INSTALLATION OF A 49KW WIND TURBINE AT FIELDHEAD FARM WITH HEIGHT TO TIP OF 33.471M, HEIGHT TO HUB OF 23.4M AND A ROTOR DIAMETER OF 18.9M

Turbine Location:
TURBINE 1 – 341618 853248

STATEMENT OF REVIEW

Introduction

This Statement has been prepared to support the application for Local Review of the refusal decision made by Moray Council for the installation of a 49kw wind turbines on land associated with Fieldhead Farm.

The application, reference number, 17/01591/APP pertained to a single Orenda 49kw wind turbine comprising the following specifications and measurements:

- 9.2m blades
- 18.9m rotor diameter
- 3 blades
- 23.4 tower
- 49kW generating capacity
- 55 rpm

Application Site

The site lies within an area of land associated with Fieldhead Farm. The Farm is situated within an area known as Aultmore which has a series of unclassified public roads. The turbine position lies in the region of 313m North, 212m West, 1.08km south and 670m South West of the aforementioned unclassified roadways. The B9017 lies in the region of 1.5km to the South, the B9016 lies 1.29km to the West and the A96 1.85km to the West. Keith lies 2.2km to the south and Newmill 1.7km to the south east. Lying 4.5km south East of the proposed development site lies Mill Wood (SSSI), the only designated site within 5km of the proposed turbine.

The application was denied on two grounds – landform type and cumulative impact - considered separately below. This appeal is addressed to the Local Review Body.

Refusal Ground 1: landform type

MORAY WIND ENERGY LANDSCAPE CAPACITY STUDY by Carol Anderson Landscape Associates including Updated and Revised Final Appendix Report July 2016 ("The Guidance") states (our italics) "This size of turbine is more likely to fit with the landscape if they are sited to clearly relate to a specific landform. Turbines of this size could be accommodated on low hills or ridgelines across the more expansive farmed areas, or in the wider and more extensive areas of farmed valleys. Other opportunities include *the rising ground which provides the immediate backdrop to the farmed lowland areas and valley floors, especially if they are back-dropped by larger hills.*" A sketch (figure 1) is included in the Guidance to illustrate the relative scales of the turbine and the undulations being described.

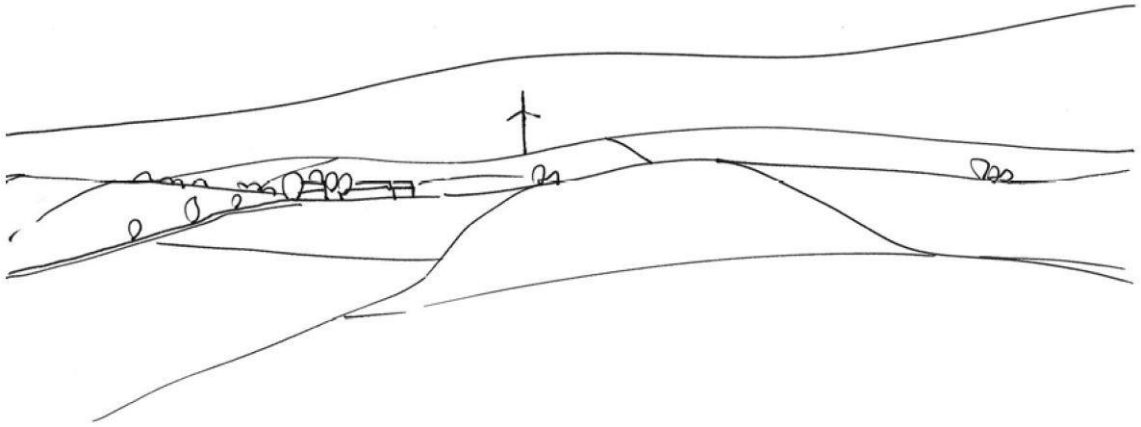

Image 8 – Landscape scale and size of features: *A 'small typology' (20m – 35m) turbine located on a low-lying ridgeline set back from but still associated with the pattern of settlement. In this location, the turbine is linked to the scale of the landform and there are no features in the immediate proximity against which to judge turbine height. It is sited at a slight dip in the ridge, and back-dropped in this view by higher ground. It is located away from the house, to avoid overwhelming the buildings in terms of scale.*

Figure 1 - Image 8 from the Guidance, Appendix Report, with caption

The turbine proposed at Fieldhead would be situated above Fieldhead Farm on rising ground forming the immediate backdrop to farmed lowland areas occupied by Fieldhead and Auchairn Farms, back-dropped by the much larger Millstone Hill when seen from those areas of Keith and those sections of the A96 with a line of sight to the proposed turbine. This is precisely the type of setting described in the Guidance (italicised text above) as capable of providing a good fit for this scale of turbine, and the visualisations provided by the AE Associates ("the Agent for the Applicant") (for example figure 2 - the LRB is invited to compare this with figure 1) show that the scale of the turbine proposed relative to the scale of the undulations in the landscape is significantly smaller than that envisaged in the Guidance.

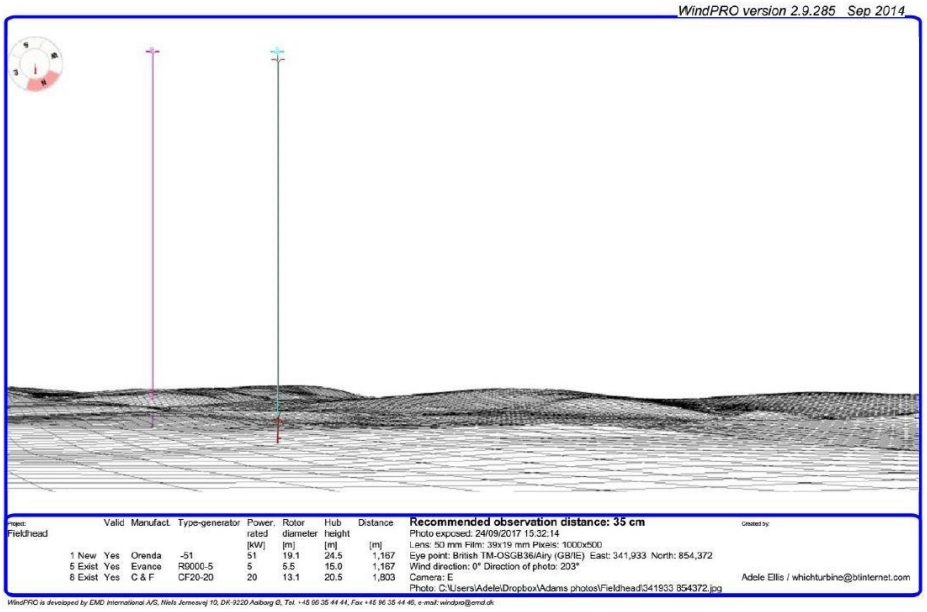

Figure 2 - approved visualisation, with proposed turbine in foreground

In the Decision Notice the Authority makes no reference to the landscape types defined in the Guidance but instead asserts (Ground 1 for refusal) that the proposed turbine would have "no adjacent landform or features to mitigate its scale and impact", a statement which unfortunately is factually incorrect as is evident from the Applicant's visualisations and from their location plan (figure 3 below, annotated in the terms of the Guidance). The Decision Notice goes further and concludes that the turbine "would appear as an unduly prominent feature in the landscape." It continues, "as such the proposal would fail to integrate sensitively with the landscape and would cause unacceptable adverse visual and landscape character impacts to the detriment of the landscape." In the absence of any guidance this view could be defended by an argument that visual impact is wholly subjective but in this case the Authority's own guidance, issued very recently for the specific purpose of helping developers like the Applicant to decide on locations which might be acceptable for wind turbines at particular scales, flatly disagrees and we invite the Local Review Body to agree with us that the reasoning set out in the Guidance should prevail and that this ground for refusal must be declared invalid.

SITE LOCATION

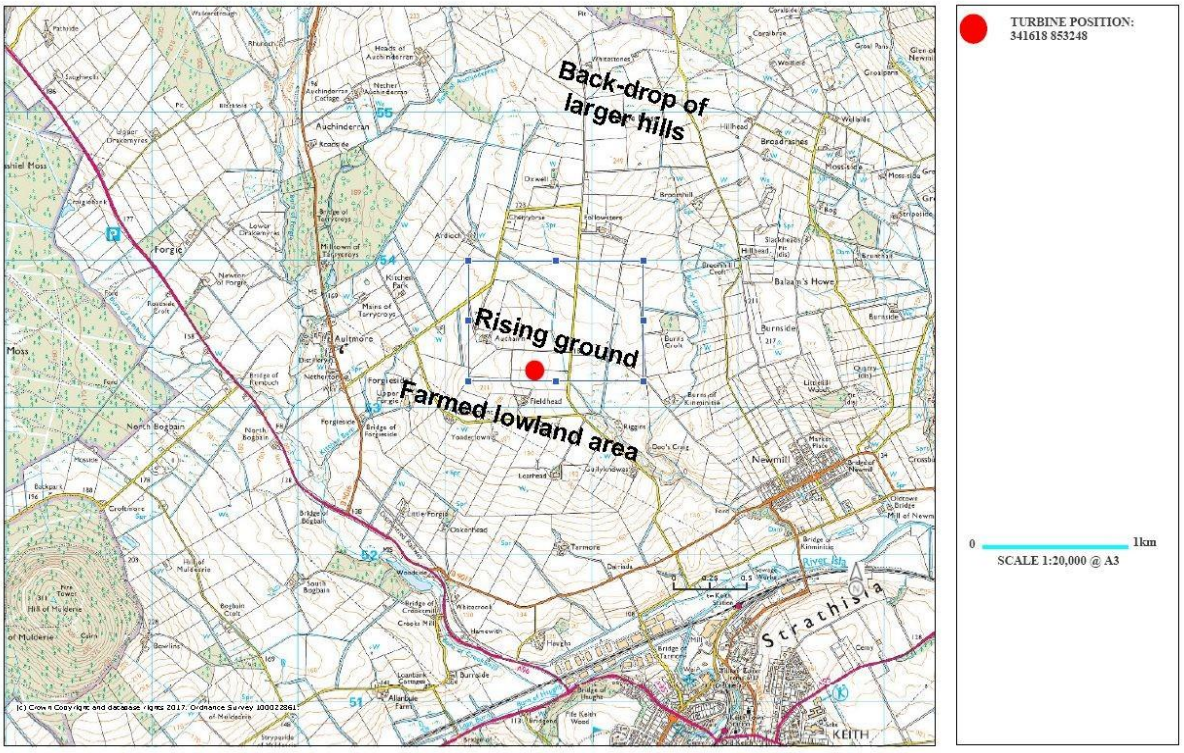

Figure 3: Approved location plan

Refusal ground 2: cumulative impact

The visualisations prepared by the Applicant (figure 2 and others) show constructed and consented turbines alongside the proposed turbine. In every case there are few turbine visible and the majority are very small. For example in figure 2 above the two constructed turbines shown are smaller than the proposed turbine and difficult to pick out.

The Guidance sets out the following issues to be considered when determining cumulative visual and landscape impact, but the Authority in its Decision Notice has not referred to any of these:

- Several individual, or small groups of turbines, could begin to dominate local character
- Lack of a clear siting strategy could lead to fragmentation of an existing robust and recognisable landscape pattern –where possible, it is important to site turbines on similar landforms, at similar elevations and with a similar relationship to the existing settlement pattern;
- Diverse designs of turbine, all spinning at different speeds – or even several turbines of the same type – strung along a prominent or important skyline could become a visual distraction from other landscape features or from perceived visual amenity, especially from key viewpoints;
- The larger the turbine, the harder it is likely to be to accommodate a number of them in a single view or recognisable tract of landscape without them becoming the

dominant feature. It is also harder to accommodate the turbines in a sequence of views experienced, for example, when travelling along a road;

- The variety of potential different types of wind turbines within the landscape could lead to clutter with different styles, sizes of structures and speeds of blade movement dotted across a Landscape;
- Potential clutter may also be easily created if there are other masts, such as telecoms masts, overhead wires and pylons within the same vicinity;
- There may be the added complication of increased visual clutter created by a wide range of different heights of turbine within a farmed landscape with micro-, small and small/medium sized turbines;
- An additional complication may be the visual interrelationship with larger wind farms of large and medium sized turbines, especially along the upper edge of farmland adjacent to upland character types.

There are very few constructed or consented turbines visible from within the ZTV. Further, because the proposed turbine is situated 2km from Keith and the same distance from those sections of the A96 which lie within the ZTV, it would appear as a very small feature in the landscape seen from sensitive viewpoints from where it can be seen at all. Crucially the scale as seen by an observer of the proposed turbine and of all constructed and consented turbines visible at these viewpoints is commensurate with the scale of the landscape features around them. So the proposed turbine and the constructed and the consented turbines which would be visible with it are very much smaller than they would have to be in order to begin to dominate the local character.

The valid concerns about potential cumulative impact raised in the Guidance would be relevant to this application if large numbers of different types of turbine were constructed or consented close by but this is not the case and we urge the Local Review Body to recognise this fact and declare cumulative impact invalid as a ground for refusal of this application.

<u>Conclusion</u>

In this appeal we have examined the planning application, the decision notice and some very relevant and recent, guidance commissioned by the Authority. Our conclusion is that the proposal accords with the recommendations given in the Guidance for this scale of wind turbine but that the justification for refusal given in the Decision Notice does not pay proper attention to the Guidance and instead makes subjective assertions about landscape and visual impact which are contrary to the conclusion that would reasonably have been reached if the guidance had been followed in detail. On this basis we ask the Local Review Body to overturn the refusal and allow the application.

SUPPORTING STATEMENT

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Turbine Location:
TURBINE 1 – 341618 853248

OCTOBER 2017

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1 INTRODUCTION

This Statement has been prepared to support the planning application lodged with Moray Council for the installation of a 49kw wind turbines on land associated with Fieldhead Farm. The candidate turbine for this project is the Orenda Skye™. This turbine comprises the following specifications and measurements:

- 9.2m blades
- 18.9m rotor diameter
- 3 blades
- 23.4 tower
- 49kW generating capacity
- 55 rpm

In line with standard planning conditions, permission is sought for this development for 20 years from the first generation of electricity on site, after which time the turbine will be removed and the site restored.

1.1 Application Site

The site lies within an area of land associated with Fieldhead Farm. The Farm is situated within an area known as Aultmore which has a serios of unclassified public roads. The turbine position lies in the region of 313m North, 212m West, 1.08km south and 670m South West of the aforementioned unclassified roadways. The B9017 lies in the region of 1.5km to the South, the B9016 lies 1.29km to the West and the A96 1.85km to the West. Keith lies 2.2km to the south and Newmill 1.7km to the south east. Lying 4.5km south East of the proposed development site lies Mill Wood (SSSI), the only designated site within 5km of the proposed turbine.

The proposed location for the wind turbine sits at a height above sea level of approximately 190m AOD. In support of the application we have provided noise impact information as well as relevant drawings, maps, images and technical details.

1.2 Site Identification

Feasibility work carried out has assessed particular technical, environmental and aesthetic issues relating to the installation of the proposed turbine.

In technical terms, a number of factors were initially considered which included:

- **Topography**: the steepness of the land determines which parts of the site are most suitable for erecting a turbine;
- **Existing infrastructure**: local roads, rights of way, overhead or underground services, etc. which pass in close proximity to or through the proposal site, that require to be protected or safeguarded during construction and in the unlikely event of a structural failure during operation;
- **Access**: the means of accessing the proposal site via the local road network can influence the size of turbine that can be accommodated;
- **Grid connection capacity and location**: the means of carrying the power off-site and the electrical power that can be accommodated by the grid network in the area; and

- **Proximity to housing**: to safeguard the amenity of nearby properties from the potentially intrusive effects of the installation, both visually and noise related.

In environmental terms, the capacity of a proposal site may be further affected by areas of sensitivity, which may limit or even preclude development. Issues considered at the proposal site included:

- **Ecology and ornithology**: valuable habitats and protected species of plants, animals and birds that may be present on site, including the flight path of birds and bats;
- **Cultural heritage**: archaeological features that may be present on site; and
- **Other features**: property boundaries, hedgerows, proximity to buildings.

In landscape and visual terms, the capacity of the proposal site relates to its ability to accommodate wind turbine without creating unacceptable effects on the physical fabric of the site itself, on the character of the surrounding landscape and on views from surrounding areas. A number of landscape and visual design objectives were set out to guide the design process, as follows:

- Turbine positioning within the site should respond to **prevailing wind resource**;
- Turbine positioning within the site should relate to **landform features**, contours and boundaries in order to provide a landscape basis for a wind energy development;
- The development should respond to the **scale of the landform** and be appropriate for the overall landscape scale;
- The development should respond to the **local landscape context**, so that when seen it forms a positive image, with a clear rationale for turbine positioning, particularly from key local receptors;
- The turbine should be sited as far from **local residential properties** as is practicable; and
- The overall **visual intrusiveness** of the development should be minimised.

1.3 The Proposed Development

The intention of the proposal is to generate electricity from the power of the wind. The NOABL wind speed database gives an estimated wind speed of 8m/s at 10m AGL at the proposed turbine locations. The Orenda Skye™ wind turbine can produce 200,000kWh of electricity at an average annual wind speed of 8m/s. Given that the candidate turbine tower measures 23.4m, this figure is an estimate of each turbine's output.

The Orenda Skye™ turbine has a generation capacity typically seen with larger turbine dimensions. The oversized rotor in relation to tower height ensures a relatively large energy output is generated without the need for a larger, more visually intrusive machine.

Concrete foundations will secure the turbine. Underground cabling will transfer the power generated from the wind turbine.

The tower is constructed from high strength columbium-vanadium low alloy steel. The rotor blades are constructed from fibreglass.

1.4 Access

Access to the site by delivery and construction vehicles is likely to be taken from the main unclassified public road which leads directly to the farm and associated field networks. No new access track will be required. The Orenda Skye™ turbine has a hydraulic tower which is raised from ground level without the need for a crane. Therefore, unlike most wind energy

installations, there is no requirement for the creation of permanent access tracks in association with the proposal.

No issues associated with site access are predicted.

