigation currently available is to reduce generation or shut down turbines, a properly effective control methodology would involve a loss of revenue for turbine operators, hence the resistance by the wind industry. Noise and specifically AM are widely considered to be a key constraining factor to the deployment of wind power generation capacity due to the adverse effects of noise on communities living close to turbines.

Had the ReUK proposals been adopted by Government, it would have allowed the wind industry to continue with *'business as usual'* since it would have been virtually impossible to demonstrate a breach of the proposed planning control AM limits. This would have restricted complainants to the use of public or private nuisance laws that have to date proved to be totally ineffective in protecting against wind turbine noise.

Fortunately, the criticisms of the ReUK proposed methodologies resulted in these proposals not being adopted by government. This resulted in a strategy rethink by the wind industry and its closely allied small group of acousticians acting through the Institute of Acoustics (IoA) wind turbine noise working group (NWG). It was speculated at that time that the wind industry would adopt a different political strategy after making minor cosmetic changes to their AM measurement and control proposals.

This speculation as to the likely wind industry response was subsequently shown to be correct as events subsequently unfolded. The first development occurred after a period of several months when the IoA announced on 1 August 2014 that it was setting up an amplitude modulation (AM) sub working group (AMWG) reporting to the main wind turbine NWG, to conduct its own study into wind turbine noise amplitude modulation (AM). This announcement was met with scepticism and concern by those who had been affected and experienced problems arising from wind turbine noise.

When the IoA AMWG was formed during August 2014, the stated objective was to produce a metric for measuring AM and then a planning condition that could control AM to an

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acceptable level, essentially a repeat of the ReUK study objectives. This scope was subsequently changed during October 2014 such that the IoA AMWG would focus solely on a metric for defining and measuring AM and Government would conduct a separate study to determine the AM dose response relationship and an appropriate control method that could be applied as a planning condition. The contract for this government funded AM study was subsequently awarded by DECC to WSP/Parsons Brinckerhoff (WSP/PB) during August 2015, this being during the transition period following the election of the new government. The WSP/PB study project leader was by coincidence at that time, also the Chair of the IoA NWG. Significantly WSP/PB is also a consultant to and a major player within the wind industry supply chain.

In response to the IoA announcement of the formation of the AMWG, the Independent Noise Working Group (INWG) was formed during late August 2014 by a diverse group of experts and non-experts having independence from the wind industry supply chain. The objective of the INWG being to conduct an independent study into AM that could credibly assess and if necessary, challenge the findings of the IoA sponsored study.

The INWG study looking at all aspects of wind turbine noise and its effects was carried out over the following year, with individual work packages released during the summer and autumn of 2015. A presentation of the INWG findings and recommendations was made to the Government (DECC) Energy Minister on 13 October 2015. This was followed by a paper and presentation at the IoA annual conference on 15 October 2015. Reports from the INWG AM study are available at: <https://www.heatonharris.com/reports-publications>.

The then Energy Minister Andrea Leadsom MP, confirmed during a meeting held on 13<sup>th</sup> October 2015 and in a subsequent letter that the INWG report would be considered alongside the IoA and WSP/PB reports when received including the INWG recommendation to replace the use of ETSU with BS4142:2014.

It is believed that the interim INWG report presented to the Energy Minister and at the IoA annual conference during October 2015 forced, the IoA AMWG and WSP/PB to reconsider and delay the release of their reports. In what subsequently appeared to be a synchronised activity, the AMWG report was finally released on 9 August 2016. Then a summary of the WSP/PB report was presented a few days later as a paper at the Inter.noise conference at Hamburg on 23 August 2016. The full WSP/PB report to government (DBEIS) dated August 2016 was finally released on 25 October 2016, in response to a Freedom of Information request. Further details of the background leading up to the IoA AMWG and WSP/PB studies are provided in INWG work package 8.

Since the release of the IoA and WSP/PB reports, the INWG has conducted the review as presented below. The review includes some preliminary testing of the AMWG proposed AM measurement metric. Additionally it is intended that the INWG will carry out further testing of the combined AMWG measurement metric and the WSP/PB proposed AM control scheme, using real turbine noise data to be described later. The INWG initial concerns with the two reports and the apparent lack of independence of the IoA were also outlined in a press release dated 5 October 2016 (Appendix E).



As a follow-up activity since the release of the IoA and WSP/PB reports, the IoA held a one day seminar at Birmingham on 7 December 2016. The seminar title being '*ETSU-R-97 Time to move on?*' was attended by most of the authors of the IoA and WSP/PB AM reports. Two members of the INWG also attended. The first seminar session dealt with options for replacement of ETSU and the second session discussed the IoA and WSP/PB AM reports.

### 3 AMWG Final Report

The AMWG final report was released by the IoA on 9 August 2016, two years after their study into AM was launched. The report has now been reviewed by the INWG and a detailed critique of the document is included at Appendix A. Note that Appendix A was written prior to the release by DBEIS of the full WSP/PB report. Additional comments relating to an AM planning condition from a legal perspective are included at Appendix D. The key points arising from the report are:

- The report proposes a method for measuring and rating AM. In line with the revised study scope it does not include the dose response relationship, limits of acceptance for AM or methods of control, but prepares the way for the WSP/PB report.
- The report states the intent to regulate AM only from new wind turbine developments, there being no intent to regulate AM from existing wind turbines.
- The report rules out any intention of measuring noise indoors despite most AM complaints are relating to wind turbine noise experienced inside homes.
- The authors intimate that wind turbine AM was first identified during 2002 to 2004. This is considered to be misleading as AM was described in detail during the 1980s by NASA in the USA and later by others but all this was ignored by the wind industry.
- The IoA study consultation process to which the INWG submitted a consultation response is shown to be seriously faulty. Valid criticisms from qualified individuals have been ignored by the AMWG without any serious attempt at rebuttal or technical justification. It is also widely suspected that the four supportive but anonymous consultation responses are from individuals '*close*' to the AMWG and that revealing their identity would be embarrassing to the integrity of the report authors.
- Crucially the report summarily dismisses the INWG proposal to adopt BS4142:2014 as being the most effective methodology to rate and control AM. The AMWG provide no technical justification for the decision to disregard the recently updated British Standard that applies to virtually all forms of industrial noise assessment except for wind turbines.
- The AMWG report proposes a highly complex 'hybrid' method of measuring AM. This opaque process is essentially a 'black box' since the nature of the Fourier transforms employed makes it incomprehensible to even experienced observers.
- The proposed measurement method has not been adequately tested by the AMWG on real wind turbine noise data to demonstrate its accuracy and reliability. If it has been tested, the results are not revealed, however, it is thought inconceivable that the AMWG are unaware of the performance characteristics of their proposed methodology.