1.5 Development Phases

Construction

Depending on weather conditions, the turbine could take in the region of six weeks to build and are designed to have an operational life of 20 years. The construction process will consist of the following principal activities:

Week 1

- Site survey, preparation and installation of any temporary storage facilities
  - Duration – c. 1 day.
  - Vehicles – works van to transport construction workers
- Excavate turbine foundations and construct the turbine and transformer bases
  - Duration - 1 week
  - Vehicles required – 1 x digger, 1 x dumper truck, 1 x standard size articulated lorry to transport the digger and dumper truck to and from the site, 2 x concrete wagons, making c. 7 trips to site over a period of c. 3 days, 1 x aggregate wagon, 1 x works van to transport construction workers to site

Weeks 2 – 5

- No activity as concrete base is left to set

Week 6

- Excavate cable trench and lay the power and instrumentation cables
  - Duration: c. 1 day
  - Vehicles required: 1 x digger, 1 x dumper
- Install the grid connection
- Wind turbine component deliveries and turbine erection
  - Duration: 1 day
  - Vehicles required: 4 x standard-size articulated lorries to transport turbine components including tower sections, 1 x works van to transport construction workers to site
- Testing and commissioning the wind turbine
- Site restoration of disturbed areas
  - Duration: 1 day
  - Vehicles required: digger and dumper truck

Operation

Wind turbine operations would be overseen by suitably qualified local contractors who would visit the site to carry out maintenance. The following turbine maintenance would be carried out along with any other maintenance required by the manufacturer's specifications:

- Initial service
- Routine maintenance and servicing
- Blade inspections

Routine servicing would take place once a year with a main service at twelve-monthly intervals. Servicing would include the performance of tasks such as maintaining bolts to the required torque, inspection of blade pitch and braking mechanism, greasing of bearings, inspections of welds and structural integrity of the tower and maintaining all hydraulic and electrical systems.

Decommissioning

The development has been designed to have an operational life of 20 years. At the end of this period the development will either be decommissioned or an application submitted to extend its life.

Decommissioning will take account of the environmental legislation in operation and technology available at the time. Notice will be given to the local authority in advance of commencement of the decommissioning works, with all necessary licenses or permits being acquired.

2 PLANNING POLICY FRAMEWORK

The following is a summary of renewable energy law and national and local planning policy relevant to the determination of this application.

International, EU, UK and Scottish law and policy on renewable energy is a material consideration in the determination of this application.

Section 25 of the Town and Country Planning (Scotland) Act 1997 provides that:

"Where, in making any determination under the planning Acts, regard is to be had to the development plan, the determination is, unless material considerations indicate otherwise-

(a) to be made in accordance with that plan..."

The development plan comprises the Moray Local development Plan 2015. National planning policy is set out in Scotland's Third National Planning Framework (NPF3) – (June 2014) and Scottish Planning Policy (June 2014) and other documents that are a material consideration in the determination of the application.

The following outlines the renewable energy law and policy context within which the proposal has been brought forward and relevant national planning policy and applicable development plan polices.

Renewable Energy Law and Policy

Following the Rio Earth Summit in 1992 the development of law and policy in this area has been through various Conventions, Directives and policy statements. These include the United Nations Framework Convention on Climate Change (UNFCCC) 1992,

the Kyoto Protocol and the EU Renewable Energy Directive 2009/28/EC. In the UK context they include the UK and Scottish Government's climate change and renewable energy laws and policies which set out the UK's and Scotland's responses to their international and EU obligations;

Fundamentally, the requirement for cleaner energy generation (both for a secure energy supply and to positively impact on climate change) is the key driver to increasing the proportion of the UK's and Scotland's energy generated from renewables.

The first commitment period applied to emissions between 2008 and 2012; with the total emissions of the developed countries to be reduced by at least 5 % over the period, when compared with 1990 levels.

The second commitment period applies to emissions between 2013 and 2020. In 2010 it was agreed that future global warming should be limited to below 2.0 °C (3.6 °F) relative to the pre-industrial level.

The Protocol identified measures for attaining its objectives including the introduction of national policies to reduce GHG emissions, which is to be achieved in part through the development of renewable energy sources.

EU Law and Policy Renewable Energy Directive 2009/28/EC

Following on from the Kyoto Protocol the European Union implemented a number of measures pursuant to its obligations under the Protocol. Key amongst these has been the enactment of the Renewables Directive, 2009/28/EC. The Directive mandates levels of renewable energy use within the European Union.

Article 3 of the Directive requires that 20% of the energy consumed within the

European Union is renewable by 2020. This target is pooled among the Member States, with different targets being set for each member state. The target sits alongside existing commitments to reduce GHG emissions reductions (by 20%) and improvements in energy efficiency (of 20%), together known as the "20/20/20 targets".

The target for the UK is that 15% of its energy comes from renewable sources by 2020.

Members States are also obliged to prepare a National Renewable Energy Action Plan under Article 4, which sets out the road map of the trajectory to achieve the targets and, under Article 22, report on their implementation of the Directive and their progress towards their targets.

The Directive constitutes an essential part of the package of measures needed to comply with the commitments made by the EU under the Kyoto Protocol on the reduction of GHG emissions.

Updated EU Climate Change and Energy Policy – A Policy Framework for Climate and Energy in the Period from 2020 to 2030 (COM/2014/015 final)

EU policy on climate change and energy has remained under review since the implementation of the Renewable Energy Directive, and in March 2013 the European Commission issued a Green Paper looking beyond 2020 with the purpose of

establishing a revised Framework for Climate Change and Energy policies through to 2030. This was followed in January 2014 by a Commission Communication which proposes to set a greenhouse gas emissions reduction target for domestic EU emissions of 40% in 2030 relative to emissions in 1990. It also proposes a revised target of at least 27% as the share of renewable energy to be consumed in the EU by 2030. It is proposed that the latter should not be delivered through setting individual targets for Member States, as is currently the case, but instead by securing clear commitments to be decided by the Member States themselves, supported by strengthened EU level delivery mechanisms and indicators.

The intention is that European Union should pledge a GHG emissions reduction of 40% compared with 1990 by 2030 as part of the new Paris Agreements concluded in December 2015. In order to achieve this, significantly higher levels of renewable energy will be required.

UK Renewable Energy Law, Policy and Targets

At a UK level, following the UK's commitments through a range of legislation, strategies, plans and other documents to deliver the commitments under the Kyoto Protocol and in response to implementation of the EU Renewables Directive. It is clear that whilst great advances have been made towards meeting targets that there is still substantial additional investment in renewables generating capacity required if the Paris Agreements is to be met up to 2020 and beyond.

The Climate Change Act 2008

In the UK the Government responded to the challenge of the UNFCCC and Kyoto Protocol by the Climate Change Act 2008. The Act commits the UK to reducing emissions of GHGs by at least 80% in 2050 from 1990 levels. The 80% target includes GHG emissions from the devolved administrations, which currently account for around 20% of the UK's total emissions.

The Act requires the Government to set legally binding 'carbon budgets'. A carbon budget is a cap on the amount of greenhouse gases emitted in the UK over a five-year period. The first four carbon budgets have been put into legislation and run up to 2027.

The Renewable Energy Strategy 2009

The UK Renewable Energy Strategy sets out the UK Government's strategy in response to the obligations under the EU Renewable Energy Directive. The Strategy explains how the UK will meet its legally-binding target to ensure 15% of its energy comes from renewable sources by 2020: an almost seven-fold increase in the share of renewables in little more than a decade.

The Strategy seeks to reduce the UK's emissions of carbon dioxide (CO2) by over 750 million tonnes by 2030, promoting the security of the UK's energy supply, reducing overall fossil fuel demand by around 10% and gas imports by 20–30% against what they would otherwise have been in 2020.

UK Low Carbon Transition Plan 2009

The UK low carbon transition plan subsequently set out how the UK Government is to meet its binding carbon budget; an 18% cut in emissions on 2008 levels by 2020 (34% on 1990 levels). It also allocates individual carbon budgets for the major UK government departments, which are expected to produce their own plans. The plan amongst other measures identifies that emission cuts would come from the power sector.

The plan aims to cut emissions from the power sector and heavy industry by 22% on 2008 levels by 2020 - using 40% of electricity from low-carbon sources by that date. This is to be achieved by producing around 30% of the UK's electricity from renewables by substantially increasing the requirement for electricity suppliers to sell renewable electricity.

Carbon Plan 2011 – Delivering Our Low Carbon Future, December 2011

The Carbon Plan 2011 sets out the UK Government's proposals and policies for meeting the first four carbon budgets. It identifies that large-scale deployment of low carbon generation will be needed, estimating that 40–70 GW of new capacity will be required by 2030.

UK Renewable Energy Roadmap (2011) (including 2012 and 2013 Updates)

The UK Renewable Energy Roadmap, which was first published in 2011, sets out how the renewables required will be deployed in order for the UK to achieve its 15% target for meeting the UK's energy demand from renewables in accordance with the EU Renewables Directive. It identifies that in Scotland the Scottish Government has now introduced a target to deliver the equivalent of 100% of demand from renewable electricity by 2020.

The analysis of potential deployment to 2020 considers factors such as technology, cost, build rates, and the policy framework. These variables are modelled to produce illustrative 'central ranges' for deployment. The report identifies that, despite uncertainty about the contribution from individual technologies, the UK can deliver 234 TWh of renewable energy overall in 2020 – equivalent to 15% of its projected energy consumption.

In relation to onshore wind, the Strategy identifies that the UK in 2012 had more than 4 GW of installed onshore wind capacity in operation (generating approximately 7 TWh of electricity annually). The indicators are that onshore wind could contribute up to 13 GW by 2020. Achieving this level of capacity equates to an annual growth rate of 13%.

The UK's total onshore wind capacity increased by 1 GW between the end of 2014 Quarter 2 and end of 2015 Quarter 2, bringing total installed capacity to 5 GW.

The Roadmap updates confirm that, although there has been considerable progress, significant additional investment in new renewable capacity is still required if the UK

is to meet its target of 15% of the UK's energy demand being met from renewables by 2020 in accordance with the EU Renewables Directive.

Renewable Energy Review 2011

The review of renewable energy by the Committee on Climate Change (CCC) was commissioned by the UK Government with a view to advising on the scope to increase ambition for energy from renewable sources. It was concluded that the UK Government's 2020 ambition is appropriate, and should not be increased. Instead it stated that the focus should be on ensuring that existing targets are met: this continues to require large-scale investment in renewables over the next 10 years, supported by appropriate incentives.

The CCC's overall conclusion was that there is scope for significant penetration of renewable energy to 2030 (e.g. up to 45%, compared to 3% in 2011). Higher levels subsequently (i.e. to 2050) would be technically feasible. Equally, however, it would be possible to decarbonise electricity generation with very significant nuclear deployment and have limited renewables. Carbon capture and storage may also emerge as a cost-effective technology.

The Review concluded that new policies are required to support technology innovation and to address barriers to uptake in order to suitably develop renewables as an option for future decarbonisation. With specific regard to onshore wind, the Report concludes that cost-estimates suggest that onshore wind is likely to be one of the cheapest low-carbon options. The Report also concluded that over 6 GW (generating 20 TWh a year) of onshore wind capacity could be added in the 2020s.

National Infrastructure Plan 2014

The National Infrastructure Plan (NIP) was first published in 2010, with subsequent updates in 2011, 2012, 2013 and most recently 2014. It sets out the Government's plan for investment in new infrastructure over the next decade and beyond. The latest edition of the Plan identified that the UK Government's strategic energy objectives in response to the Updated EU Climate Change and Energy Policy with its commitment to a greenhouse gas emissions reduction target for domestic EU emissions of 40% in 2030 relative to emissions in 1990.

As far as wind is concerned the NIP identifies that wind will remain in the top 40 priority infrastructure investments and will continue to play a significant part in the UK's energy mix.

Scottish Renewable Energy Law and Policy

The legal and policy framework in Scotland mirrors the development in UK law and policy, although the Scottish Government has committed itself to considerably more ambitious targets than the UK Government, reflecting the current government's proactive stance and the greater renewable energy resource that exists in Scotland.

Key Scottish legislation and policy includes the following:

The Climate Change (Scotland) Act 2009

The Climate Change (Scotland) Act was passed in 2009, committing Scotland to a 42% reduction in GHG emissions by 2020 and an 80% reduction target for 2050. To help ensure the delivery of these targets, the Act also requires that the Scottish Ministers set annual targets, in secondary legislation, for Scottish emissions from 2010 to 2050.

Low Carbon Economic Strategy for Scotland 2010

Low Carbon Economic Strategy for Scotland 2010 sets out the Scottish Government's commitment to supporting the transition to a low carbon Scottish economy, necessary to meet Climate Change Act targets, to reduce emissions by 42% by 2020 (compared to the equivalent UK target of 34%), and by 80% by 2050. Furthermore, the Scottish Government has, since the publication of the Strategy, upgraded its commitment to delivering the equivalent of at least 100% of gross electricity consumption from renewables by 2020, and it is envisaged that onshore wind will continue to play a central role in achieving the target as the technology that can make the most immediate positive impact on Scotland's low carbon economy. The Strategy therefore expresses continuing encouragement to large, medium and small scale developments that are sited appropriately.

Low Carbon Scotland Meeting the Emissions Reduction Targets 2013-2027 - The Second Report on Proposals and Policies (RPP2) 2013

Low Carbon Scotland Meeting the Emissions Reduction Targets 2013-2027 is the Scottish

Government's Second Report on Proposals and Policies (RPP2) for meeting its climate change targets. It sets out how Scotland can deliver its statutory annual targets for reductions in GHG emissions for the period 2013–2027 set through the Climate Change (Scotland) Act 2009.

Scotland's targets from 2013–2027 are expressed in tonnes of carbon dioxide equivalent (CO2e). A key part of the Scottish Government's Proposals and Policies is to largely decarbonise the electricity generation sector by 2030, using renewable sources for electricity generation with other electricity generation from fossil-fuelled plants utilising carbon capture and storage. The RPP2 reports that to date, the carbon intensity of electricity generation has fallen from 347 gCO2/kWh in 2010 to 289 gCO2/kWh in 2011 and that Scotland is on track for a further 83% reduction in carbon intensity by 2030. The decarbonisation target is a carbon intensity of 50 gCO2/kWh by 2030.

The RPP2 states that progressing the Scottish Government's thematic energy policy objectives is critical to achieving the Climate Change Report on Proposals and Policies' (RPP)'s decarbonisation target. These include achieving at least 30% overall energy demand from renewables by 2020 and delivering the equivalent of at least 100% of gross electricity consumption from renewables by 2020 with an interim target of the equivalent of 50% of gross electricity consumption from renewables by 2015.

Electricity Generation Policy Statement 2013

The Scottish Government's Electricity Generation Policy Statement (EGPS) was published in 2013 to support the RPP. The EGPS examines the way in which Scotland generates electricity, and considers the changes which will be necessary to meet the targets which the Scottish Government has established, and reflects views from both industry and other stakeholders and also developments in UK and EU electricity policy.

It looks at the sources from which that electricity is produced, the amount of electricity used to meet Scotland's needs and the technological and infrastructural advances and requirements which Scotland will require over the coming decade and beyond.

8.53 The Scottish Government's policy on electricity generation is that Scotland's generation mix should deliver a secure, affordable, largely de-carbonised source of electricity supply by 2030 which also achieves the best possible economic benefit and competitive advantage for Scotland.

2020 Routemap for Renewable Energy in Scotland 2011 and December 2013 Update

The 2020 Routemap for Renewable Energy in Scotland updates the Scottish Government's Renewables Action Plan (2009). It sets out a routemap for achieving the Scottish Governments target to meet an equivalent of 100% demand for electricity from renewable energy by 2020, as well as a target of 11% renewable heat. The Routemap identifies the need for rapid expansion of renewable electricity across Scotland. It includes projections of potential patterns of deployment of renewable electricity capacity, based on historical trends, which indicates deployment of up to 16,000 MWe installed capacity by 2021. The Routemap, including the December 2013 Update, provides status reports on deployment to date (by individual sector) and identifies the main actions required to make progress towards the 2020 target. It identifies that the target requires a sustained annual renewable deployment rate of more than twice that ever previously experienced in Scotland. It states that as part of this deployment the Scottish Government is committed to the continued expansion of a portfolio of onshore wind farms to help meet renewables targets.

Despite the previous success of deploying renewables, the latest published data demonstrate that there is still very considerable additional investment in renewables required over coming years if the Scottish Government's target to meet an equivalent of 100% demand for electricity from renewable energy by 2020 is to be achieved. Considering the rapid decline in smaller scale on shore wind turbine developments it is imperative to encourage well planned and sustainable projects wherever possible in order to have the potential to meet the given targets.

2.1 Scottish Planning Policy

The planning policy context provides the spatial aspect to the Scottish Government's policy on renewables and onshore wind farm development and sets out the key policy criteria against which planning applications under the Town and Country Planning (Scotland) Act 1997 are to be determined including, the environmental impacts.

General Planning Policy Approach to Renewable Energy and Onshore Wind

The general planning policy context in respect of proposals for renewables including onshore wind farms are brought forward in Scotland includes both national and local planning policy.

National Planning Policy concerning renewables on onshore wind farms has evolved with Scottish renewable energy law and policy to ensure that the planning system assists in the delivery of the Scottish Government's target to meet an equivalent of 100% of electricity demand from renewable energy by 2020.

The key planning documents on renewable energy and onshore wind set out both the strategic policy framework, providing overarching guidance for Scottish Ministers and Local Planning Authorities, in terms of providing a generally supportive spatial framework within which proposals for renewable energy projects can be brought forward.

The national policy includes the National Planning Framework (NPF) for Scotland and Scottish Planning Policy (SPP), both of which have recently been reviewed and updated by the Scottish Government. Revised editions of both documents were published by the Scottish Government in June 2014.

2.2 Development Principles

The overarching aim of Scottish Planning Policy (2014) is to achieve sustainable economic growth. The SPP holds a presumption in favour of sustainable development, and seeks to consider the benefits and costs of a development over its entire life cycle.

In supporting business, the SPP states that the planning system should promote business development that increases economic activity while maintaining natural and cultural assets. In line with this, the proposed wind turbine for installation at Fieldhead Farm will complement and balance the existing business operations by reducing the financial burdens of the farming enterprise by creating a secondary income stream through means other than agricultural farming. The National Planning Framework for Scotland (NPF 2) has the central theme of highlighting the importance of renewable energy as a vital component of the country's energy mix, and identifies small-scale wind energy developments as being effective in contributing to the provision of local renewably generated electricity. The policy views small-scale installations as important in decentralising energy generation, noting that when taken together these projects result in a significant cumulative contribution to renewables targets.

The following include details of overall planning policy approach to renewables and onshore wind.