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- Reasoning behind the IoA 'hybrid' AM assessment method was to allow for automatic assessment of large amounts of data and to minimise false positives. However, the IoA method requires extensive manual review of recorded data upon discovering any positive AM results, thus negating any automatic assessment benefits. An AM assessment method such as that described in the original Den Brook type planning condition is simpler, easily understood and can be completed in a similar time.

A preliminary review dated 28 September 2016 of the IoA AMWG hybrid measurement methodology has since been carried out by L Huson Associates Pty Ltd, VIC Australia as described at Appendix F. This review is based on the data provided by the AMWG with their report. The key points arising from this review are:

- Huson disagrees with the IoA decision to limit the sound to an A-weighted frequency range from 50Hz to 800Hz as he has experience of turbines producing amplitude modulation in the 32Hz one-third octave band. This AM component would be excluded from the IoA analysis.
- From his preliminary investigation of the IoA AMWG recommended hybrid method, it is apparent that the metric can produce false negatives (failure to identify AM) and provides underestimates of the amplitude modulation in the input data. This being particularly so when there are multiple turbines rotating at different speeds.
- Huson also notes that the IoA hybrid method and the understanding of its technical deficiencies is clearly beyond the comprehension of the general public and probably most if not all local Council's environmental health officers.

This preliminary review has since been followed by some initial testing by Huson of the AMWG hybrid method, using real turbine noise data from the Leonards Hill wind farm in Australia. The report dated 11 October 2016, including charts are provided at Appendix G. The conclusion from this limited testing is that the AMWG 'black box' processing is artificially reducing the reported AM and would not capture the intermittent 'whump / thump' because of the way the 10 sec data samples are processed.

The AMWG metric employed to determine AM magnitude is based on the difference between two statistical values: the 95 percentile (L5, level exceeded for 5% of each 10-second sample) minus the 5 percentile value (L95, level exceeded for 95% of each 10-second sample). Huson does not agree with this because of the averaging effect and as such that it does not reflect the actual peak to trough values.

The conclusion from this preliminary testing, is that the AMWG AM measurement metric under records the actual level of AM at best and will completely miss recording intermittent AM and situation where there are multiple turbines operating at different rotational speeds.

## 4 WSP/Parsons Brinckerhoff report to Government

WSP/PB submitted their tender for the government (DECC) funded AM review during April 2015. The tender price of £25,000 submitted to DECC for the study is clearly well below cost for a consulting business such as WSP/PB and indicates an apparent willingness to subsidise AM research if it can influence government policy. However, WSP/PB did declare their membership of ReUK and the European Wind Energy Association in their tender. Additionally, with their well-known business interests allied with the wind industry, many observers consider it inconceivable that WSP/PB would ever propose an effective AM control methodology since it would potentially harm the wind industry. Since the only way to control AM is curtailment (reduced generation) or stopping offending turbines, any control of AM would in effect constrain wind turbine revenue. This highlights the risks involved in Government awarding such contracts to the lowest priced bidder.

The AM study contract was awarded by DECC to WSP/PB and confirmed in a letter dated 3 August 2015. Then during September 2015 Richard Perkins, Technical Director of WSP/PB who was acting as the project manager for the government funded AM study resigned as the Chair of the IoA Noise Working Group (NWG) in what is seen by many as a token gesture to allay conflict of interest concerns.

WSP/PB submitted their report to the government Department for Business, Energy and Industrial Strategy (DBEIS) during August 2016. Although the report was not made publicly available at that time, on 23 August WSP/PB presented a paper at the Inter.noise 2016 conference at Hamburg summarising the results of the government funded AM study. A review and critique of this paper has been carried out by the INWG and is included at Appendix B with comments relating to proposals for an AM planning condition included at Appendix D. Note that these appendices were written before the full report was released by DBEIS hence there is inevitably some duplication with the later review of the full report at Appendix C.

Key points from the WSP/PB paper presented at Inter-noise 2016 are:

- The paper downplays the significance of AM despite the large body of evidence to the contrary, (see INWG WP2.2) and implies that AM has only recently arisen. This again ignores the large body of evidence to the contrary (see INWG WP2.1) going back to the 1980s. There still exists a *denial mentality* to the fact that AM is common or can be predicted to occur ignoring evidence to the contrary.
- The paper acknowledges the potential for bias (also known as conflict of interest) but provides no detail as to how it was dealt with.
- Finally an admission from the wind industry of a 2dB (peak to trough) threshold of perception for AM, that adverse impacts increase during the night time and that modulation of 3dB and above warrants control.
- The statement '*The AM control has only been designed for use with new planning applications; applicability for use in Statutory Nuisance investigations on existing wind turbine sites, where the legal regime is different (and outside the research scope), has not been considered*' demonstrates the futility of this report when there

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is evidence we have large numbers of existing wind turbines across the country causing AM noise related complaints.

- There is ambiguity as to whether an AM planning condition would be lawful. The wind industry has argued for many years that an AM condition is not needed and would be unlawful as it was claimed one did not comply with the 6 tests for a planning condition mentioned in Circular 11/95. The consequences of this were that many planning inspectors then conceded to their requests. We note that the WSP/PB report suggests that “.....it is likely that the default position for a decision maker would be to apply the condition on all sites unless evidence is presented to the contrary”. But the scope of this is unclear.
- The WSP/PB paper claims that since AM is unpredictable, control would by necessity be reactive, being initiated by complaints only.
- The paper recommends what is essentially the same control methodology for AM as was proposed in the 2013 ReUK AM study. This ReUK report is discussed at INWG WP8 and tests have clearly shown that it is unlikely to resolve the problem.
- This latest proposed control methodology provides for a 3dB to 5dB sliding penalty to be applied to the ETSU time averaged noise level. Acousticians describe 3dB as a ‘barely perceptible change in loudness’ so the AM penalty being proposed is at the level of a ‘barely perceptible change in loudness’. However, since complaint causing AM typically occurs when background noise levels are low and well below the ETSU derived limit, it is considered highly unlikely that the limit would ever be breached and the AM control triggered.
- The paper does not claim to have tested the proposal with real wind turbine noise data, so only independent testing will confirm the reliability or otherwise of the WSP/PB proposal. However, it is thought unlikely that WSP/PB are unaware of the performance characteristics of their proposed scheme to ensure it will not adversely impact wind industry revenues.
- During the Inter.noise conference presentation at Hamburg, the WSP/PB presenter in response to a question claimed there is very little noise data available in the UK for testing purposes. It is inconceivable that WSP/PB are not aware of the Cotton Farm noise database, probably the largest such database available anywhere in the world.
- To further ensure that AM controls would rarely if ever be triggered, the WSP/PB report states that even if the control is triggered it is yet again by the much vaunted ‘professional judgment’ notion-option to trigger enforcement. It then proposes a 2 to 5 year testing programme for a number of sites from planning approval being granted. This is seen as a clear attempt to kick the issue into the long grass.