Scotland's Third National Planning Framework (NPF3), published in June 2014, provides the statutory framework for Scotland's long term spatial development. NPF3 sets out the Scottish Government's spatial development priorities for the next 20 to 30 years and what is expected of the planning system and the outcomes that it must deliver. Whilst it is not prescriptive, NPF3 forms a material consideration when determining applications for new wind energy developments. Strategic and local development plans should take into account the strategy, actions and developments set out in NPF3.

The NPF3 recognises that the Scottish Government has set a target of at least an 80% reduction in GHG emissions by 2050.

Reference to onshore wind is set out in the 'A Low Carbon Place' section. Key points emerging from NPF3 include:

Paragraphs 3.1 to 3.6 which discuss how planning will play a key role in delivering on the commitments set out in Low Carbon Scotland. The priorities are intended to set a clear direction, consistent with the climate change legislation.

Paragraph 3.7 confirms support for onshore wind energy but notes that development should avoid internationally and nationally protected areas. It is also recognised that there is strong public support for wind energy but opinions about onshore wind in particular areas can vary. In some places concern is expressed about the scale, proximity and impacts of proposed wind developments. In other places they are recognised as an opportunity to improve the long-term resilience of rural communities, with more communities benefiting from local ownership of renewables, with at least 285 MW of community and locally-owned schemes installed by 2013.

Paragraph 3.8 sets out targets for renewable energy generation. It is the aim of the Scottish Government to reduce total final energy demand by 12% by 2020. In order to do this it will be necessary to diversify the energy supply. It is also an aim to meet at least 30% of overall energy demand from renewables by 2020 which includes generating at least 100% of gross electricity consumption from renewables, with an interim target of 50% by 2015.

Paragraph 3.9 clarifies that Scotland will continue to capitalise on wind resources as part of the push to diversify Scotland's energy generation capacity. In particular, it is desired that Scotland become a world leader in offshore renewable energy. In time, it is expected that the pace of onshore wind energy development will be overtaken by marine energy opportunities.

Paragraph 3.23 reiterates that onshore wind will continue to make a significant contribution to diversification of energy supplies but that wind development is not desirable in National Parks or National Scenic Areas and points to spatial frameworks which are to be prepared in line with the SPP to guide new wind energy developments to appropriate locations.

Sustainable development is now firmly embedded as the underlying objective of the planning system, although in recent years, policy has tended to place greater emphasis on sustainable economic development. This is clear from the opening paragraph 1.1 of Scotland's Third National Planning Framework (NPF3) – (June 2014), which states that the Scottish Government's central purpose is to create a more successful country, with opportunities for all of Scotland to flourish, through increasing sustainable economic growth. This emphasis is carried thorough into SPP – (June 2014) (paragraph 1). As stated above this identifies that there is a presumption in favour of development that contributes to sustainable development, which we consider the proposed development provides.

Scottish Planning Policy (June 2014)

The new edition SPP was published in June 2014; its purpose is to set out national planning policies that reflect priorities of Scottish Ministers for the operation of the planning system and the development and use of land through sustainable economic growth. SPP aims to promote a planning process that is consistent across Scotland but flexible enough to

accommodate local circumstances. It sets out a commitment to sustainable growth through a balance of development in the appropriate places.

According to the SPP, the commitment to increase the amount of electricity generated from renewable sources is a vital part of the response to climate change. Renewable energy generation will contribute to more secure and diverse energy supplies and support sustainable economic growth. The current target is for 50% of Scotland's electricity to be generated from renewable sources by 2020.

Paragraph 184 of SPP makes clear that the planning system should support the transformational change to a low carbon economy, consistent with national renewable energy objectives and targets.

Onshore Wind is referred to specifically in paragraphs 161 to 166 (development planning considerations) and paragraphs 169 to 174 (development management considerations) of the SPP.

Further advice is included the Scottish Government's On-line Renewables Planning Advice – On Shore Wind Turbines (Updated May 2014). This is not a policy document but provides more detailed best practice advice on onshore wind farms and wind turbine developments. This includes advice on development planning and the determination of planning applications for wind turbine development, including 'Typical Planning Considerations in Determining Planning Applications for Onshore Wind'.

As extracted and shown below the Finalised Implementation Guide states:

The land use planning context

The context for renewable development proposals is summarised below.

: Land Use Planning Context

The National Planning Framework 2 (NPF2)

• aims to 'realise the potential of Scotland's renewable energy resources and facilitate the generation of power and heat from clean, low carbon sources, including … producing heat and power from renewable sources …'

• requires 'landscape and visual impacts … to be important considerations in decision making on developments'

• identifies major infrastructure projects needed to deliver the national strategy, including the electricity grid through the Moray region.

3 NATURAL HERITAGE ASSESSMENT

Information concerning statutory and non-statutory natural heritage designated sites was sought within an area extending up to 5km from the proposed site.

3.1 Statutory Designated Sites

Mill Wood (SSSI) is the only designated site located within a 5km radius of the proposal site.

3.2 Non-statutory Designated Sites

There are no non designated sites within 5km.

3.3 Assessment of Impacts

The proposal is for the installation of a wind turbine with a tower height of 23.4m and an 18.9m rotor diameter. No landscape feature, such as trees, hedgerows or ponds will be disturbed by the proposal. The single SSSI site is located some distance from the turbine and separated by built environment. There is no potential for impact to the site due to the turbine installation. The potential landscape and visual impact is further explored within the submitted LVIA.

4 CULTURAL & ARCHAEOLOGICAL HERITAGE ASSESSMENT

To ensure the development meets planning policy requirements in respect of cultural heritage, its potential effect upon the baseline cultural heritage resource for the site and for buffer zones extending at most to a 5km radius, has been assessed.

4.1 Scheduled Ancient Monuments

There are no Scheduled Ancient Monuments (SAMs) and or Scheduled Monuments & Sites within the vicinity of the proposal.

4.2 ARCHAEOLOGY

A search for sites within a 1km radius of the proposal site was undertaken through Canmore data and noted below:

Canmore ID	Site Name	Classification
156286	Killiesmont	Building (Period Unassigned)
75889	'kinminitie'	House (Period Unassigned)

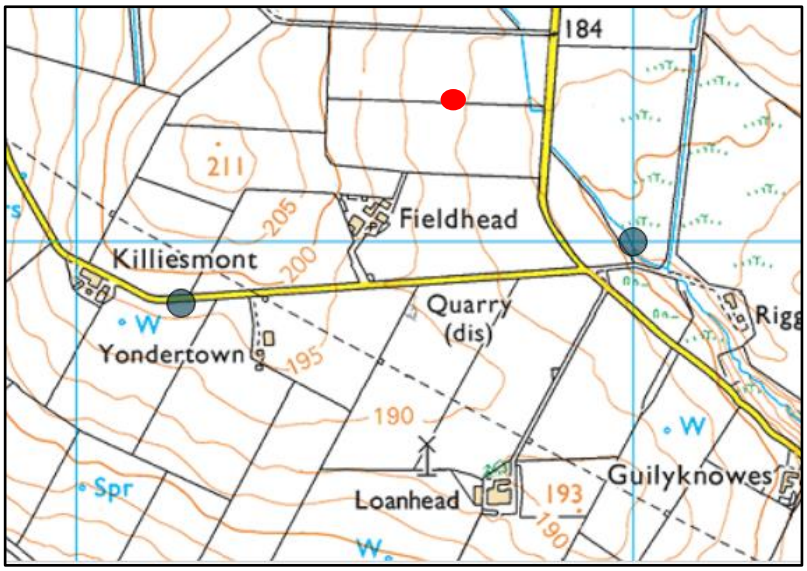
Gardens and Designed Landscapes

There are no entries on the Gardens and Designed Landscapes Inventory located within a 1km radius of the proposal site.

4.3 Assessment of Direct Impacts

This section considers the potential for the development to cause direct effects in the form of damage or destruction during construction upon features of cultural heritage and archaeological interest, whether known sites or unknown buried archaeology. These effects would be most likely to occur during construction and decommissioning, and would be permanent and irreversible.

The proposal site is not located immediately on any historic, cultural or built site, monument or building as shown in the extract from Canmore below:



It is noted that there are no sites within the immediate proximity to the development site nor is there any along the access route. There should be no archaeological impact due to the turbine development. If, in the unlikely event of the uncovering of archaeological remains during the construction stage of the project, work will halt immediately and archaeological expertise sought.

4.4 Assessment of Indirect Impacts

This section considers the potential for indirect, visual impacts to occur upon the settings of features of cultural heritage and/or archaeological interest. The setting of a scheduled monument or listed building can be loosely interpreted as features, spaces and views that are historically and functionally related, and which can be considered to be vital to their intrinsic interest.

Setting can be tangible, such as a defined boundary, or intangible such as atmosphere or ambience. The main concern for visual effects on a cultural heritage setting is the potential for the development to fragment the historic landscape, separate connectivity between historic sites and impinge on views to and from sites with important landscape settings, although, the visually permeable nature of the development may permit the visible setting to a special interest to still be apparent. Visual dominance, scale, intervisibility, vistas and sight lines as well as noise, movement and light as potential effects upon features of cultural heritage interest that might be derived from wind energy projects. Indirect effects can occur during construction, operation and decommissioning.

The potential for indirect impacts from the proposal is considered to be low for the following reasons:

- No SMs lie within a 5km radius of the proposed turbine location and the scale of the landscape and the existence of turbine developments reduce the potential for visual impact to any noted site. The ZTV gives a worse case scenario and whilst it shows turbine visibility it does not demonstrate how much of the turbine will be visual. In some cases only partial visuals are experienced greatly reducing the perceived level of impact. It is highly unlikely that the turbine will have any damaging effect on the setting.

RESIDENTIAL AMENITY

4.5 Noise

ETSU-R-97 is the industry standard document for setting appropriate noise emission levels for operating turbine and guides planning conditions. ETSU-R-97 includes a simplified noise criterion appropriate for single turbine developments, whereby limiting turbine noise at the nearest properties to no greater than 35 dB, $L_{A90,10min}$ at wind speeds of up to 10 ms^{-1} is considered to afford sufficient protection of amenity (a higher noise limit of 40 dB(A) may be applied to properties where the occupier has a financial involvement). The candidate turbine for the development is the Orenda Skye 49kW machine with an 23.4m tower having a sound power level of 93.5 dB(A) at a wind speed of 10m/s.

A site specific desk top assessment has been carried out to ascertain compliance both as an individual development and cumulatively with turbines within the area.

In order to address any potential cumulative noise levels we took into consideration any turbine development within proximity of the proposed development that in conjunction with the proposed turbine would elevate the noise levels to the residential properties. Please refer to Noise analysis report for full details.

4.6 Shadow Flicker

Shadow flicker is most commonly experienced upon land to the west and east of turbine structures as the sun rises and falls respectively, and is less likely during summer months when the sun is higher in the sky. Planning policy stipulates that a separation distance equivalent to 10 times the rotor diameter is sufficient to avoid unacceptable levels of shadow flicker. In this instance a 18.9m rotor diameter equates to a 189m separation requirement from the nearest receptor. As the nearest dwelling is far in excess of this from the turbine there should be no residential property either involved with the development or outwith that will be affected by shadow flicker from the proposed turbine.

5 LANDSCAPE & VISUAL IMPACT

A Visual assessment has been undertaken with regard to the proposed development with images being taken from key viewpoints. Reference has been taken with regard to the Carol Anderson Landscape Architects 2017 guidance as per the Finalised Draft Onshore Wind energy Guidance 2017.

As per guidelines care has been taken to ensure that the turbine will not be highly visible against the sea and sky and out of scale with the landform, low buildings and wind pruned trees. It is our opinion that the turbine is capable of being viewed in context with the existing landscape and built environment and that it can function without causing undue visual intrusion.

The landscape in which the turbine is to be sited does have elements of sensitivity but it is our view that this particular site and the closer vicinity in general has the potential to comfortably site turbine without any undue harm being caused to the landscape.

The proposal is of an appropriate scale and context for the area.

The Zone of Theoretical Visibility (ZTV) map accompanying the proposal gives an indication of the visual influence of the proposal within a 15km radius. It is important to note that the ZTV

is based solely on ground contour data and so does not account for landscape features such as vegetation and buildings which can limit or block views. As such, the ZTV should be considered as representing a visual impact worst-case scenario.

It is our contention that the scale of turbine corresponds appropriately to the scale of the surrounding landform, ensuring that the turbine 'fits' and will not dwarf or impose upon any landscape feature.

6 FURTHER CONSIDERATIONS

6.1 Cumulative Considerations

Wind energy projects either in the planning process at the time of writing or having been granted approval within a 5km radius of the proposal site, are presented within the noise analysis. Those within 1km would have an effect when considered in cumulative upon noise impact and/or visual impact to residential properties within the area and these have been shown within the visual montage and considered within the cumulative noise assessment as shown previously.

6.2 Aviation

It is acknowledge that because of their height and the rotating blades which can cause 'clutter' on radar, wind farms can have an effect on the aviation domain. As stated rotating wind turbine blades may have an impact on certain aviation operations, particularly those involving radar. The aviation community has procedures in place designed to assess the potential effect of developments such as wind farms on its activities and where necessary to identify mitigating measures.

We do not considered that there will now be an issue raised with regard to unacceptable levels of impact with regard to turbine operations from this proposal.

6.3 Flood Risk

SEPA's interactive flood risk mapping tool has been consulted, which demonstrates that the proposed site lies outwith any area deemed at risk from flooding.

7 CONCLUSIONS

The proposed wind turbine for installation at Fieldhead Farm is the small to medium scale Orenda Skye™ 49kW machine with a 23.4m tower and 18.9m rotor diameter. The proposal will generate electricity from a renewable, non-depleting source. The production of such a clean energy, which will be fed into the grid and utilised on a local level will ensure a further contribution to lowering carbon emissions. The financial benefit of the turbine will have a beneficial effect on a small enterprise that strives to ensure continuance in the area. Even small benefits can lead to the enterprise growing and improving over time. This can benefit the local economy and inevitably lead to offering employment in the area. It may only be a small contribution when taken into consideration a National employment of renewable projects but in conjunction with all similar projects throughout the country it will play its part in reaching targets.

It is considered that the turbine will not result in an unacceptable impact to residences, the landscape or the natural and cultural heritage. No access track is involved, therefore the land take requirement is minimal. The benefits of the proposal, can be seen to exceed any perceived harm and as such intrinsically complies with the principle of sustainable development which both the Scottish Government and The Moray Council promote.

CONFIDENTIAL

Acoustic Performance Test of a 49 kW rated Orenda 'Skye' Wind Turbine unit

A Report from NEL for

Orenda Energy Corporation

Reference No: ORE005

Report No: 2016/328
Issue 2

Date: February 2017

0432

www.tuvnel.com

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NEL
East Kilbride
GLASGOW G75 0QF
UK
Tel: +44 (0)1355 220222
Fax: +44 (0)1355 272999
www.tuvnel.com

0432

IEC 61400-11:2012 Acoustic Performance Test of a 49 kW rated Orenda 'Skye' Wind Turbine unit

A report from NEL for

24A Bath Rd
Iroquois
ONTARIO
K0E 1K0
Canada

Issue No.	Revision	Date
1	Original (running to 52 pages excluding front cover sheets & 3 appendices)	Feb. 2017
2	• Appendix added showing an Immission Noise Map based on wind speed (WS) at 10 m, using 0.1 roughness length to scale down Hub-Ht. WS's. • For informative purposes text changed in Figures 5 - 12 so it includes corresponding wind speeds at 10 m a.g.l. and elsewhere for continuity.	Feb. 2017

Prepared by:	Approved by:
[redacted]	[redacted]
Patrick Jones	**Lynn Hunter**

For
Brian Millington
Director
Date: February 2017

CONTENTS

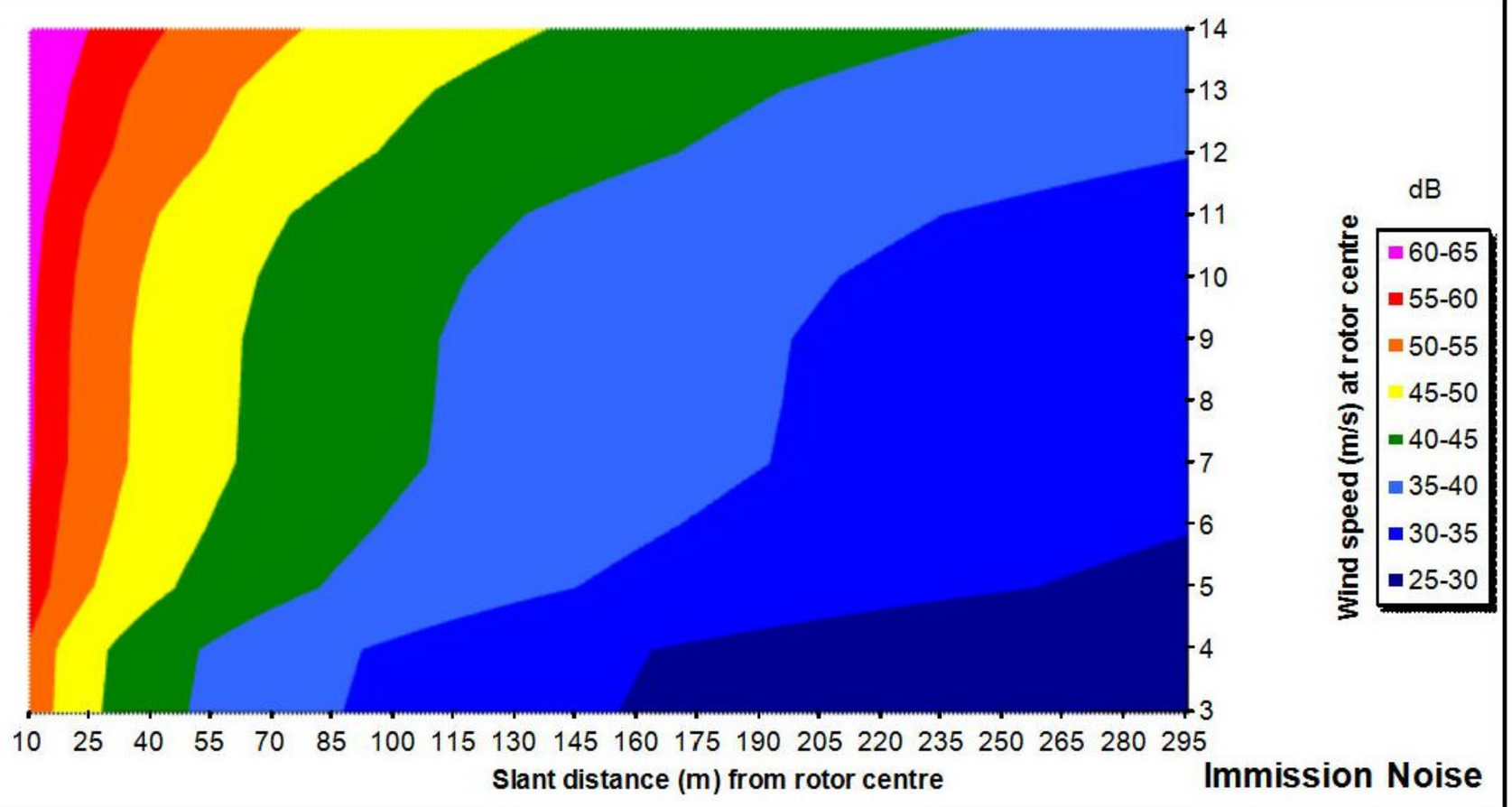
SUMMARY

NEL (TUV SUD Ltd) have carried out a series of acoustic noise measurements on a 49 kWe rated Orenda 'Skye' Wind Turbine unit on 1st and 21st December 2016.
A summary of test results are shown in the immission noise map below.