These and other concerns with the WSP/PB and IoA AMWG reports were detailed in an INWG Press Release dated 5 October 2016 (Appendix E) and were raised in a letter to The Rt. Hon Greg Clark MP Secretary of State in the Department for Business Energy & Industrial Strategy. This included the recommendation that the INWG considers it unwise for Government to adopt the WSP/PB proposals, without thorough testing to verify the effectiveness and reliability of the methodology and for comparison with alternatives including BS4142:2014 as proposed previously by the INWG. The INWG is also of the view that a suitably worded AM planning condition is required for all future wind turbine

planning certificates, unless there are sound reasons for not doing so. The wording of such a condition still has to be determined.

The WSP/PB final report was eventually released on 25 October 2016 following a FOI request and has subsequently been reviewed by the INWG. The critique of this report is provided at Appendix C. The released report consists of two sections. The phase 1 report sets out the contractors (WSP/PB) approach and methodology for the review. The phase 2 report describes the review and findings including recommendations for elements of a planning condition for controlling excessive AM. Key points from the final WSP/PB report are:

### Phase 1 report

This document describes a reasonable and professional approach to the study. However, the exception is the apparent special emphasis given to evidence from the RenewableUK (ReUK) AM report released during 2013. The ReUK report is mentioned under 'Study Aims' at para 1.2 at the 1<sup>st</sup> and 3<sup>rd</sup> bullet items and under the 'Proposed Approach' at para 2.1.1 Phase 2, 1<sup>st</sup> and 3<sup>rd</sup> bullet items. No other item of literature or potential evidence is mentioned in this way, indicative perhaps of a pre-conceived decision to adopt the ReUK report recommendations. This suspicion held since 2013 and discussed at the Preamble section above is confirmed following the review of the phase 2 report below.

The phase 1 report also names the WSP/PB production team. These being Ross Singleton, Richard Perkins and James Wright of WSP/PB plus sub-consultants Bernard Berry, Colin Grimwood and Stephen Stansfield. However, by the time the phase 2 report was produced the WSP/PB team had been changed with Michael Lotinga replacing James Wright. Additionally, the presentation made on 7 December by Perkins and Lotinga at the IoA ETSU seminar names the three independent peer reviewers, Frits van den Berg, Sabine Janssen and Jesper Hvass Schmidt. Significantly these three peer reviewers submitted feedback during drafting but were not asked to endorse the conclusions of the report.

### Phase 2 report

#### Executive Summary

Key points from the WSP/PB report executive summary are:

- An admission at page 3 that modulating WTN-like sounds are more annoying than similar noise without significant modulation.
- The threshold of perception of AM is around 2dB and increasing modulation depth is associated with increased annoyance.
- That wind turbine related noise annoyance is associated with increased risk of sleep disturbance and stress. Additionally, the annoyance increases during normal resting periods during the late evening, night-time and early morning.
- At page 4 the report notes that the prevalence of unacceptable AM has not been evaluated as part of the study. This would appear to be a critical shortcoming of the WSP/PB study.
- That AM cannot be predicted at the planning stage so the likely default position for a planning decision maker should be to apply an AM planning condition unless there is good reason not to. It concludes that where there are high levels of AM, the adverse effects could be significant. On this basis a control for AM is required.

### Evidence Review

The evidence review described at Para 2.3.1 is divided into categories 1 and 2. Category 1 is described as; *'Research directly addressing a scaled response to a quantified human exposure to amplitude-modulated wind turbine noise (real or simulated)'*. Category 2 is described as; *'Other papers (e.g. self-reported complaints, anecdotal evidence, etc.)'*.

Para 2.3.2 confirms that each of the category 1 papers were reviewed by two of the external reviewers (sub-consultants) and that the category 2 papers were reviewed by the internal (WSP/PB) research team and only where deemed important reviewed by an external reviewer.

The category 1 evidence review conclusions at Para 3.2.46 include:

- Within laboratory and field test environments, *'increasing overall time-averaged levels of AM WTN-like sounds showed a strong and significant association with increasing ratings of annoyance'*.
- Within a laboratory test environment, *'the onset of fluctuation sensation for a modulating WTN-like sound appeared to be in the region of around 2 dB modulation depth'*.

The category 2 paper review follows and starting at Para 3.3.85 is where it becomes apparent of the departure from the professional approach by the WSP/PB authors. At the section covering health effects we find a very limited selection of health related literature has been reviewed, with just 10 papers and reports in contrast to the over 100 reviewed by Hanning for his review of health related literature at INWG work package 3.2. It should also be noted that Hanning is a highly respected sleep expert in his own right.

At Para 3.3.87 the authors first acknowledge that; *'There is strong evidence to show that exposure to WTN can cause increased annoyance amongst exposed populations'* but then attempts to cast doubts on the motives of those affected by WTN. The 5<sup>th</sup> bullet item lists a range of reasons that those affected by WTN and complaining could somehow be making it all up. The final two sub-bullet items are particularly concerning displaying a blatant attempt to negate the effects of WTN by shifting the blame from the turbine operator to the victim;

- *'Exposure to positive / negative media coverage of wind energy and wind farm noise, and the activities of campaign groups; and*
- *Sensitivity to noise and possible sensitisation due to awareness of wind farm noise research'*

The claim at Para 3.3.88: *'that at the current time there is insufficient evidence to indicate that the AM component in WTN at typical exposure levels directly causes any significant adverse effects beyond increased annoyance'* contradicts the statement at the executive summary at page 3: *'The Category 2 papers reviewed in section 3.3 provide supporting evidence that there is a potential association between WTN-related annoyance and increased risks of sleep disturbance and stress'*. The subsequent omission of the mention to sleep disturbance and stress is significant and press statements made by ReUK since have specifically claimed a lack of evidence showing a link between WTN and health effects.

The claim at Para 3.3.88 also contradicts the findings of Hanning at INWG work package 3.2 although this is unsurprising given the limited and selective nature of the evidence reviewed by WSP/PB. Para 3.3.88 would appear to be an attempt by WSP/PB to close off any further debate concerning the health effects of WTN which is of considerable concern to INWG and local communities.

### **Publications Produced by an Independent Noise Working Group**

WSP/PB then report on their reviews of the INWG work packages starting at Para 3.3.96. These reviews were included in the WSP/PB study at the request of DECC following the meeting between the Energy Minister and representatives of INWG on 13 October 2015. What follows are considered to be a series of selective comments and misrepresentations with the focus of criticisms aimed at topics most threatening to the combined IoA and WSP/PB proposals.