ACOUSTIC NOISE LEVELS													
Turbine Make:	Orenda	Model:	Skye										
IEC 61400-11:2012 NOISE EMISSION LEVELS													
Wind Speed (m/s) at Rotor Centre Height	3	4	5	6	7	8	9	10	11	12	13	14	
Apparent Sound Power Level, L_{WA}, dB(A) re 10^{-12}W	84.8	85.2	89.2	90.6	91.7	91.8	91.9	92.4	93.4	95.6	96.8	98.8	
Combined Uncertainty, U_c, dB	1.06	0.84	0.64	0.64	0.62	0.63	0.62	0.62	0.63	0.66	0.68	0.77	
Declared Sound Power Level, L_{Wd}, dB(A) re 10^{-12}W	86.5	86.6	90.3	91.7	92.7	92.9	93.0	93.5	94.5	96.7	98.0	100.1	
IEC 61400-11:2012 TONALITY													
General Comment	0-20 kHz narrow-band analysis using Δf = 1.5625 Hz												
Wind Speed (m/s) at Rotor Centre Height	3	4	5	6	7	8	9	10	11	12	13	14	
Critical Band Centre Frequency (Hz)	591	591	591	-	-	-	-	-	-	-	-	-	
Tonal Audibility, ΔL_a	+1.6	+2.7	+0.5	-	-	-	-	-	-	-	-	-	

ESTIMATED NOISE IMMISSION LEVELS (dB(A) at a distant observer location)

Note: based on 'Apparent' Sound Power Level at Hub-height and 'Spherical' propagation.



ORE005 - 2016/328

Tested and Issued by:
TUV SUD Ltd.
Feb. 2017

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IEC 61400-11:2012 TONALITY												
General Comment	0-20 kHz narrow-band analysis using Δf = 1.5625 Hz											
Wind Speed (m/s) at Rotor Centre Height	3	4	5	6	7	8	9	10	11	12	13	14
Critical Band Centre Frequency (Hz)	6250	6250	-	-	-	-	-	-	-	-	-	-
Tonal Audibility, ΔL_a	+1.3	+2.3	-	-	-	-	-	-	-	-	-	-

1 INTRODUCTION

The wind turbine manufacturer Orenda Energy Corporation commissioned NEL to undertake a series of acoustic noise measurements on its 49 kW rated 'Skye' wind turbine model. Details of the test campaign and the results of the data analysis are presented in this report.

2 STANDARDS AND REFERENCE DOCUMENTS

The execution of the acoustics performance measurements and analysis of relevant data were undertaken in compliance with the following standards:

- IEC 61400-11: 2012 Wind turbine generator systems – Part 11: Acoustic noise measurement techniques (identical to BS EN 61400-11: 2013).
- IEC/TS 61400-14:2005 Wind Turbines – Part 14: Declaration of Apparent Sound Power Level and Tonality Values.
- ISO 17025:2005 General requirements for the competence of testing and calibration laboratories.

3 TEST WIND TURBINE CONFIGURATION

The Orenda Skye wind turbine is a three-bladed upwind design and is rated at 49 kWe. The test turbine was installed at NEL's Myres Hill wind turbine test site. Table 1 provides a summary of the test configuration and it should be noted that the test results are only applicable to the wind turbine configuration tested.

4 DESCRIPTION OF TEST SITE

The Myres Hill wind turbine site is located in high moorland in the central belt of Scotland, within the Whitelee Forest area above Eaglesham, south of Glasgow and is centred at Ordnance Survey grid reference NS 568 467, approximately 330 m above sea level. Photographs of the surrounding area are shown in Figure 1.

There are a few small steel container or portacabin style out-houses within the confines of the test site, the closest of these lying approximately 10 m north of the turbine under test. The terrain slopes away steeply from the test site fence some 80 west of the turbine while sloping down more gradually southwards from the turbine. There are areas with long grass, heather or otherwise low lying shrubbery spread in all directions across the grounds of the test site.

There are a number of wind turbines at the test site too. During the acoustic testing reported here, it was ensured that all these other turbines remained in a parked condition. There are some large wind turbines and also forested areas within the Whitelee Wind Farm lying on neighbouring lands. These are well to the south and west outside the test site, with the closest being wind turbines that lie some 700 m away. The potential effect of any such far-away features on the background readings and thereby the reported results, is however deemed negligible following tests carried out many years ago when the whole of the Whitelee Wind Farm was off.

5 DESCRIPTION OF MEASUREMENT EQUIPMENT

Table 2 lists the measurement instrumentation used. The corresponding calibration certificates are provided in Appendix 1.

6 ACOUSTIC PERFORMANCE MEASUREMENTS

Audible noise measurements were undertaken at Myres Hill on 1st and 21st December 2016 and covered a 10-second averaged wind speed range of 3 m/s to 14 m/s for a height above ground level of 19.5 m. The measurements were taken in accordance with Annex F of the IEC 61400-11: 2012 test standard.

During each measurement session, A-weighted 1/3-octave spectra were measured concurrently with the overall continuous A-weighted sound pressure levels. An audio recording of each session was also made on a Brüel & Kjær (B&K) 2250 noise analyser. The audio signal was played back later via the B&K BZ-5503 Measurement Partner Suite software and input to a Quattro DP240 dynamic signal analyser which generated the fine frequency spectra to be used in the tonal assessment.

6.1 Measurement Procedure

A trailer based meteorological mast was used to cover westerly winds on the two days. This mast had an anemometer mounted at 19.5 m above ground level, corresponding to the hub height of the wind turbine, and was sited 38 m, i.e. 2D from the turbine on a bearing of 250°.

The total testing period covering the measurements used in the analysis lasted from 15:17 until 16:21 on 01/12/2016 and 12:22 until 12:56 on 21/12/2016. During the total testing period the measured hub height wind speed ranged from 2.3 to 14.3 m/s.

The direction of the wind, air temperature and pressure were also monitored over this total testing period. The air temperature was in the range 2.9 to 3.1°C and the atmospheric pressure was 969 mBar to the nearest mBar on the 1st test day and on the 2nd test day the air temperature was in the range 6.5 to 7.5 °C while the atmospheric pressure was in the range 988 to 990 mBar.

Noise measurements were made using a ½" diameter microphone located at the centre of a 1 m diameter ground-mounted (acoustically hard) board located 38 m downwind from the wind turbine. Noise, wind speed and direction data were captured in 10-second periods. The location of the ground mounted board and microphone was chosen to minimise influence of any out-houses, parked turbines, MET masts and ground vegetation in the immediate vicinity of the wind turbine upon reported test results. The conditions complied with free field behaviour for reflecting planes. Photographs showing the test arrangements are shown in Figure 2.

Simultaneous noise and wind speed measurements were made with the turbine running and then, as part of the same measurement session, with it parked and the control panel isolated.

Wind speeds were normalised to standard meteorological conditions as per Equation (F1) of IEC 61400-11:2012 where required.

Data were filtered to remove data points where either the noise board position was outside the valid sector (± 45° relative to the wind direction) or the anemometer mast position was not in the valid sector (± 90° upwind of the turbine). Filtering was also performed to discard data where there had been interference due to extraneous noise events, e.g. passing aircraft or any noisy birds during the background tests.

6.2 Apparent Sound Power Levels

There were 442 valid data sets, post-filtering, of which 289 samples had the wind turbine running and 153 samples had it switched off. Figure 3 shows data captured during the various measurement sessions, with the turbine running and with it parked.

A summary of the apparent sound power levels and associated uncertainty at wind speed bin centres at hub height are given in Table 3.

6.3 Noise Immission Levels

Estimated noise immission levels for different wind speeds and for selected slant distances from the rotor centre are presented in Figure 4. The sound pressure levels, dB(A), shown in the noise immission map are based on the Apparent Sound Power Levels referenced to the wind turbine hub height and are calculated assuming spherical propagation.

From the graph it can be seen that for a hub height wind speed of 10 m/s the sound pressure immission level at a slant distance of 215 m from the rotor centre is 35 dB(A). This distance reduces to 140 m for a wind speed of 5 m/s.

6.4 One-Third Octave Band Spectra

The A-weighted one-third octave band sound power spectra are shown in Figures 5 - 12 for each of the rotor wind speed bins. Note that the wind speed is referenced to the rotor centre height. Numbers shown in square brackets represent points where the background level is within 3 dB of the total noise level, i.e. with the turbine running. The wind speed bin centre A-weighted one-third octave band sound pressure levels are presented in Table 4 with the corresponding uncertainty values. Wind speed is referenced to rotor centre height. The values marked with an asterisk represent the points in the spectrum where the difference between total noise and background noise is between 3 dB and 6 dB. Results shown in brackets indicate the difference is less than 3 dB and these values were not used in the calculation of the average.

6.5 Tonal Audibility

For each of the bins, 30 fine frequency spectra were available for the analysis with the exceptions of the 3 m/s bin where there were only eleven valid measurements available and then bins 12 – 14m/s where only fifteen valid measurements available, spread over the higher integer wind speed bins, roughly averaging five in each bin.

The search for tones was conducted in the frequency range 20 - 11,200 Hz. Narrowband spectra, with a resolution of 1.5625 Hz were generated from the Quattro DP240 dynamic signal analyser in 10-second periods using a Hanning window with an overlap of 50%.

Figures 13a to 24b show one representative fine frequency spectrum from each of the wind speed bins. Two graphs, a, and b, are presented for each spectrum. The first, a, shows the whole spectrum with the frequency of highest tonality marked with a blue dotted vertical line. The two vertical blue lines show the limits of the associated critical band. Similarly red verticals lines highlight the critical band with the next second highest tonality value and green lines mark the critical band containing the spectrum's peak. In some cases the spectrum peak and highest tonality coincide.

The second figure, b, shows the critical band in more detail. The spectral lines (points in the frequency domain) identified as possible tones are highlighted as red markers and the masking noise shown in green. Calculating the energy sum of all the points identified as tones gives the sound pressure level of the tone, Lpt, which is shown as a red dotted horizontal line on the graph. The black dotted horizontal line labelled, Lpn,avg, represents the energy average of all the masking points and the dot-dash line represents the defined masking level, Lpn.

The tonality, ΔLtn, for each spectrum is determined by subtracting the masking level, Lpn, from the sound pressure level of the tone, Lpt. The final step is to calculate the

tonal audibility, ΔLa, by subtracting the frequency dependent audibility criterion, La, specified in IEC61400-11:12 from the tonality.

The results of the analysis shows a reportable tonal audibility at 591 Hz for the wind turbine in the range 3 - 5 m/s. Table 5 shows a summary of this reportable audibility.

There are no reportable audible tones for wind speeds above 5 m/s. In the range 3 to 5 m/s there are two tones with audibility greater than 0 dB. These are at 591 Hz with its highest audibility being +2.6 dB for 4 m/s wind speed and 6.25 kHz with its highest audibility being +2.3 dB but is always lower in audibility than for 591 Hz, over 3 -14 m/s.

A tonal audibility calculation summary sheet for each of the wind speed bins is presented in Appendix 3. This includes the subordinate tone at 6.25 kHz for 3 - 4 m/s.

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APPENDIX 2 Explanation of uncertainty calculations

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APPENDIX 4 Immission Noise Map for wind speeds 10 m (a.g.l.)/ 0.1 roughness.

TABLE 1 SUMMARY OF TEST WIND TURBINE CONFIGURATION

Turbine Characterisation (Section 10.2 IEC 61400-11:2012)	
WIND TURBINE DETAILS	
Manufacturer	Orenda Energy Solutions
Model number	Skye
Serial number	00018
OPERATING DETAILS	
Vertical or horizontal axis wind turbine	Horizontal axis
Upwind or downwind rotor	Upwind rotor
Hub height	19.5m
Horizontal distance from rotor centre to tower axis	1.4m
Diameter of rotor – manufacturer's data*	18.9m
Tower type (lattice or tube)	2 - nesting tubular sections
Passive stall, active stall, or pitched controlled turbine	Passive stall
Constant or variable speed	53 r.p.m. +/- 10%
Power curve (if required for wind speed determination)	N/A
Rotational speed at each integer standardised wind speed bin from 6 - 10 m/s and at rated power.[Speeds at 12 - 24m/s]	46, 53, 54, 54, 54 & 54 [54 - 58 Max.]
Pitch angle at each integer standardised wind speed from 6 - 10 m/s	Fixed for all speeds
Rated power output	49 kWe @ 11m/s
Control software version	V.1.00.05
ROTOR DETAILS	
Rotor control devices	None
Presence of vortex generators, stall strips, serrated trailing edges	N/A
Blade type	Aerosa 191
Number of blades	3
GEARBOX DETAILS	
Manufacturer	N/A
Model number	N/A
Fixed-parallel-shaft or planetary gearbox	N/A
GENERATOR DETAILS	
Manufacturer	EM
Model number	49 kW
Rotational speed	54 rpm
Rated power	49 kW
Nominal current	80 A
Nominal voltage	400 V

* The rotor diameter (swept) was noted from the Wind Turbine Installation Datasheet pro-forma (WI/WE/4348/F1) completed by Orenda and emailed to NEL on 16/05/16.

TABLE 2 INSTRUMENTATION USED IN ACOUSTIC TESTS

PARAMETER	INSTRUMENT	MANUFACTURER	TYPE	SERIAL NUMBER	CALIBRATION CERTIFICATE. REF.	CALIBRATION LABORATORY
Sound Level	Microphone	Brüel & Kjær	4189	2643613	Cert. No. 02399_2	Salford Uni. (UKAS 0801)
Sound Level	Handheld Analyser	Brüel & Kjær	2250	2653893	Cert. No. 02399_3	Salford Uni. (UKAS 0801)
Sound Level	Calibrator	Brüel & Kjær	4231	2651818	Cert. No. 02399_1	Salford Uni. (UKAS 0801)
Sound Level	DP240A	D48-023	A66-02	21717	Cert. No. 28450	Data Physics Corp.
Wind Speed	Anemometer	Vector Instruments	A100R/K	11778/E88F	1612813 06/2016	Deutsche WindGuard (DAkkS D-K-15140-01-00)
Wind Direction	Vane - potentiometer	Vector Instruments	W200P/F20	55392/V92	N/A	N/A
Pressure	Barometric pressure transducer	Setra/ Campbell Scientific	CS100-278	4288972	U80137-16	Antech Calibration Services (UKAS 0489)
Temperature	Temperature sensor	Vaisala/ Campbell Scientific	HMP45AC	E3350007	U80150-16	Antech Calibration Services (UKAS 0489)
-	Datalogger	Campbell Scientific	CR1000	6242 (E4107)	N/A	N/A

TABLE 3 SUMMARY OF L_{WA} LEVELS AND ASSOCIATED UNCERTAINTY uL_{WA}, AT BIN CENTRES

Parameter	Wind Bin Centre, k (m/s) at Rotor Centre Height											
	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Run points (289 total)	11	32	31	35	33	35	32	34	31	7	5	3
Run V^{Bar}	3.21	3.97	4.99	6.01	6.97	8.05	9.09	9.98	10.99	11.92	12.90	13.96
Bkgd points (153 total)	9	19	23	24	14	13	12	9	10	8	7	5
Bgd V^{Bar}	3.04	3.97	4.94	5.92	7.10	7.99	9.14	10.02	11.16	12.01	12.82	14.01
L_{WA} @ H	**84.8**	**85.2**	**89.2**	**90.6**	**91.7**	**91.8**	**91.9**	**92.4**	**93.4**	**95.6**	**96.8**	**98.8**
L_{WA} Status	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
uL_{WA} dB	**1.08**	**0.84**	**0.64**	**0.64**	**0.62**	**0.63**	**0.62**	**0.62**	**0.63**	**0.65**	**0.68**	**0.77**
$L_{WA,d}$ @ H	**86.5**	**86.6**	**90.3**	**91.7**	**92.7**	**92.9**	**93.0**	**93.5**	**94.5**	**96.7**	**98.0**	**100.1**

Note: Status = "OK" if Background noise is at least 6dB less than Turbine running

TABLE 4 BIN CENTRE A-WEIGHTED 1/3rd OCTAVE BAND SOUND PRESSURE LEVELS AND UNCERTAINTY VALUES FOR ROTOR CENTRE HEIGHT WIND SPEEDS

Wind Bin centre, k (m/s)	Parameter	1/3rd Octave Band Centre Frequency																												dBA Total
		20Hz	25Hz	31.5Hz	40Hz	50Hz	63Hz	80Hz	100Hz	125Hz	160Hz	200Hz	250Hz	315Hz	400Hz	500Hz	630Hz	800Hz	1kHz	1.25kHz	1.6kHz	2kHz	2.5kHz	3.15kHz	4kHz	5kHz	6.3kHz	8kHz	10kHz	
4	Total $L_{V,T}$	2.5	5.2	9.0	14.4	17.0	19.8	25.0	30.3	27.2	27.3	32.4	31.5	32.5	31.5	32.7	38.7	35.1	36.6	39.2	39.4	38.1	33.4	27.1	23.4	20.6	22.2	13.9	9.7	47.2
	Bgnd $L_{V,B}$	0.1	4.0	8.8	12.8	16.7	18.8	20.2	19.9	20.0	20.0	19.0	19.1	19.6	19.2	19.5	19.9	19.9	18.0	14.0	10.0	7.4	7.2	7.5	7.7	7.9	7.8	7.2	6.2	31.2
	Corrected $L_{V,c}$	[0.9]	[2.4]	[6.1]	[11.5]	[14.1]	[17.0]	24.8	30.2	27.1	27.2	32.3	31.3	32.4	31.3	32.5	38.5	34.9	36.5	39.0	39.2	38.0	33.3	26.9	23.3	20.5	22.1	13.7	9.5	47.1
	u_c	[1.2]	[1.2]	[1.0]	[1.1]	[1.2]	[1.1]	0.90	0.91	0.73	0.73	0.70	0.66	0.67	0.66	0.65	0.64	0.64	0.64	0.63	0.63	0.63	0.63	0.63	0.62	0.62	0.61	0.63	0.67	
5	Total $L_{V,T}$	1.5	5.1	10.5	14.2	17.2	21.0	30.9	36.2	32.9	35.2	36.7	37.6	38.5	38.6	38.4	41.2	39.5	41.4	43.3	41.0	45.8	43.6	42.9	34.7	27.2	24.7	18.2	14.6	52.9
	Bgnd $L_{V,B}$	1.1	3.9	9.3	13.3	16.6	19.6	19.7	21.9	21.6	22.0	20.9	20.4	21.1	20.6	20.8	20.2	20.3	17.6	12.3	9.6	7.3	6.9	7.4	7.8	7.9	7.8	7.1	6.2	32.2
	Corrected $L_{V,c}$	[0.0]	[2.3]	[7.6]	[11.4]	[14.4]	[18.1]	30.7	36.1	32.8	35.0	36.5	37.5	38.3	38.4	38.2	41.1	39.3	41.2	43.1	40.8	45.6	43.4	42.8	34.6	27.0	24.6	18.0	14.5	52.8
	u_c	[1.1]	[1.0]	[0.9]	[1.1]	[1.0]	[1.1]	0.89	0.55	0.56	0.58	0.56	0.57	0.57	0.55	0.56	0.57	0.54	0.61	0.58	0.56	0.63	0.71	0.68	0.72	0.70	0.73	0.71	1.10	
6	Total $L_{V,T}$	7.3	11.8	15.3	18.6	21.8	24.7	28.4	34.7	34.8	34.1	39.0	38.9	39.3	40.3	41.7	44.7	43.9	45.7	44.8	43.4	44.8	45.2	44.8	42.7	34.7	28.6	22.5	17.1	55.0
	Bgnd $L_{V,B}$	6.1	10.4	14.1	17.2	20.4	22.6	24.1	25.2	25.9	25.9	26.2	26.7	27.3	26.9	27.1	26.3	25.8	24.6	21.3	18.9	16.6	15.3	13.9	11.9	9.8	8.3	7.3	5.9	37.5
	Corrected $L_{V,c}$	[4.7]	[9.1]	[12.6]	[15.8]	[18.9]	[21.7]	26.1*	34.0	34.0	33.1	38.5	38.3	38.7	39.8	41.2	44.2	43.4	45.2	44.3	43.0	44.4	44.8	44.4	42.3	34.4	28.6	22.5	17.0	54.7
	u_c	[1.3]	[1.3]	[1.4]	[1.4]	[1.4]	[1.4]	1.12	0.70	0.72	0.75	0.66	0.66	0.67	0.66	0.65	0.64	0.64	0.64	0.63	0.63	0.63	0.63	0.63	0.62	0.61	0.60	0.66	0.67	
7	Total $L_{V,T}$	12.2	17.7	20.8	24.0	26.0	29.8	33.0	35.2	36.4	39.0	41.9	44.0	45.1	45.4	46.1	46.6	46.3	45.1	43.5	43.7	43.1	43.7	43.1	40.2	36.7	33.3	28.2	22.4	56.2
	Bgnd $L_{V,B}$	9.2	15.5	18.3	22.1	23.9	26.9	27.6	28.1	29.5	30.3	30.6	32.1	34.1	32.2	33.2	32.0	30.8	30.1	28.4	26.4	24.5	21.5	17.5	14.2	11.4	9.5	8.0	6.4	42.7
	Corrected $L_{V,c}$	[10.2]	[14.0]	[17.2]	[20.2]	[23.3]	[26.2]	30.2*	35.0	36.0	36.7	40.3	41.2	41.6	42.7	43.9	45.9	46.2	47.2	45.2	43.5	44.2	45.0	44.0	43.1	38.4	30.9	24.9	18.7	56.0
	u_c	[1.3]	[1.3]	[1.4]	[1.4]	[1.4]	[1.4]	0.84	0.74	0.73	0.68	0.65	0.66	0.69	0.68	0.66	0.64	0.63	0.63	0.63	0.62	0.61	0.61	0.60	0.59	0.59	0.58	0.63	0.63	
8	Total $L_{V,T}$	13.8	17.7	21.1	24.4	28.0	31.8	33.7	35.8	36.9	39.5	42.5	44.6	45.8	46.4	46.5	46.9	46.7	45.6	44.1	44.4	44.0	44.4	43.6	40.7	37.3	33.9	28.8	23.0	56.8
	Bgnd $L_{V,B}$	12.6	17.2	20.3	22.3	24.7	27.4	28.9	28.5	29.6	29.9	31.0	32.5	33.0	33.4	34.1	34.5	32.6	32.0	30.9	29.9	28.8	26.7	23.7	20.7	18.0	16.5	14.9	12.9	43.9
	Corrected $L_{V,c}$	[11.1]	[15.1]	[18.6]	[21.5]	25.3*	28.5*	32.6*	36.2	37.2	38.6	41.8	43.7	44.5	45.8	46.5	47.6	46.9	46.1	43.0	42.5	43.1	44.4	44.0	41.6	37.8	32.5	26.7	20.4	56.6
	u_c	[1.3]	[1.3]	[1.4]	[1.4]	1.65	0.98	0.74	0.68	0.69	0.65	0.63	0.64	0.65	0.64	0.64	0.63	0.62	0.62	0.62	0.62	0.61	0.60	0.60	0.59	0.58	0.58	0.63	0.63	
9	Total $L_{V,T}$	14.8	18.5	21.4	24.6	27.0	30.5	34.2	35.8	36.9	39.6	42.4	44.5	45.7	46.2	46.3	46.8	46.6	45.7	44.4	44.5	44.2	44.7	43.8	40.7	37.5	34.3	29.2	23.3	56.8
	Bgnd $L_{V,B}$	14.0	17.5	20.5	22.4	24.6	27.7	29.3	28.4	29.5	30.1	30.9	32.4	32.8	33.1	33.7	33.2	32.2	31.5	30.4	29.4	28.3	27.1	24.5	21.2	18.3	16.5	14.8	12.5	43.6
	Corrected $L_{V,c}$	[11.9]	[15.2]	[18.3]	[20.8]	[23.7]	[27.1]	30.1*	35.3	36.6	37.6	41.3	43.9	44.8	45.5	46.2	47.3	46.7	46.1	43.2	43.0	44.1	45.0	44.0	42.3	38.9	33.3	28.1	22.3	56.6
	u_c	[1.2]	[1.3]	[1.3]	[1.3]	[1.4]	[1.4]	1.15	0.72	0.71	0.70	0.64	0.63	0.63	0.62	0.63	0.61	0.61	0.61	0.62	0.61	0.60	0.59	0.59	0.58	0.58	0.57	0.63	0.65	
10	Total $L_{V,T}$	15.9	20.6	22.3	25.0	27.6	30.8	33.7	35.7	36.7	39.5	42.4	44.6	45.9	46.2	46.4	47.1	47.0	46.3	45.0	44.7	44.3	44.8	44.0	40.9	37.5	34.5	29.3	23.4	57.0
	Bgnd $L_{V,B}$	16.1	18.5	21.4	23.1	25.4	28.0	29.3	29.8	30.3	31.1	32.1	33.5	35.0	34.3	34.3	33.8	32.1	31.4	30.2	28.7	27.1	24.9	21.7	18.5	15.6	13.5	11.8	9.8	44.2
	Corrected $L_{V,c}$	[12.1]	[16.4]	[19.3]	[21.5]	[23.9]	[27.3]	30.8*	35.5	36.9	39.3	42.7	44.9	45.3	46.5	47.0	47.4	47.1	46.3	43.1	42.9	42.8	44.1	44.2	41.6	37.6	33.6	28.3	22.5	56.8
	u_c	[1.3]	[1.3]	[1.3]	[1.4]	[1.4]	[1.4]	0.66	0.64	0.65	0.63	0.62	0.62	0.62	0.63	0.63	0.62	0.62	0.62	0.62	0.62	0.61	0.61	0.61	0.60	0.60	0.59	0.64	0.63	
11	Total $L_{V,T}$	19.2	23.0	24.1	26.5	29.1	31.4	34.8	36.9	37.9	40.5	43.5	45.5	46.4	46.5	47.3	48.2	48.2	47.7	46.4	45.8	45.3	45.8	45.1	42.2	38.7	35.5	30.5	24.6	58.0
	Bgnd $L_{V,B}$	16.6	20.1	22.6	24.3	26.7	28.6	30.8	30.1	31.7	32.0	33.1	34.0	35.4	36.0	36.0	34.3	33.9	34.1	33.4	32.7	31.7	30.3	28.2	24.9	21.5	18.3	14.9	12.3	45.9
	Corrected $L_{V,c}$	[13.9]	[18.1]	[20.6]	[22.6]	[25.4]	[28.9]	32.6*	36.6	37.6	40.3	43.6	45.9	46.9	47.3	47.7	48.2	47.6	46.4	44.5	44.3	44.2	45.4	44.7	41.9	38.2	34.7	29.5	23.6	57.7
	u_c	[1.3]	[1.4]	[1.4]	[1.4]	[1.4]	[1.4]	0.68	0.65	0.66	0.65	0.63	0.63	0.63	0.64	0.64	0.63	0.62	0.63	0.63	0.63	0.62	0.62	0.61	0.61	0.60	0.59	0.65	0.64	

TABLE 5 TONAL AUDIBILITY RESULT FOR EACH WIND SPEED BIN

Wind Speed Bin at Rotor Centre (m/s)	Frequency (Hz)	Critical Bandwidth (Hz)	Tonality ΔL_k	Tonal Audibility $\Delta L_{a,k}$
3	590.6	124	-0.8	+1.6
4	592.2	124	0.3	+2.7
5	592.2	124	-1.9	+0.5
6	590.6	124	-2.5	- 0.1
7	No Relevant Tones			
8				
9				
10				
11				
12				
13				
14				

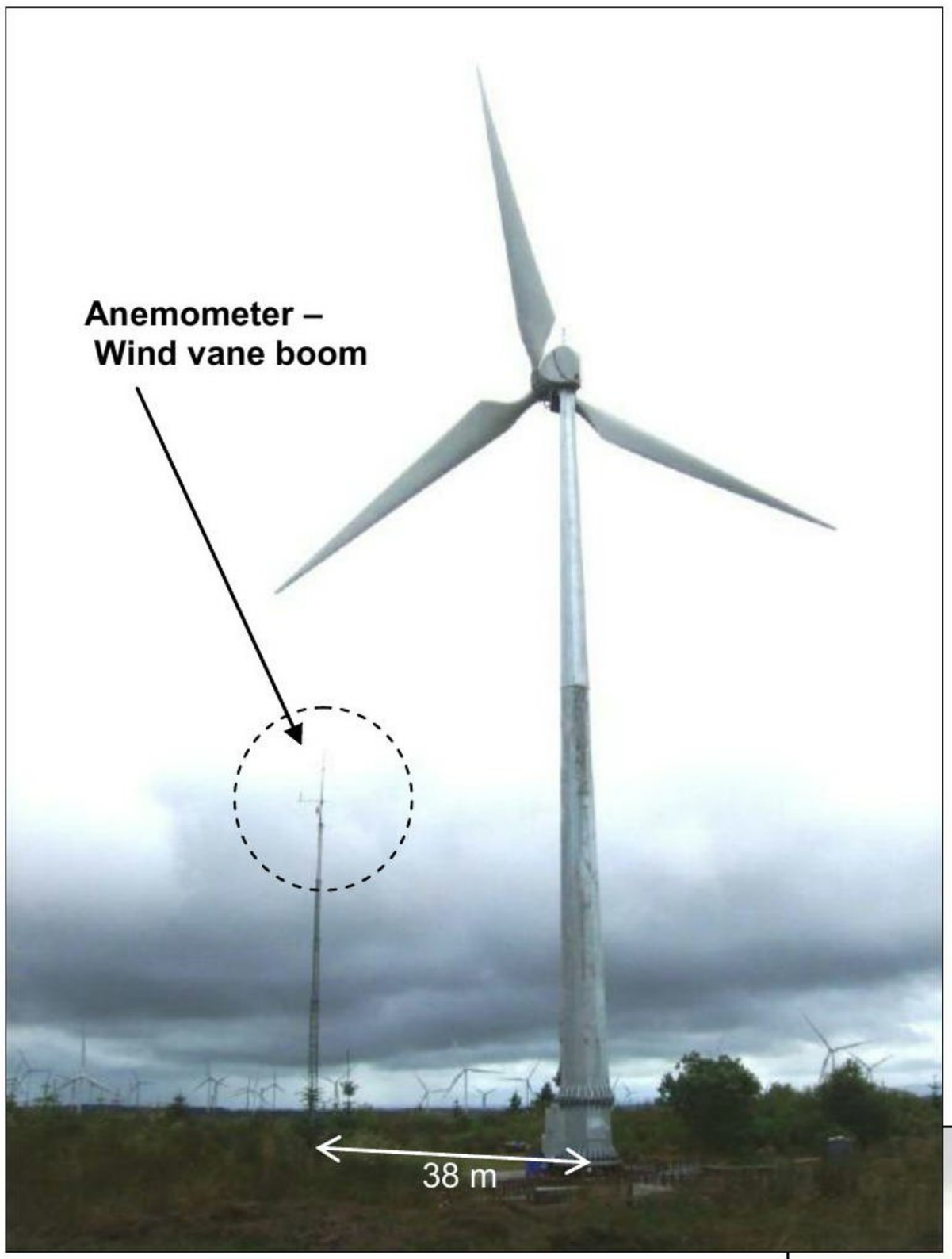
Wind Speed Bin at Rotor Centre (m/s)	Frequency (Hz)	Critical Bandwidth (Hz)	Tonality ΔL_k	Tonal Audibility $\Delta L_{a,k}$
3	6250	1227	-3.4	+1.3
4	6250	1227	-2.4	+2.3
5	No Relevant Tones			
6				
7				
8				
9				
10				
11				
12				
13				
14				

Wind Speed Bin at Rotor Centre (m/s)	Frequency (Hz)	Critical Bandwidth (Hz)	Tonality ΔL_k	Tonal Audibility $\Delta L_{a,k}$
3	98.4	124	-4.6	-2.6
4	100.0	124	-5.1	-3.0
5	No Relevant Tones			
6				
7				
8				
9				
10				
11				
12				
13				
14				

Viewing WSW from the Wind Turbine under test to NEL's Trailer MET Mast.

Viewing WNW from the Wind Turbine under test on Test Pad No. A6.

FIGURE 1 PHOTOGRAPHS FROM THE TEST BASE ON MYRES HILL



Trailer MET Mast with cup anemometer
(above)

Board mounted
microphone
(below)

FIGURE 2 PHOTOGRAPHS SHOWING ACOUSTIC TEST ARRANGEMENT

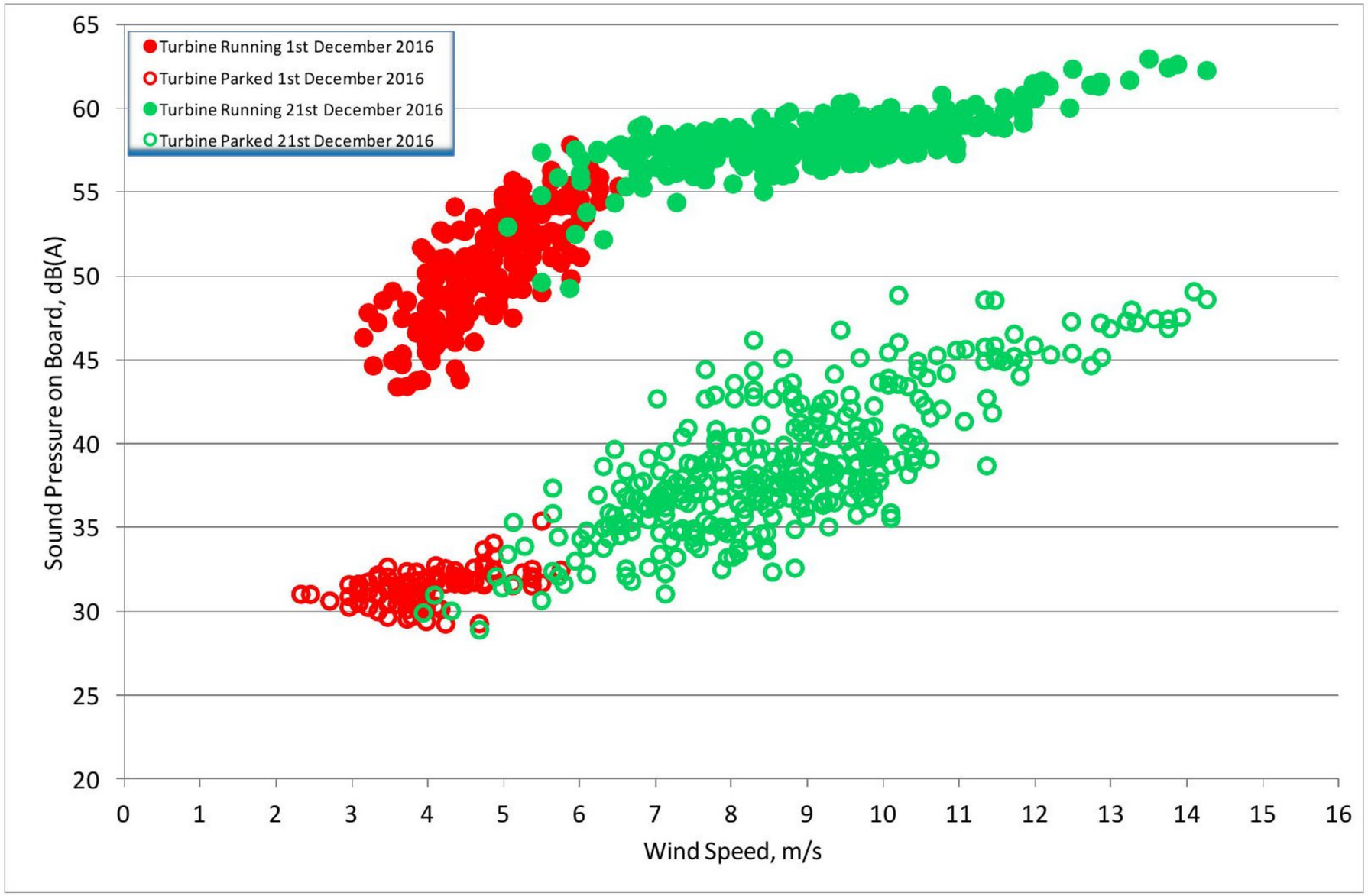


FIGURE 3 AUDIBLE NOISE (AS MEASURED AT THE GROUND BOARD) AS A FUNCTION OF WIND SPEED AT 19.5 M ABOVE GROUND LEVEL (Rotor Centre Height/ Hub Height a.g.l.)