At Paras 3.3.109 to 3.3.113 WSP/PB are initially positive regarding the technicalities of AM as described in WP1 The fundamentals of amplitude modulation of wind turbine noise (Yelland, 2015) and Para 3.3.112 states: *'The report is very strong, clear and objective on the technicalities of the characteristics and causes of AM'*, but then becomes dismissive and negative when faced with evidence based criticisms especially of ETSU and the ReUK report. No constructive attempt has been made by the WSP/PB authors to rebut the scientific evidence and claims presented in WP1.

At Paras 3.3.114 to 3.3.122 the WSP/PB authors have selectively chosen a small number of areas from WP2.1 Review of reference literature (Cox, 2015) for negative criticism. They provide a distorted view of the work package ignoring the vast body of evidence, much of it inconvenient to the WSP/PB authors as presented in the reviewed literature and summarised in the work package.

An example of this misrepresentation is illustrated by the comments at Para 3.3.119 dismissing the INWG conclusions regarding ETSU. Whereas, the INWG conclusions are based on reviews of literature by others including Bowdler, July 2015 and the Northern Ireland Assembly (NIA) report, January 2015. The extensive NIA government report was especially critical of ETSU making the recommendation to *'review the use of the ETSU-R-97 guidelines on an urgent basis'*.

Significantly the NIA report has not been included in the WSP/PB literature review despite it being highly relevant to the AM study requested by DECC. The WSP/PB authors will be fully aware that replacing ETSU as recommended in the NIA report would completely undermine their own report conclusions and recommendations.

At Paras 3.3.123 to 3.3.128 the WSP/PB authors are highly dismissive of WP2.2 AM Evidence Review (Large, 2015) and make no mention of the extensive volume of noise data presented as evidence of AM. There still seems to be a reluctance by WSP/PB to accept that AM is not rare, that it is being generated by the majority of wind turbines and that under certain meteorological conditions adverse AM can occur for long periods of time.

## Work Package 8.1 – Review of IoA & WSP/PB AM Reports

At Paras 3.3.129 to 3.3.135 the WSP/PB authors are dismissive of WP3.1 Study of noise and AM complaints received by local planning authorities in England (Sherman, 2015). WP3.1 is the most comprehensive survey of this type to date and despite the limitations highlighted by Sherman serves to confirm that wind turbine noise complaints are much more widespread than the wind industry has hitherto admitted. These findings disprove the findings of the earlier and much criticised ‘Salford report’, (Research into Aerodynamic Modulation of Wind Turbine Noise, University of Salford July 2007) where it was claimed that incidences of AM were rare and stated ‘*The low incidence of AM and the low numbers of people adversely affected make it difficult to justify further research funding*’.

The INWG survey also highlighted the inconsistent approaches by local authorities across the country in dealing with wind turbine noise complaints due to the lack of useful guidance. Additionally, local authorities expressed the need for guidance that works for and protects communities regarding operating wind farms.

At Paras 3.3.136 to 3.3.138 the WSP/PB authors have ignored the findings and conclusions presented by Hanning having reduced the 47 page WP3.2 Excessive amplitude modulation, wind turbine noise, sleep and health (Hanning, 2015) to less than half of a page of misleading comment. They have reproduced their own version of what is claimed to be Hanning’s conclusions. It is suggested that this is an attempt by the WSP/PB authors to keep health effects arising from WTN and criticism of ETSU out of their report. It being more convenient to claim that excessive AM is merely restricted to causing annoyance only.

An example of this misrepresentation by WSP/PB is the first listed conclusion at Para 3.3.137 that claims to quote Hanning as stating, ‘*Current setback distances for wind turbines recommended by ETSU are not safe for health*’. Whereas the actual conclusion by Hanning from WP3.2 Para 5.73 states, ‘*It is abundantly clear that wind turbine noise adversely affects sleep and health at the setback distances and noise levels permitted in the UK by ETSU. There is no reliable evidence at all that wind turbines are safe at these distances and noise levels, not a single study. In contrast there is an increasing volume of studies outlined here to the contrary*’.

The WSP/PB critique consists merely of author opinions with their conclusions echoing the INWG WP3.2 conclusions but downplaying the significance. These conflicting conclusions may be partly due to the very limited selection of health related literature that has been reviewed by WSP/PB with just 10 papers and reports reviewed in contrast to the over 100 reviewed by Hanning for WP 3.2. However, the WSP/PB authors have gone some way to admitting that wind turbines do adversely affect sleep. This in itself is another significant admission from the wind industry.

The adverse effects of WTN on sleep have also been demonstrated in a recent paper; Smith et al (September 2016) Physiological effects of wind turbine noise on sleep that concludes, ‘*Physiological measurements indicate that nights with low frequency band amplitude modulation and LAEq,8h=45 dB, slightly open window (LAeq,8h=33 dB indoors) impacted sleep the most. In particular, amplitude modulation and the presence of beating were important constituents of the wind turbine noise contributing to sleep disruption*’. These findings support the conclusions reached by Hanning at WP3.2 and demolish the theoretical



## Work Package 8.1 – Review of IoA & WSP/PB AM Reports

basis behind the AM control scheme advocated by WSP/PB in that simply reducing the overall noise level will alleviate the problems associated with AM.

At Paras 3.3.139 to 3.3.143 the WSP/PB authors have not presented any significant objections to WP4 Den Brook (Hulme, 2015) but have misrepresented the situation regarding the Den Brook AM planning condition. Concern is heightened by the commentary beginning with a footnote [42] clearly miscomprehending and so misrepresenting events surrounding the Den Brook AM conditions. Three iterations are incorrectly stated to have taken place with a ‘final’ AM condition erroneously said to be in the form of an “amendment” by the wind farm’s developer.

The reality, however, is that the extant AM conditions in fact remain precisely as drafted and imposed by the Government Inspector on his granting of planning approval for the Den Brook wind farm in 2009. Neighbourhood legal challenges since have resulted in important clarifications and ratification of the AM noise conditions by the Court of Appeal. To amend the conditions as suggested at both b) and c) of the footnote would of course be unlawful as no planning application made under Section 73 of the Town and Country Planning Act 1990 for such a revised planning approval has been progressed through to a conclusion.

A requirement of the conditions has however been discharged and resulted in measures being introduced arguably designed by the applicant to significantly water down the AM noise control parameters that were specifically set for planning permission to be awarded. The sole conclusions drawn and outlined by the WSP/PB authors’ mirror only unsubstantiated assertions of unenforceability whereas the Court of Appeal’s crucial clarification and unequivocal ratification of the AM conditions appears to have escaped any attention from the WSP/PB authors suggesting a perhaps less than thorough or objective review.

Nonetheless, the WSP/PB review reasonably concludes that the process outlined in WP4 was “*conflictual*” at times. However, to state that the issues generate high levels of emotion might be more appropriately defined in terms of ongoing, deep and widespread concern.