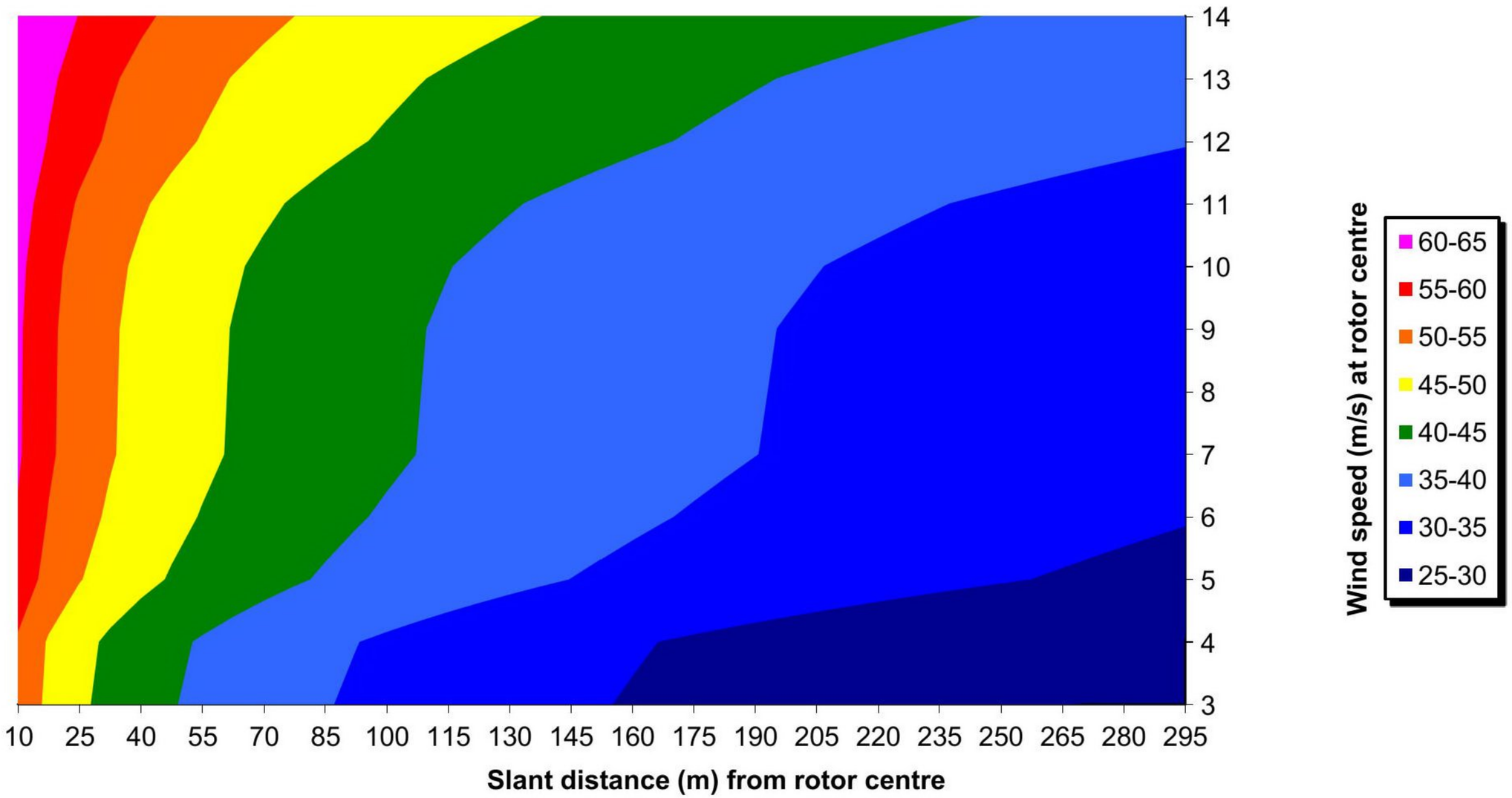


FIGURE 4 IMMISSION NOISE MAP

1/3rd Octave Band Centre Frequency																											dBA Total
20Hz	25Hz	31.5Hz	40Hz	50Hz	63Hz	80Hz	100Hz	125Hz	160Hz	200Hz	250Hz	315Hz	400Hz	500Hz	630Hz	800Hz	1kHz	1.25kHz	1.6kHz	2kHz	2.5kHz	3.15kHz	4kHz	5kHz	6.3kHz	8kHz	10kHz	
[37]	[39]	[42]	[48]	[50]	[53]	61.1	66.5	63.4	63.5	68.6	67.6	68.7	67.6	68.8	74.8	71.2	72.8	75.3	75.5	74.3	69.6	63.2	59.6	56.8	58.4	50.0	45.8	84.6

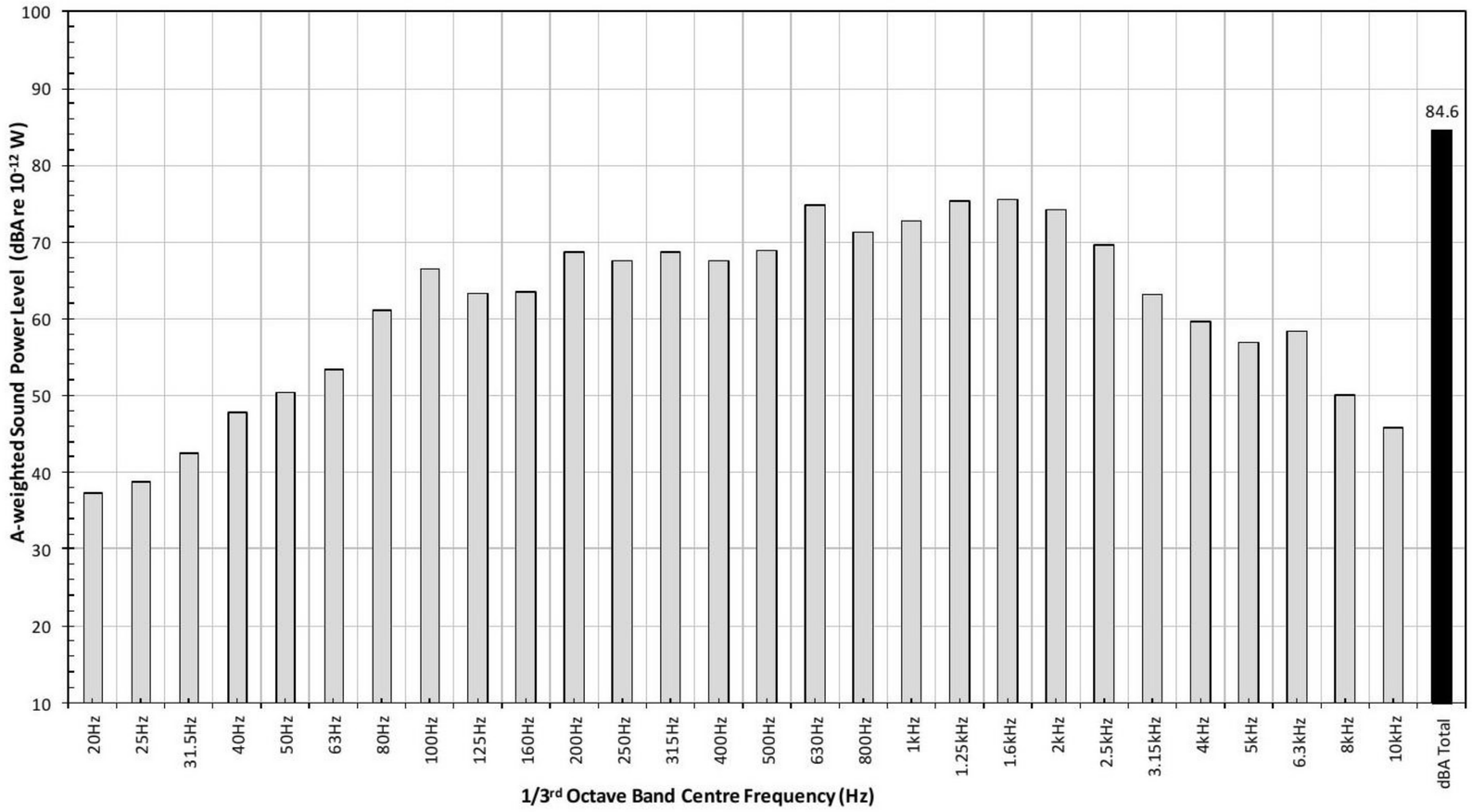


FIGURE 5 A-WEIGHTED 1/3rd OCTAVE BAND SOUND POWER LEVELS FOR 4 m/s WIND SPEED BIN AT ROTOR CENTRE HEIGHT
(3.5 m/s @ 10 m ABOVE GROUND LEVEL, WITH A ROUGHNESS LENGTH OF 0.1)

1/3rd Octave Band Centre Frequency																											dBA Total
20Hz	25Hz	31.5Hz	40Hz	50Hz	63Hz	80Hz	100Hz	125Hz	160Hz	200Hz	250Hz	315Hz	400Hz	500Hz	630Hz	800Hz	1kHz	1.25kHz	1.6kHz	2kHz	2.5kHz	3.15kHz	4kHz	5kHz	6.3kHz	8kHz	10kHz	
[36]	[39]	[44]	[48]	[51]	[54]	67.0	72.4	69.1	71.3	72.8	73.8	74.6	74.7	74.5	77.4	75.6	77.5	79.4	77.1	81.9	79.7	79.1	70.9	63.3	60.9	54.3	50.8	89.1

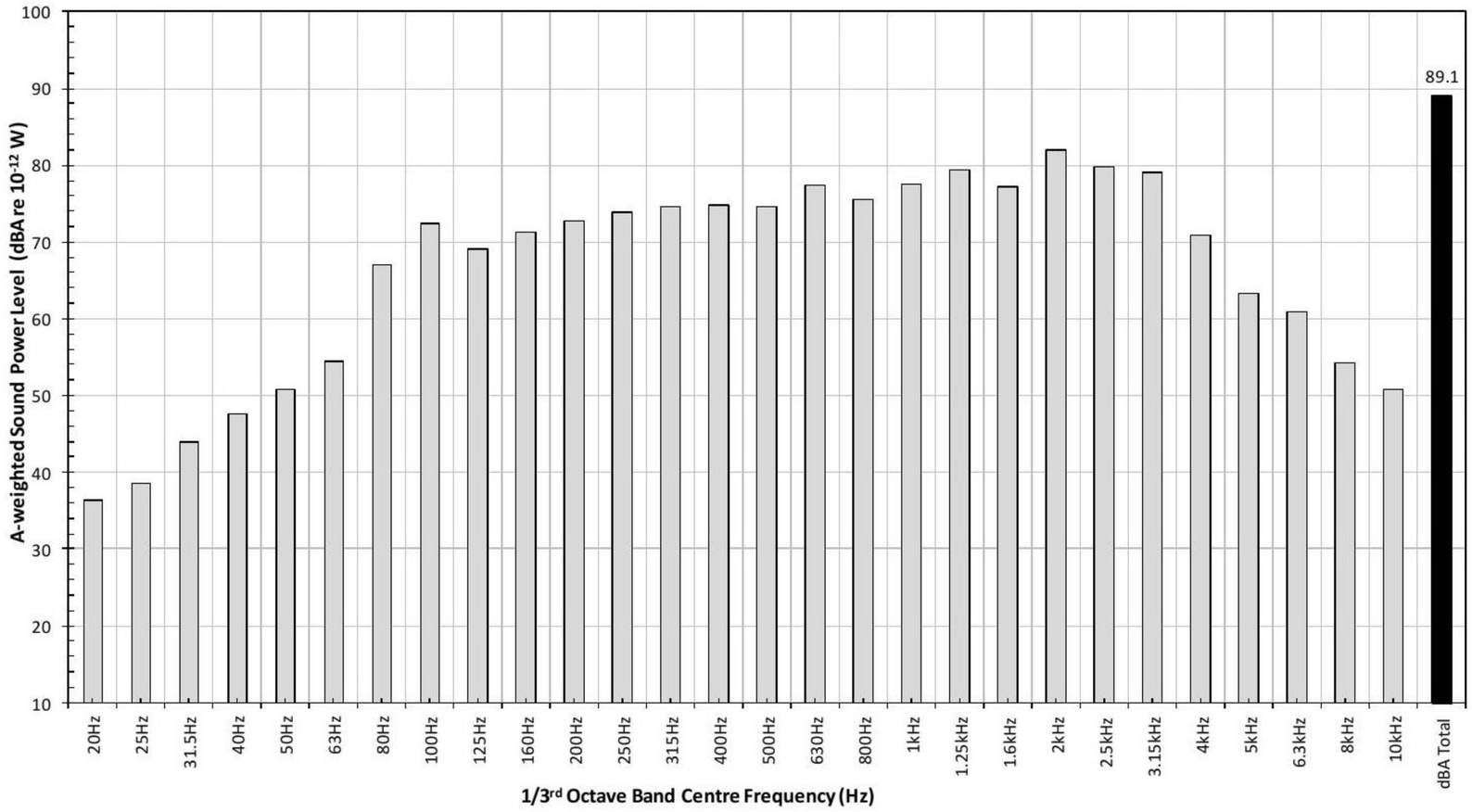


FIGURE 6 A-WEIGHTED 1/3rd OCTAVE BAND SOUND POWER LEVELS FOR 5 m/s WIND SPEED BIN AT ROTOR CENTRE HEIGHT
(4.4 m/s @ 10 m ABOVE GROUND LEVEL, WITH A ROUGHNESS LENGTH OF 0.1)

1/3rd Octave Band Centre Frequency																											dBA Total
20Hz	25Hz	31.5Hz	40Hz	50Hz	63Hz	80Hz	100Hz	125Hz	160Hz	200Hz	250Hz	315Hz	400Hz	500Hz	630Hz	800Hz	1kHz	1.25kHz	1.6kHz	2kHz	2.5kHz	3.15kHz	4kHz	5kHz	6.3kHz	8kHz	10kHz	
[41]	[45]	[49]	[52]	[55]	[58]	62.4*	70.3	70.3	69.4	74.8	74.6	75.0	76.1	77.5	80.5	79.7	81.5	80.6	79.3	80.7	81.1	80.7	78.6	70.7	64.9	58.8	53.3	90.6

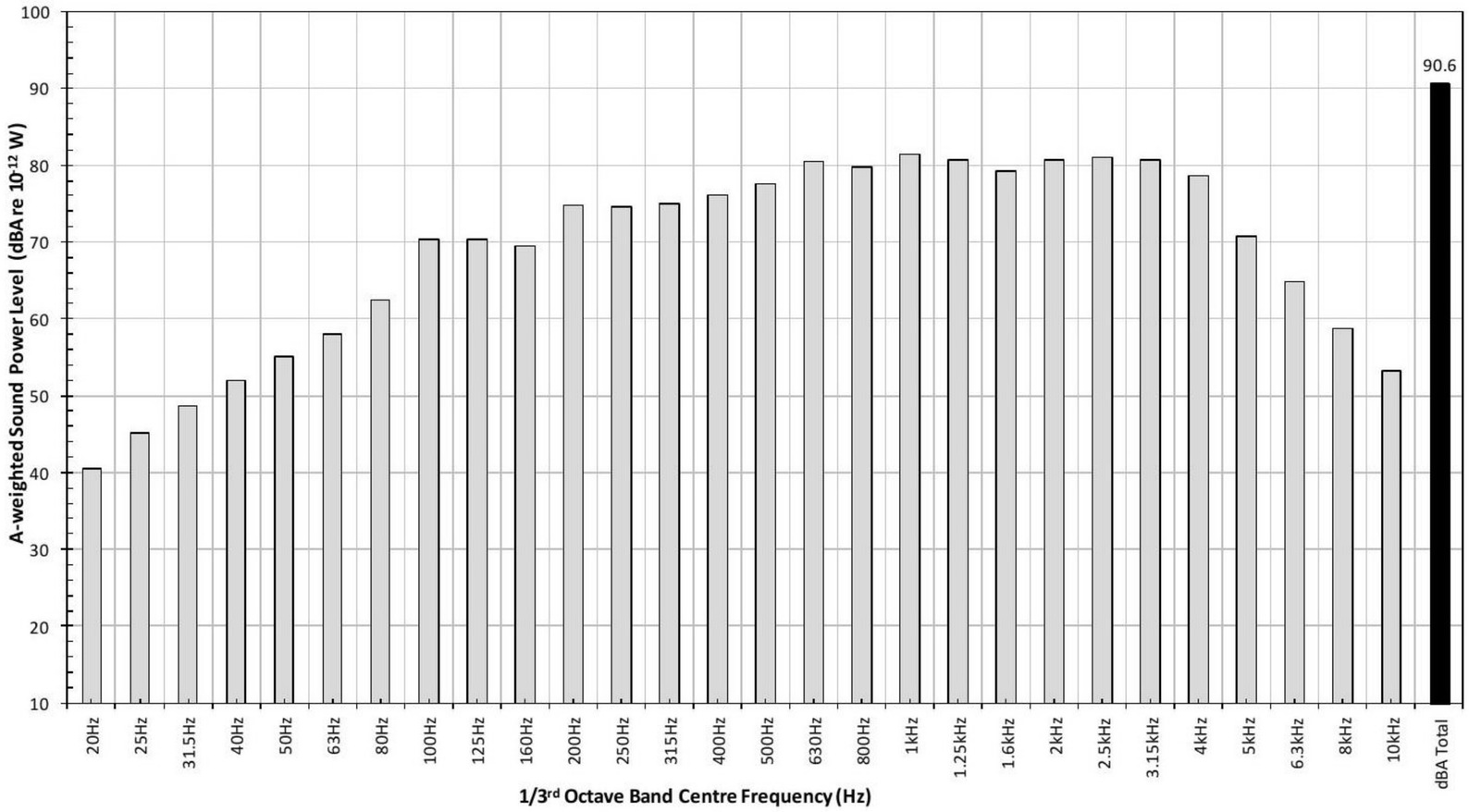


FIGURE 7 A-WEIGHTED 1/3rd OCTAVE BAND SOUND POWER LEVELS FOR 6 m/s WIND SPEED BIN AT ROTOR CENTRE HEIGHT
(5.2 m/s @ 10 m ABOVE GROUND LEVEL, WITH A ROUGHNESS LENGTH OF 0.1)