At Paras 3.3.144 to 3.3.158 the WSP/PB authors have mostly commented positively to WP5 Towards a draft AM condition (Large, 2015) but have glossed over much of the 161 pages. However the concluding Para 3.3.158 is misleading. The WSP/PB authors misquote WP5 as recommending that ETSU is one of two methods for assessing and controlling excessive AM. WP5 is clear at para 1.10 that it recommends that ETSU should only be used where noise from the wind farm is steady, benign and anonymous; this being when AM is at very low levels. For the assessment and control of excessive AM then WP5 recommends that BS4142:2014 be used and at para 11.6 states ‘*Where there are generic wind farm noise complaints, including noise level, noise character etc, BS4142 should be used as a stand-alone assessment independent of any other assessment, for example ETSU-R-97 compliance*’.

At Paras 3.3.159 to 3.3.168 the WSP/PB authors’ state that WP6.1 Legal issues: the control of excessive amplitude modulation from wind turbines (Cowen, 2015) is a carefully written legal review and make no objections to the conclusions reached. This would seem to be an endorsement of the need for a suitable AM planning condition to be imposed in every

planning certificate for a wind turbine unless there are clear reasons to show that it is unnecessary.

At Paras 3.3.169 to 3.3.175 commenting on WP6.2 Control of AM noise without an AM planning condition using Statutory Nuisance (Gray, 2015) the WSP/PB authors state that a *'reasonable case is made here'* and seem to agree with the conclusions reached including that Statutory Nuisance law is ineffective and that only an AM planning condition could be effective in controlling excessive AM.

At Paras 3.3.176 to 3.3.180 the WSP/PB authors dodge the evidence presented at WP8 Review of Institute of Acoustics amplitude modulation study and methodology (Cox, 2015) concerning conflicts of interest by simply stating at Para 3.3.178 that it is outside the scope of their review. The WSP/PB authors then ignore the bulk of WP8 confining their comments to para 49 concerning the AMWG consultation reproduced as seven bullet items at Para 3.3.179 stating *'this is a useful critique of the IoA AMWG consultation that is of direct relevance'*. The following Para 3.3.180 then attempts unsuccessfully to respond to just three of the bullet items.

### **Institute of Acoustics Method for Rating AM**

At section 3.5 the WSP/PB report discuss the Institute of Acoustics Method for Rating AM. The WSP/PB authors describe in just over one page details taken from the IoA AMWG report effectively endorsing the IoA proposals. There is no attempt to critique or question any aspect of the IoA proposed measurement metric including the most obvious being the lack of testing with real turbine noise data. The INWG have critiqued the IoA AMWG report separately above and at Appendix A.

### **Factors Affecting Development of a Planning Condition**

At section 4 the WSP/PB report discusses factors affecting development of a planning condition. Para 4.4.2 is where the WSP/PB authors argue against and summarily dismiss the use of the BS4142:2014 method to control AM. The claim that BS4142 has not been tested in the field is weak when compared to the slightly modified and untested version of the ReUK penalty method being proposed and the recommendation for a subsequent 2 to 5 year testing programme. The ReUK penalty method has been tested by the INWG and shown to fail to protect against even the most extreme cases of AM as described at INWG WP5. Whereas BS4142:2014 is the latest UK standard for noise assessments for all types of industrial noise that could and should include wind turbine noise.

### **Threshold of Excessive AM**

Starting at Para 4.5.3 the WSP/PB authors discuss and attempt to justify a threshold for excessive AM. Referring to ETSU Para 4.5.4 states; *'modulation of blade noise may result in a variation of the overall A-weighted noise level by as much as 3 dB(A) (peak to trough)... if there are more than two hard, reflective surfaces then the increase in modulation depth may be as much as +/- 6 dB(A) (peak to trough)'*. Introducing the effects of hard reflecting surfaces is irrelevant since ETSU requires measurements to be taken in free field conditions and away from hard reflecting surfaces. This paragraph would appear to be an attempt by the WSP/PB authors towards justifying an increase from 3dB to 6dB for what is to be considered normal AM and hence the threshold of what is to be considered as excessive.

Then at Para 4.5.5 the WSP/PB authors makes a significant misrepresentation of INWG WP5 when they quote *'If the Den Brook condition (a peak to trough method) were to be treated as a simple metric or trigger value a higher peak to trough value in the region of 6dB would need to be used'*.

What INWG WP5 actually states is *'If the Den Brook condition, or criteria, is to be used as a trigger value, i.e. one or two exceedances indicative of a breach, then the peak to trough level value needs to be increased from 3dB(A) to around 6dB(A). However, it is recommended that the Den Brook condition is not used as a simple trigger value'*. The WSP/PB statement conveniently ignores the detail of how the Den Brook condition is structured and is again seen as an attempt to justify an increase from 3dB to 6dB of what is considered to be normal and hence acceptable AM.

At Para 4.5.7 the WSP/PB authors question the current ETSU noise limits, noting that there is tension between *"the potential for some loss of local amenity in favour of wider national economic and sustainability benefits of renewable energy"* and make a case for the limits and or even for ETSU itself to be reviewed, saying *"It is unclear if the noise limits in ETSU-R-97 would still accord with these current aims without the policy support for on-shore wind"*. It also highlights that the aims of the NPPF in England today are to avoid noise giving rise to significant adverse impacts (see paragraph 123 of the NPPF). We are very concerned about this tension but INWG has been established only to consider noise from turbines with particular reference to AM and as such passes no comment on the claimed benefits or otherwise of this form of renewable energy.

Then at Para 4.5.10 the WSP/PB authors consolidate their shift of what they want to be considered normal AM from 3dB to 6dB peak to trough. This quite clearly conflicts with ETSU where the normal modulation depth referred to at ETSU page 68 is *'This modulation of blade noise may result in a variation of the overall A-weighted noise level by as much as 3dB(A) (peak to trough) when measured close to a wind turbine. As distance from the wind turbine/wind farm increases, this depth of modulation would be expected to decrease....'*. Close to the turbine is usually considered to be up to 50m so the 'normal' modulation anticipated by ETSU at typical residential distances of greater than 400m would be in the order of 1-2dB or less and unlikely to be audible.

Additionally, the reconstructed Time-Series Modulation Depth from the IoA AMWG measurement metric is defined differently and is not the same as modulation depth defined in ETSU-R-97. The proposed IoA AMWG measurement metric is an averaged value of mathematically manipulated signals, each of which is then assessed in terms of a comparison between L5 and L95, and is then further averaged across multiple 10-min samples using the L10 percentile measure.