1/3rd Octave Band Centre Frequency																											dBA Total
20Hz	25Hz	31.5Hz	40Hz	50Hz	63Hz	80Hz	100Hz	125Hz	160Hz	200Hz	250Hz	315Hz	400Hz	500Hz	630Hz	800Hz	1kHz	1.25kHz	1.6kHz	2kHz	2.5kHz	3.15kHz	4kHz	5kHz	6.3kHz	8kHz	10kHz	
[46]	[51]	[54]	[57]	[59]	[63]	66.3*	71.3	72.3	73.0	76.6	77.5	77.9	79.0	80.2	82.2	82.5	83.5	81.5	79.8	80.5	81.3	80.3	79.4	74.7	67.2	61.2	55.0	91.7

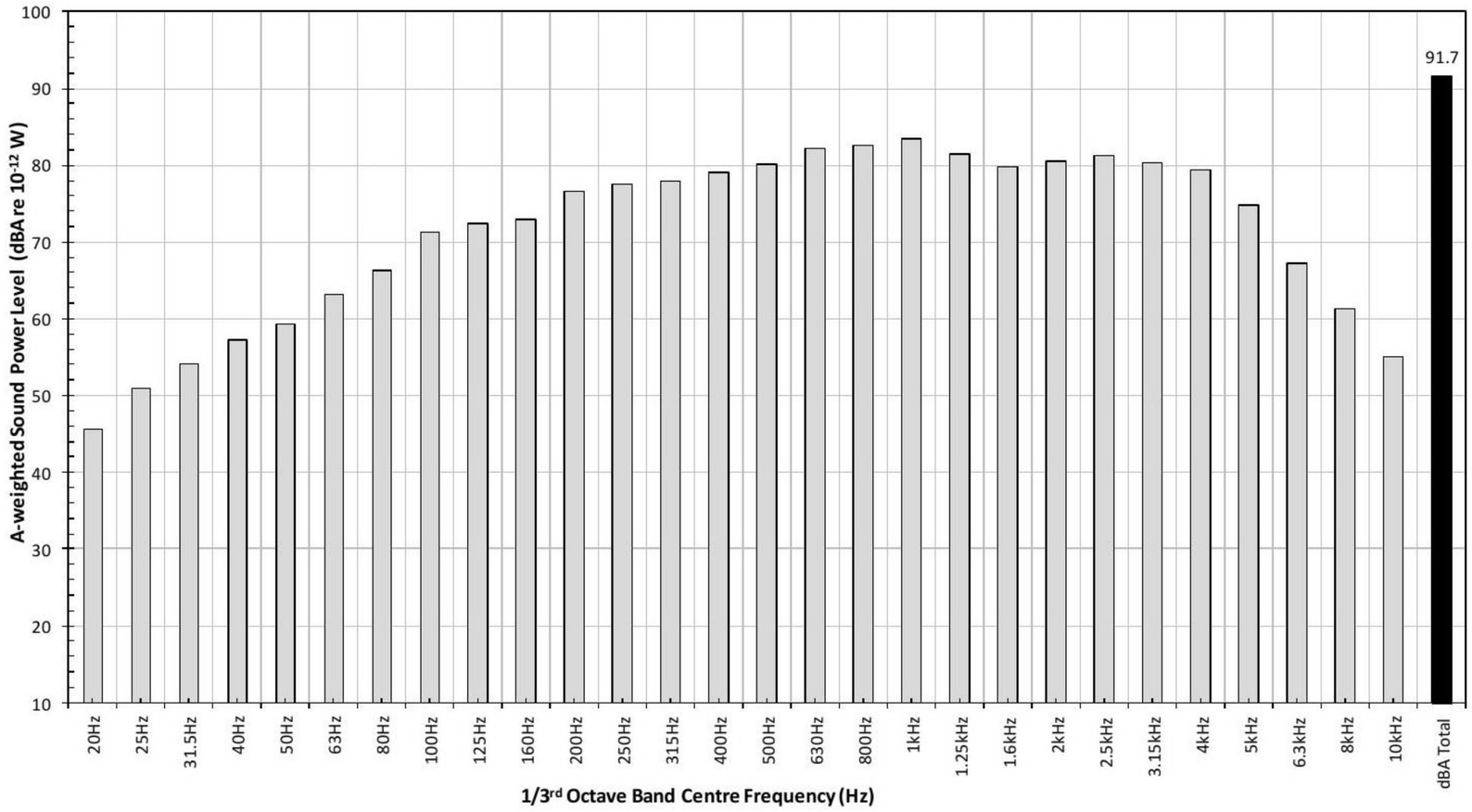


FIGURE 8 A-WEIGHTED 1/3rd OCTAVE BAND SOUND POWER LEVELS FOR 7 m/s WIND SPEED BIN AT ROTOR CENTRE HEIGHT
(6.1 m/s @ 10 m ABOVE GROUND LEVEL, WITH A ROUGHNESS LENGTH OF 0.1)

1/3rd Octave Band Centre Frequency																											dBA Total
20Hz	25Hz	31.5Hz	40Hz	50Hz	63Hz	80Hz	100Hz	125Hz	160Hz	200Hz	250Hz	315Hz	400Hz	500Hz	630Hz	800Hz	1kHz	1.25kHz	1.6kHz	2kHz	2.5kHz	3.15kHz	4kHz	5kHz	6.3kHz	8kHz	10kHz	
[47]	[51]	[55]	[58]	61.3*	65.1*	69*	72.5	73.5	74.9	78.1	80.0	80.8	82.1	82.8	83.9	83.2	82.4	79.3	78.8	79.4	80.7	80.3	77.9	74.1	68.8	63.0	56.7	92.2

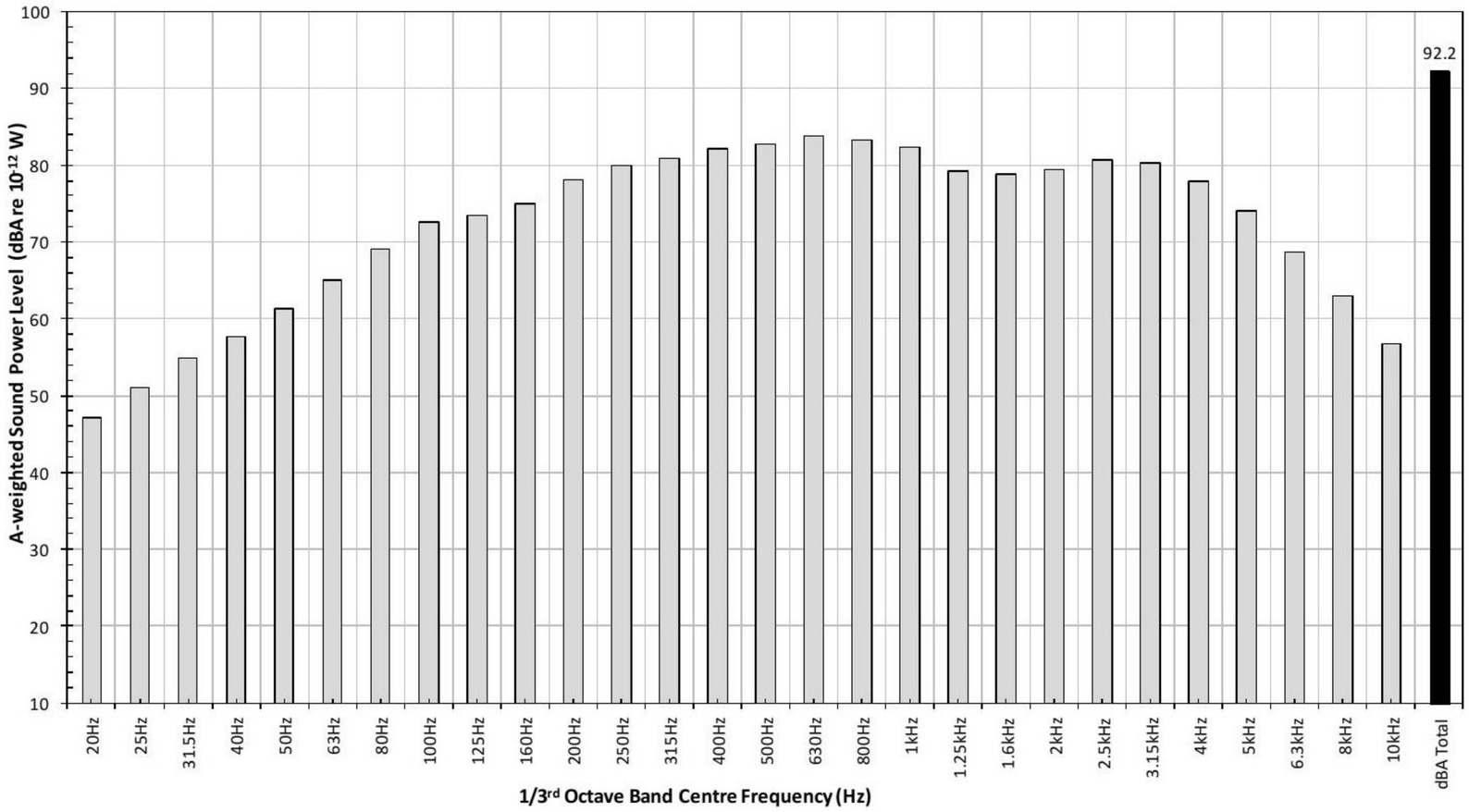


FIGURE 9 A-WEIGHTED 1/3rd OCTAVE BAND SOUND POWER LEVELS FOR 8 m/s WIND SPEED BIN AT ROTOR CENTRE HEIGHT
(7.0 m/s @ 10 m ABOVE GROUND LEVEL, WITH A ROUGHNESS LENGTH OF 0.1)

1/3rd Octave Band Centre Frequency																											dBA Total
20Hz	25Hz	31.5Hz	40Hz	50Hz	63Hz	80Hz	100Hz	125Hz	160Hz	200Hz	250Hz	315Hz	400Hz	500Hz	630Hz	800Hz	1kHz	1.25kHz	1.6kHz	2kHz	2.5kHz	3.15kHz	4kHz	5kHz	6.3kHz	8kHz	10kHz	
[48]	[52]	[55]	[57]	[60]	[64]	66.5*	71.6	72.9	73.9	77.6	80.2	81.1	81.8	82.5	83.6	83.0	82.4	79.5	79.3	80.4	81.3	80.3	78.6	75.2	69.6	64.4	58.6	92.2

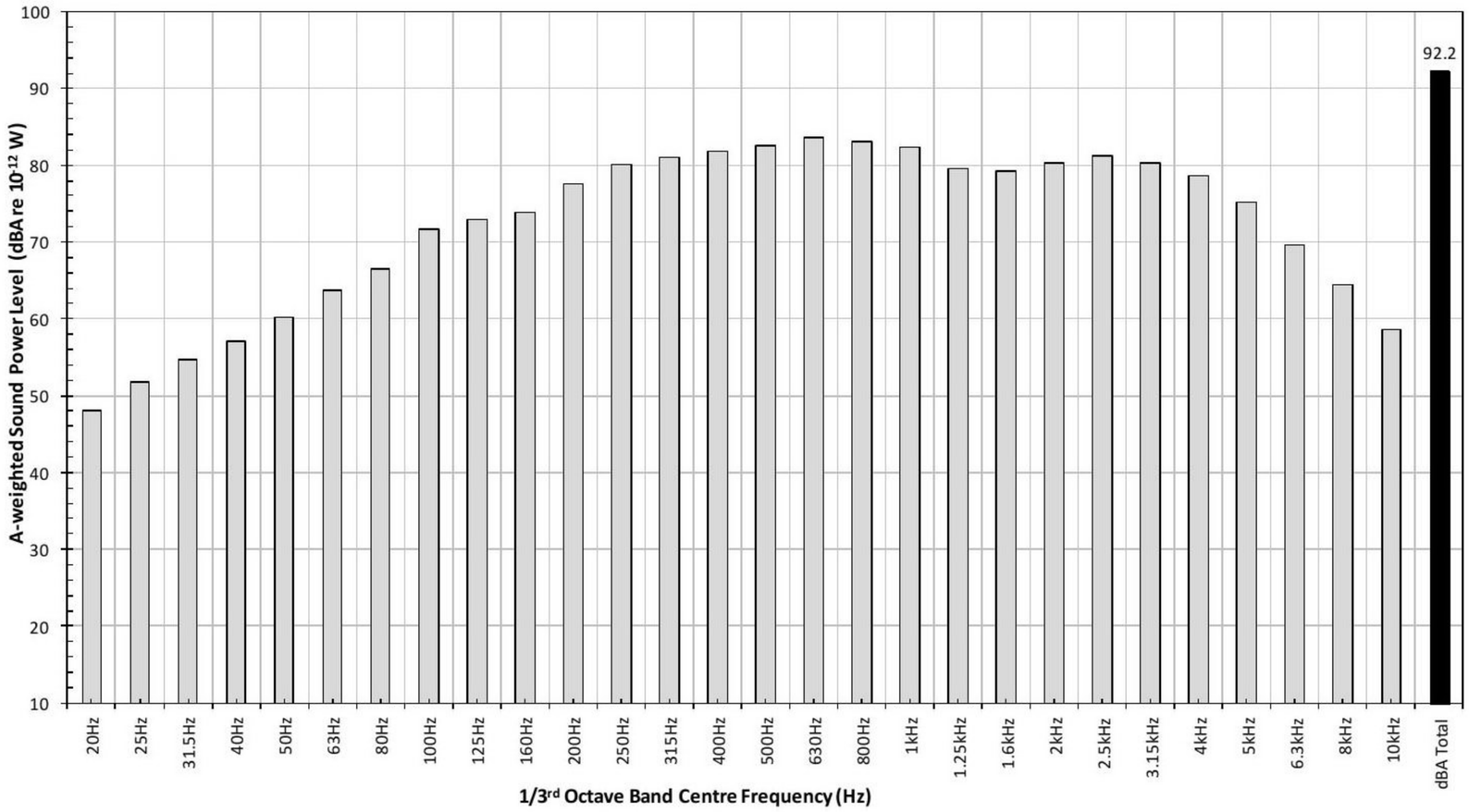


FIGURE 10 A-WEIGHTED 1/3rd OCTAVE BAND SOUND POWER LEVELS FOR 9 m/s WIND SPEED BIN AT ROTOR CENTRE HEIGHT
(7.9 m/s @ 10 m ABOVE GROUND LEVEL, WITH A ROUGHNESS LENGTH OF 0.1)

1/3rd Octave Band Centre Frequency																											dBA Total
20Hz	25Hz	31.5Hz	40Hz	50Hz	63Hz	80Hz	100Hz	125Hz	160Hz	200Hz	250Hz	315Hz	400Hz	500Hz	630Hz	800Hz	1kHz	1.25kHz	1.6kHz	2kHz	2.5kHz	3.15kHz	4kHz	5kHz	6.3kHz	8kHz	10kHz	
[49]	[53]	[56]	[58]	[60]	[64]	67*	71.8	73.2	75.6	79.0	81.2	81.6	82.8	83.3	83.7	83.4	82.6	79.4	79.2	79.1	80.4	80.5	77.9	73.9	69.9	64.6	58.8	92.5

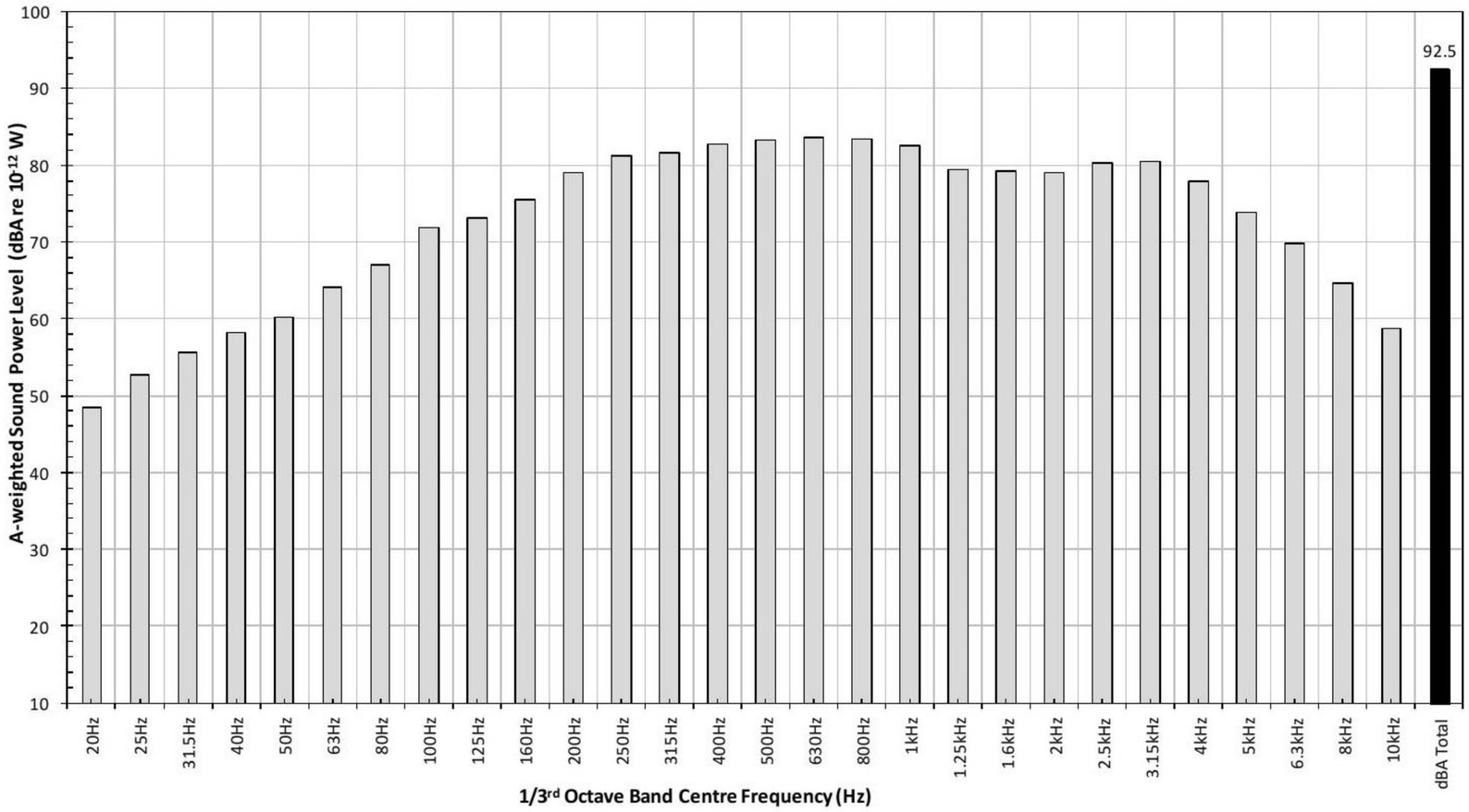


FIGURE 11 A-WEIGHTED 1/3rd OCTAVE BAND SOUND POWER LEVELS FOR 10 m/s WIND SPEED BIN AT ROTOR CENTRE HEIGHT
(8.7 m/s @ 10 m ABOVE GROUND LEVEL, WITH A ROUGHNESS LENGTH OF 0.1)