### Control Scheme for AM

Para 4.5.21 is where the discrete switch from a real AM value using the ETSU definition of peak-to-trough to the IoA synthesised and averaged value metric occurs in the report. (The INWG comment separately on the shortcomings of this proposed metric.) The proposed AM level penalty regime from WSP/PB has thus, used dissimilar amplitude modulation metrics as a basis for the suggested AM penalty regime. Para 4.5.21 also introduces the concept of introducing a penalty to the overall average noise level via the ETSU assessment during periods of unacceptable AM with the purported aim to reduce noise levels back into compliance. However, wind turbine noise complaints are rarely due to the absolute noise level (loudness) and usually due to the amplitude modulation effect.

Para 4.5.22 indicates there are two potential (mechanical) methods for reducing AM but recognises that these methods are new, not proven and will not be available to every model of turbine. The INWG suggest that any AM planning condition should be designed to assume there will be no engineering solution available and that it may be necessary to stop turbines during the conditions when excessive AM occurs.

The authors are also basing their proposed AM condition on the claimed findings from two papers, von Hünerbein et al. (2015) and Lee et al. (2011) that reducing absolute noise levels will reduce annoyance from AM. Both these papers relate to small scale laboratory studies and at Paras 3.2.7 and 3.2.8 the WSP/PB authors themselves express reservations with the laboratory study conducted by Lee et al. Importantly there is no evidence of real world testing presented that such a method would work in practice with real WTN. Evidence from actual AM noise nuisance complaints is that AM is most intrusive when absolute noise levels are relatively low and that high absolute noise levels in the absence of AM do not normally lead to noise complaints.

Para 4.5.23 then proposes essentially the same AM penalty scheme as proposed in the ReUK report from 2013. When previously tested by INWG with real turbine noise data this ReUK scheme was shown not to control AM even in the worst cases of AM. The minor changes now being proposed by WSP/PB to the original ReUK scheme are considered unlikely to make much difference. However, it is intended that INWG will later be testing the effectiveness of the proposed AM control method.

Para 4.5.24 provides more detail of the proposed penalty scheme. However, research by INWG has shown that mostly when nuisance AM occurs the overall decibel levels are below the ETSU limits by more than the penalty proposed which means it will often or nearly always be an ineffective provision. To explain this, the problem noise is measured by effectively assessing its troughs and not its peaks. As a result these troughs are well below the limits when this AM type of noise occurs and the headroom to the limit means any penalty will almost never lead to the noise being considered excessive. The control will rarely if ever be effective. In contrast, BS4142:2014 as discussed at INWG WP5 para 9.49 *'attributes a penalty for noise character and then combines assessment of noise character and noise level to be judged relative to the background sound environment. This provides a context based approach and includes combined assessment of noise level and noise character'*.

## Work Package 8.1 – Review of IoA & WSP/PB AM Reports

Para 4.5.27 sets out what WSP/PB propose the resulting action imposed on the operator during periods of AM should achieve. These are shown as either point a) or point b). INWG believe that only point a) *'reduce the degree of AM to below the 3 dB rating threshold during the complaint periods Identified'* is relevant as this ensures excessive AM is prevented irrespective of the overall noise level. It should also be noted that the 3 dB 'rating threshold' is a peak to trough value as defined in ETSU, not the L5-L95 metric. Point b) *'reduce the penalised overall time-average level below the limit. The sliding scale decibel AM penalty would be added to the overall noise level (day or night), plus the addition of X dB at night (where X is the difference between the night and day limits for each integer wind speed bin, applicable if, and only if, the numerical limit for night-time is set higher than that for daytime), again during the periods in which AM impacts had been identified'*. would effectively provide the wind turbine operator with a complicated 'get-out clause' to continue operating and generating any level of AM providing the overall average noise level remains within the ETSU limits. Such an obscure condition would make proving a breach of ETSU a lengthy and difficult process. AM control should be based on the noise people hear and considered as a nuisance.

Para 4.5.30 highlights the untested nature of the WSP/PB proposals and proposes a 2 to 5 year testing programme. This is promoting a continuation of the wind industry strategy of obfuscation and delay.

## 5 Discussion

The wind industry finally recognises they are unable to resist for much longer the introduction of an AM planning condition with future wind turbine planning approvals so are making all efforts to have their own scheme adopted. Their focus in dealing with the AM problem is by having their own toothless AM controls imposed on new turbines planning certificates would seem to be consistent with the current wind industry strategy of promoting significantly larger, hence more economically viable but noisier onshore wind turbines. There is clearly no intention of dealing with the legacy of existing turbines and the widespread WTN problems they have created. The WSP/PB proposed AM planning condition is essentially the ReUK scheme proposed during 2013 with just minor changes and is seen as a means to obtaining planning permission for these future turbines without any apparent increased risk to operating revenues.

The AMWG and the WSP/PB AM reports are interdependent and can be considered as constituting a combined measurement and AM control methodology. The two study teams, the AMWG and WSP/PB are in fact seen by many as closely connected wind industry 'insiders' with Richard Perkins of WSP/PB being the project manager for the WSP/PB study and until Sept 2015 the Chair of the IoA NWG to which the AMWG reports.

The two teams would have liaised closely during the study phase and the reports were released a few days apart and two years after the AMWG was formed. This delay is again indicative of the wind industry strategy of delaying for as long as possible any resolution to the WTN problem.

## Work Package 8.1 – Review of IoA & WSP/PB AM Reports

The WSP/PB presentation from the 7 December 2016 IoA ETSU seminar highlighted the way WSP/PB have leveraged '*respectability*' by acknowledging contributions from others. However, most of those named are wind industry '*insiders*' and their actual contributions are not specified. The three 'independent peer reviewers' van den Berg, Janssen and Schmidt are shown as submitting feedback during report drafting and were not asked to endorse the conclusions of the report. The three WSP/PB external consultants, Grimwood, Berry and Stansfeld reviewed only a limited selection of papers as decided by the WSP/PB research team. There is no evidence within the report that the external consultants endorse the final report or its conclusions.

However, the key issues arising from these reports are:

- Does it work?
- The application of AM control to a planning condition
- Conflicts of interest arising
- How to move towards a resolution of the AM problem for all wind turbine neighbours

### Does it work?

For Government, local authorities dealing with noise complaints and crucially for wind turbine neighbours troubled by noise, the all-important issue relates to how effective is the proposed control for AM. There are two aspects to consider:

Question 1: Does the proposed measurement methodology reliably and accurately provide a measure of the AM being experienced by a wind turbine neighbour?

Answer 1: The IoA AMWG proposed metric closely resembles the ReUK measurement metric from 2013 and preliminary testing of the most recent proposal discussed above shows that some AM is detected when the AM is regular but under records the true peak to trough values. When AM is intermittent or arising from more than one turbine and turbines are changing speed and/or operating at different speeds the IoA metric become more unreliable often missing occurrences of AM completely (false negatives) and under records by a greater margin. Additionally, the AMWG are excluding sound measurements being taken from inside houses, the location causing most AM noise complaints. This despite there being clear evidence that AM can be greater or more intrusive when experienced inside houses than outside.

Question 2: Does the proposed control methodology reliably and accurately provide a control method to limit the AM experienced by a wind turbine neighbour to tolerable levels?

Answer 2: Given the unreliability and under recording of the true values of AM arising from the AMWG measurement methodology it is clear the proposed WSP/PB control methodology will never be able to reliably control AM. But crucially the WSP/PB control methodology which closely resembles the ReUK methodology from 2013 relies on a dB penalty to be applied to the ETSU averaged dB limit. The INWG have demonstrated that virtually all wind turbine noise complaints relate to the character (modulation) of the noise not the absolute dB limit. As discussed above it is the

character of the AM, the constant change in loudness that is most intrusive and complaints usually arise from periods during the evening and night time and when overall dB levels (loudness) are usually well below the ETSU limit. Applying a small dB penalty in these situations as proposed by WSP/PB will almost never trigger a breach of the ETSU limit and if so only briefly such that enforcement action would never be taken.

Neither the AMWG nor WSP/PB has demonstrated their methodologies work either accurately or reliably and are expecting Government to adopt these proposals unchallenged and untested. Were these proposed methodologies adopted by Government it is anticipated the current situation of delay and obfuscation by the wind industry would continue for many more years. Local authorities would still be unable to take action in cases of noise complaints and wind turbine neighbours would be unable to obtain resolution to often intolerable situations. Additionally, WSP/PB has already proposed in their report a testing and review period of 2 to 5 years from adopting their proposals. Delay to implementation is clearly to the advantage of the wind industry and is a key part of their strategy.

### **Application of AM control to a planning condition**

The AMWG and WSP/PB make clear their proposals apply only to new wind turbine planning approvals. As a result the large numbers of existing and consented yet to be built wind turbines are excluded from any form of future control of AM if the planning certificate does not contain an AM condition.

WSP/PB refer to the six tests for the validity of a planning permission. The wind industry has previously argued such a condition would be unlawful as it claimed AM was rare and unpredictable and so was not consistent with these tests. WSP/PB continue this argument at para 4.2 of their paper that AM is unpredictable. It is not clear how this paragraph compares with the “default” position mentioned in paragraph 4.5.20 that a condition should now be included. INWG remain concerned that the industry would still raise arguments about the validity of such a condition.

The INWG believes that it is now essential for a suitably worded condition to protect residents from the impact of AM to be drafted and included in every new planning permission issued in the future. The INWG now firmly believes that it can no longer be claimed that this does not meet the tests for a planning condition and leaves local residents vulnerable to this common form of nuisance without any AM planning control.

Even with a suitably worded AM planning condition for new wind turbines the large number of existing and consented yet to be built turbines would be unaffected as a planning condition cannot be applied retrospectively. The only legal route open currently for local authorities to deal with complaints in these cases where there is no AM planning condition is private or statutory nuisance law. However, as shown at INWG work packages 6.1 and 6.2 this has proven to be totally ineffective and provides no deterrent to a wind turbine operator. There being in effect no effective legal remedy available to wind turbine neighbours against AM as pursuing High Court legal proceedings is very expensive, highly stressful, lengthy and uncertain of success. As a result local authorities are showing great

reluctance to pursue noise complaints and very few individuals have taken this course of action.

To capitalise on this situation the wind industry has been successful in arguing against the imposition of an AM planning condition in all but a very small number of cases, Den Brook being the most notable. Even where one has been imposed, the industry has made efforts to have it removed, including (unsuccessfully) at Den Brook. Similar efforts were also made in respect of the Lamb's Hill and Moor House wind farms in the North East. They have also ensured that no legal precedent regarding nuisance arising from AM has been established by utilising all available legal remedies and resources to fight legal claims. In the few high court cases where they decided they could lose, an out of court settlement has been made with suitable gagging clauses on those involved so avoiding a legal precedent. It is therefore clear why the wind industry will resist any attempts at imposing an effective AM planning condition and why the latest AMWG and WSP/PB proposals should be treated with the greatest caution. This resistance to an effective AM planning condition was quite evident in the case of the Den Brook wind farm detailed at INWG WP4.

### **Conflicts of interest arising**

The conflict of interest by the small group of wind industry acousticians and others was highlighted by the INWG in the AM study WP10 and WP8.

Previous governments established a political climate supporting wind power seemingly at all cost so providing a perceived incentive for acousticians working primarily for the wind industry to ensure that the potential for adverse noise impacts would not overly constrain the development of wind power. Additionally, government responsibility for wind turbine noise was unusually given to DECC along with their responsibility for the rollout of wind power whereas for virtually all other industries, noise is regulated by DEFRA.

This same group of wind industry acousticians and their predecessors responded to the political climate at that time by designing special and less restrictive noise assessment guidance for wind turbines resulting in the ETSU-R-97 (ETSU) guidelines released during 1997. This guidance states that it seeks to provide reasonable protection for wind farm neighbours, specifically stating that it should not impose an unreasonable burden on the industry.

Experience as outlined in the INWG AM study work packages suggests too much emphasis has been placed on protecting the industry from those burdens. ETSU is still the guidance approved by government today despite criticism over many years by numerous affected individuals and organisations. Further and more recent guidance in the form of a Good Practice Guide to the application of ETSU was produced by the same group of wind industry acousticians under the guise of the IoA NWG. This additional guidance approved by government during 2013 was seen as an attempt to silence criticism of ETSU and now allows even higher levels of noise. Significantly, apart from a brief mention it continued to ignore AM. The ongoing conflict of interest has continued with the latest AMWG and WSP/PB AM studies where this same group of acousticians has continued their attempts to manage government policy for the benefit of their industry by clever and opaque manipulation of



the science behind noise assessment. Unfortunately and with great concern there is no evidence that this is about to change.

### How to move towards a resolution

Any individual affected by wind turbine AM is faced with the impossible situation of almost 100% certainty in not being able to obtain legal redress to the noise problem however severe. There are cases of families having to vacate their homes due to the unbearable noise yet their local planning authority is either unable or unwilling to take on the wind turbine operator. If a local planning authority imposes a stop order on a wind turbine or wind farm, the operator is likely to take legal action that may well result in a large financial liability to compensate for the loss of wind turbine revenue. Such a penalty could bankrupt some local planning authorities. The Cotton Farm wind farm is an example of such a situation. Despite continuous sound monitoring for several years by the local community and extensive evidence including audio data of the high levels of AM and a huge number of complaints, the local planning authority has considered it has not been in a position or had the authority to take action against the turbine operator.

It is also clear that this report particularly at Para's 3.3.87 & 3.3.88 seeks to effectively denigrate and INWG consider undermine the suffering and harm being caused to local residents by a suggested unquantifiable or perceived level of 'annoyance' arising from those who are exposed to wind turbine noise. It is most notable that the authors of the report cite a notion of 'annoyance' no less than 216 times within the report.

The Oxford dictionary definition of annoyance is given as *1. The action of annoying or state of being annoyed, irritation vexation, 2. Something that annoys a nuisance*. It even states a colloquial definition of a '*pain in the butt*'.

Furthermore the WSP/PB report cites a notional list of non-acoustical factors contributing towards and causing 'annoyance';

- a) *Specific visual impacts (shadow flicker, lights, rotation);*
- b) *General attitude to wind farm appearance in the landscape;*
- c) *Direct economic benefits from wind energy generation or specific wind turbine installations;*
- d) *General attitudes to wind energy generation;*
- e) *Type of area (urban / rural);*
- f) *Exposure to positive / negative media coverage of wind energy and wind farm noise,*
- g) *and the activities of campaign groups; and*
- h) *Sensitivity to noise and possible sensitisation due to awareness of wind farm noise research.*

It is of great concern to the INWG that the mere hypothesis promoted within the WSP/PB report and notion that legitimate concerns and suffering of residents could be devalued in this manner. This to the point of suggesting that those complaining are doing so merely because of any of the suggested reasons listed and that this could be considered or accepted by the Government to be a contributing factor for these or any complaints arising.

Furthermore it is clear from INWG WP 3.1 Para 1.6 *'There is also a hint of a 'silent majority' who suffer in silence without knowing how to complain, or because of a fear of adverse implications, if, for example, they had to disclose any complaint should they wish to sell their house'*. So rather than local residents finding reasons for 'annoyance' to justify their noise complaints, it is apparent that those who are complaining are doing so despite all the significant barriers in pursuing a complaint, even to the extent of suffering potential financial losses.

It is also clear that acceptance and endorsement of this notion is highly likely to be seen by local communities to undermine the integrity of this whole report.

So although it is important to arrive at an effective AM planning condition for new wind turbine developments, drastic action is required by government to deal with existing wind turbines. This will require new government legislation to enable effective controls to be applied to existing wind turbines from outside of the planning system. This could take the form of regulation of the wind industry and licencing of individual wind turbine sites similar to the way many other polluting industries are regulated and licenced by the Environment Agency.

This could also take the investigation of complaints and any resultant enforcement action out of the hands of the local planning authorities who are often ill equipped for the task to a government agency with specialists better trained and resourced than EHOs to understand and deal with the complex acoustics involved.

## 6 Conclusions and Recommendations

The reviews described above of the AMWG and WSP/PB AM studies demonstrate that the wind industry acousticians are continuing with their strategy of obfuscation and manipulation of the science to the benefit of the wind industry and the disadvantage of local residents subjected to the noise. These latest two reports are basically reworked versions of the 2013 ReUK AM study and involved some of the same authors as were responsible for the ReUK study.

The IoA AMWG proposed AM measurement metric takes the form a 'black box' containing an opaque data manipulation process that when tested is shown to under record actual peak to trough levels of AM and has been shown to fail to identify intermittent burst of AM. The IoA metric is presented as an untested and unproven solution.

The WSP/PB proposed AM control scheme is to apply a small dB penalty to the existing ETSU noise assessment dB (loudness) limits. Since the most intrusive AM usually occurs when overall dB levels are well below the ETSU limits, it is considered that like the previous and similar ReUK methodology to be most unlikely to protect against even the most severe periods of AM. Again the WSP/PB AM control scheme is presented as an untested and unproven solution. Only independent testing will prove or disprove the effectiveness of the combined IoA measurement metric and WSP/PB AM control scheme.

### Summary of Recommendations to Government Ministers

The INWG recommendations to government ministers following the reviews of the IoA and WSP/PB reports are:

- The AMWG and WSP/PB untested and unproven proposals for the measurement and control of AM should be rejected by government unless proven to be reliable and effective in protecting wind turbine neighbours. These proposed methodologies have not been tested with real wind turbine noise data and shown to be able to control AM in an accurate and reliable way. Thorough independent testing is required to prove or disprove these proposals.
- Since the wind industry has shown itself to be unable or incapable of self-regulation on noise issues, Government intervention is required. The INWG therefore propose Government to introduce regulation to the wind industry requiring licencing of individual wind turbine or wind farm sites in a similar manner to other polluting industries. This being the only route to effectively control noise nuisance from existing wind turbines and so providing a workable resolution for affected wind turbine neighbours.

The INWG recommendations to government ministers as detailed at the INWG AM study summary work package 10 dated November 2015 are equally valid today and are repeated below to reinforce these points. However they should be preceded by the urgent need to introduce regulation of the wind industry in order to be able to deal effectively with the large number of existing wind turbines where major problems exist but control appears impossible.

- Based on the findings at WP2.1, WP3.2 and WP5, a key step towards protecting communities from wind turbine noise amplitude modulation would be to replace the use of ETSU as recommended by the Northern Ireland Assembly report, January 2015. ETSU should be replaced with a procedure based on the principles of BS4142: 2014. This will bring wind turbine noise assessment into line with other industrial noise controls. New guidance of this type should be formulated in a Code of Practice that sets out a BS4142: 2014 type methodology that reflects noise character and relates impact and the effects on people and not an averaged dB limit as at present.
- Based on the findings in WP6.1, experience at Cotton Farm described at WP6.2 and elsewhere it is recommended that an effective AM planning condition should be part of every wind turbine planning approval unless there is clear evidence it is not needed. It is recommended that:
  - 1) Where wind turbine noise level and character require simultaneous assessment then BS4142:2014 should be used. The rated wind farm noise level should not exceed +10dB above the background noise level.
  - 2) Where only wind turbine noise AM requires assessment then a Den Brook type planning condition should be used. There should be full consultation on any proposed wording of a condition before it is finalised as a government approved condition.

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- Continuous noise monitoring of wind turbines should become a standard planning condition for all wind turbine planning approvals as recommended in the Northern Ireland Assembly report, January 2015. This should be funded by the wind turbine operator but controlled by the LPA with the noise data (including met mast and turbine SCADA data) made openly available to ensure transparency. The Cotton Farm community noise monitor described at WP9 provides an example of how this can be achieved.
- There is a need to commission independent research to measure and determine the impact of low-frequency noise on those residents living in close proximity to individual turbines and wind farms as recommended in the Northern Ireland Assembly report, January 2015.
- Conflict of interest concerns must be properly addressed and, if established, appropriate action taken to remedy the situation and provide full transparency in determining these issues.
- That noise complaints from within communities and by local residents need to be taken seriously as being well founded and legitimate. They should be thoroughly investigated and that there should be no attempts to undermine these complaints as being as a result of mere 'annoyance' due to a perceived notion that complainants just don't like wind turbines or are even motivated by other non-acoustical factors.

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