1/3rd Octave Band Centre Frequency																											dBA Total
20Hz	25Hz	31.5Hz	40Hz	50Hz	63Hz	80Hz	100Hz	125Hz	160Hz	200Hz	250Hz	315Hz	400Hz	500Hz	630Hz	800Hz	1kHz	1.25kHz	1.6kHz	2kHz	2.5kHz	3.15kHz	4kHz	5kHz	6.3kHz	8kHz	10kHz	
[50]	[55]	[57]	[59]	[62]	[65]	68*	72.9	73.9	76.6	79.9	82.2	83.2	83.6	84.0	84.5	83.9	82.7	80.8	80.6	80.5	81.7	81.0	78.2	74.5	71.0	65.8	59.9	93.4

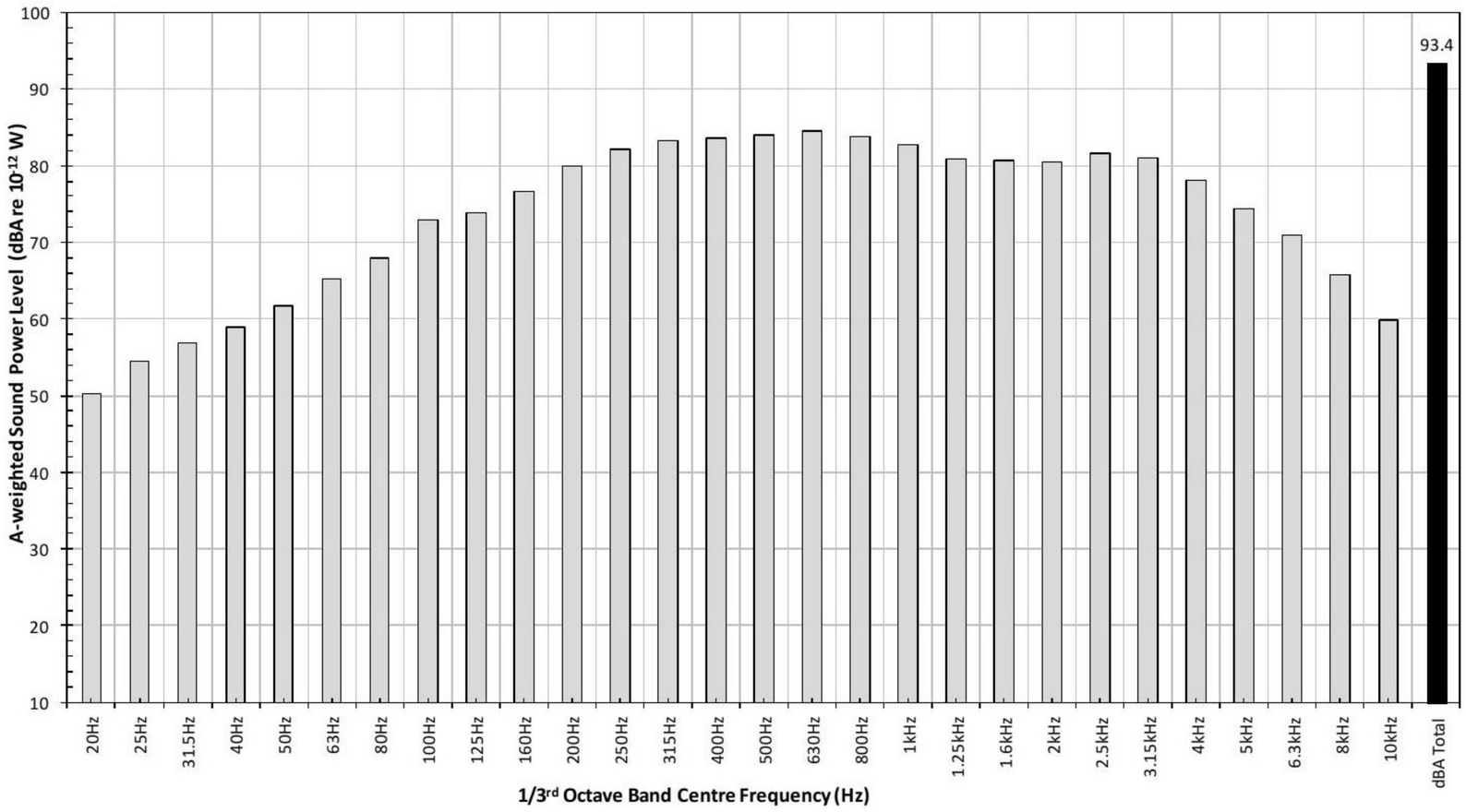


FIGURE 12 A-WEIGHTED 1/3rd OCTAVE BAND SOUND POWER LEVELS FOR 11 m/s WIND SPEED BIN AT ROTOR CENTRE HEIGHT
(9.6 m/s @ 10 m ABOVE GROUND LEVEL, WITH A ROUGHNESS LENGTH OF 0.1)

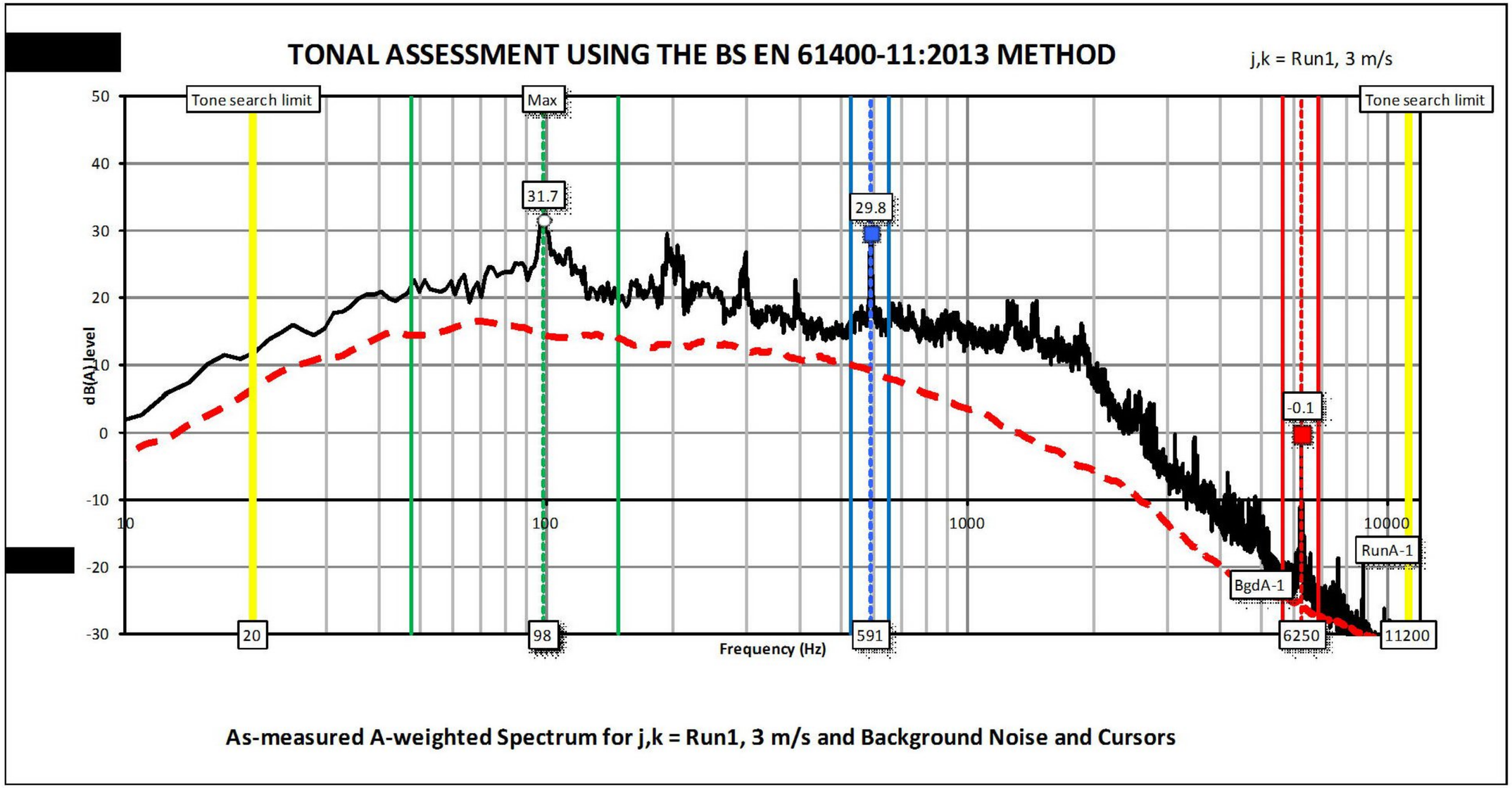


FIGURE 13a TONAL ASSESSMENT USING THE IEC 61400-11:2012 METHOD FOR THE 3 m/s HUB-HEIGHT WIND SPEED BIN

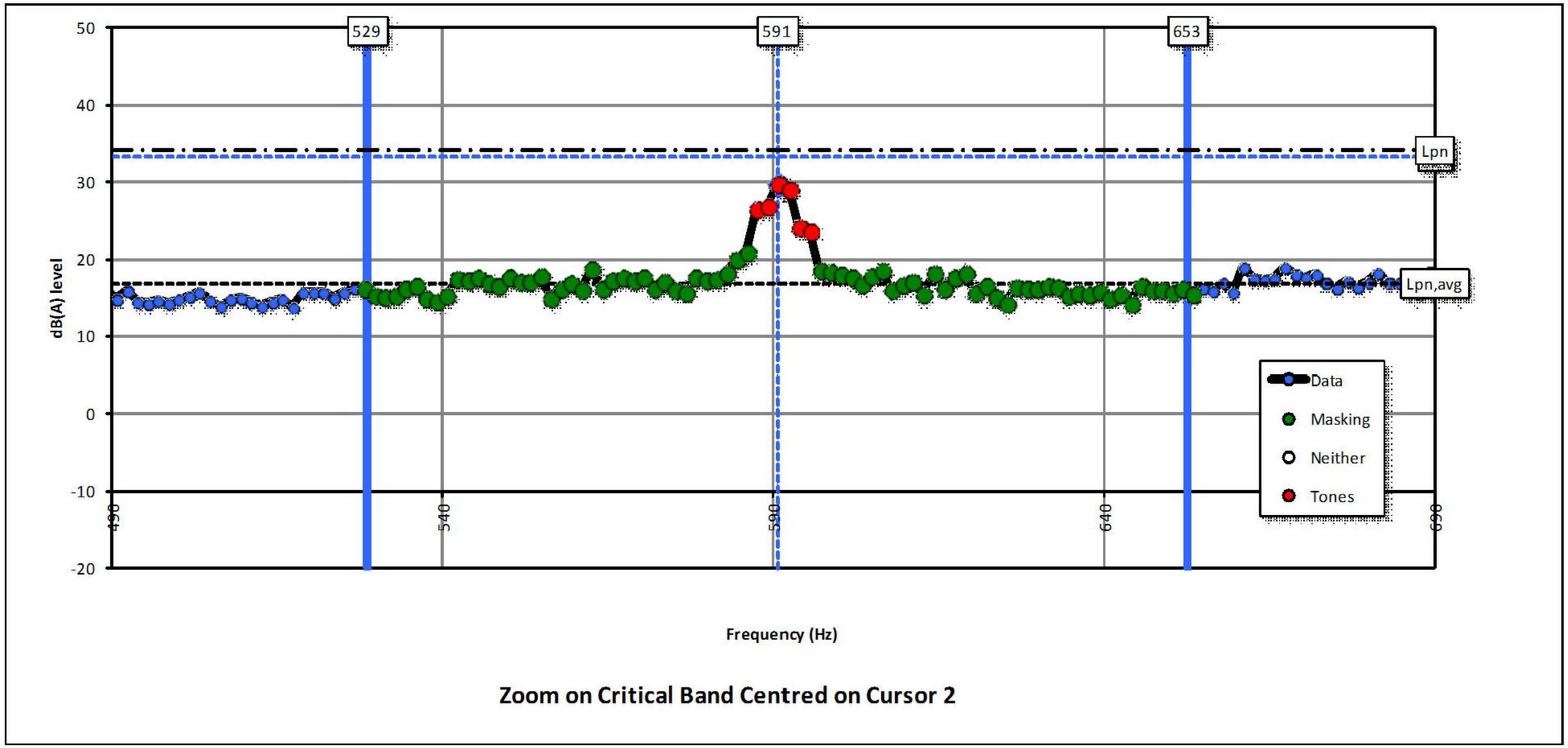


FIGURE 13b CRITICAL BAND WITH HIGHEST TONALITY SHOWING TONES AND MASKING NOISE FOR 3 m/s WIND SPEED BIN. (Tonality +1.6 dB)

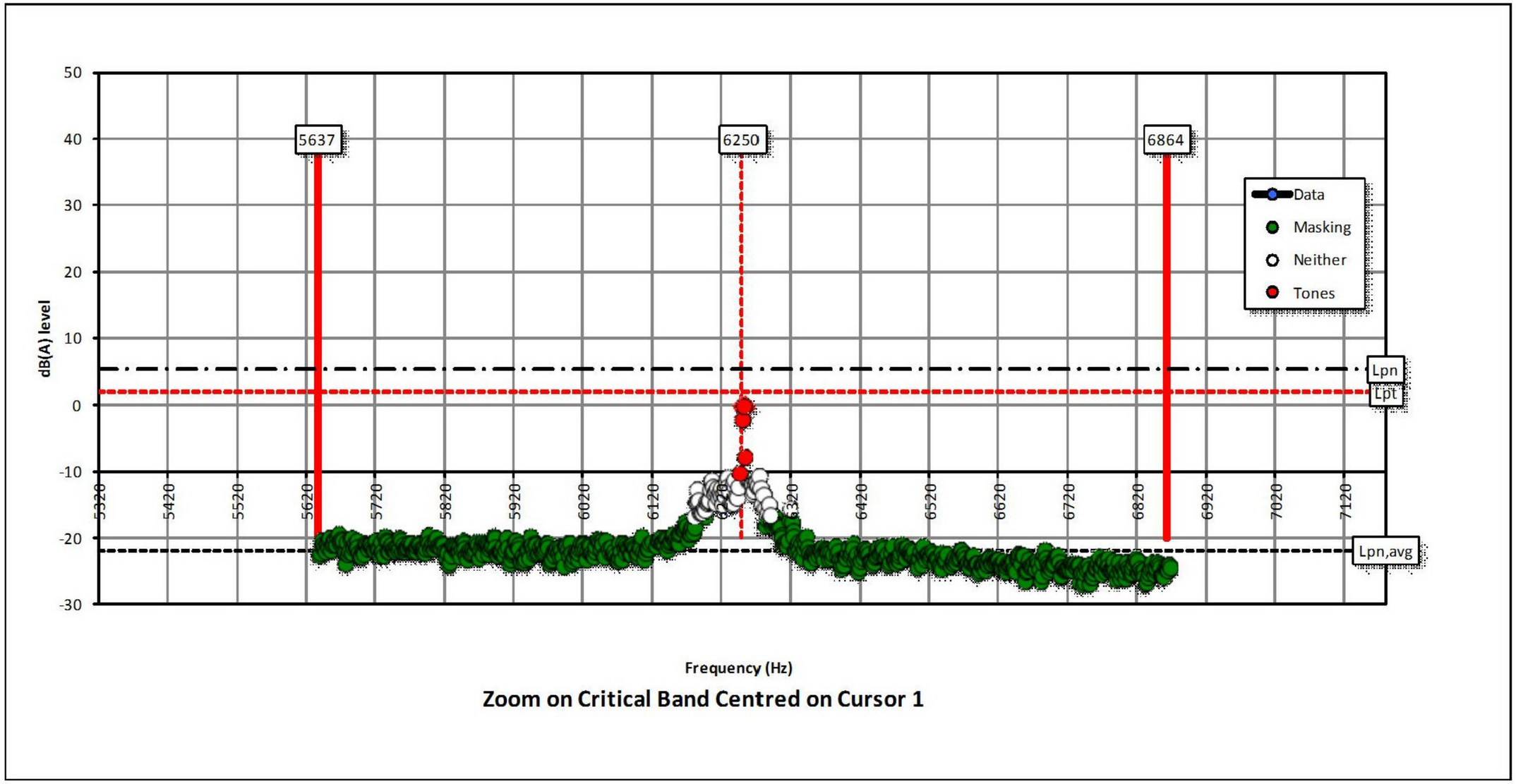


FIGURE 13c CRITICAL BAND WITH 2nd HIGHEST TONALITY SHOWING TONES AND MASKING NOISE FOR 3 m/s WIND SPEED BIN. (Tonality +1.3 dB)

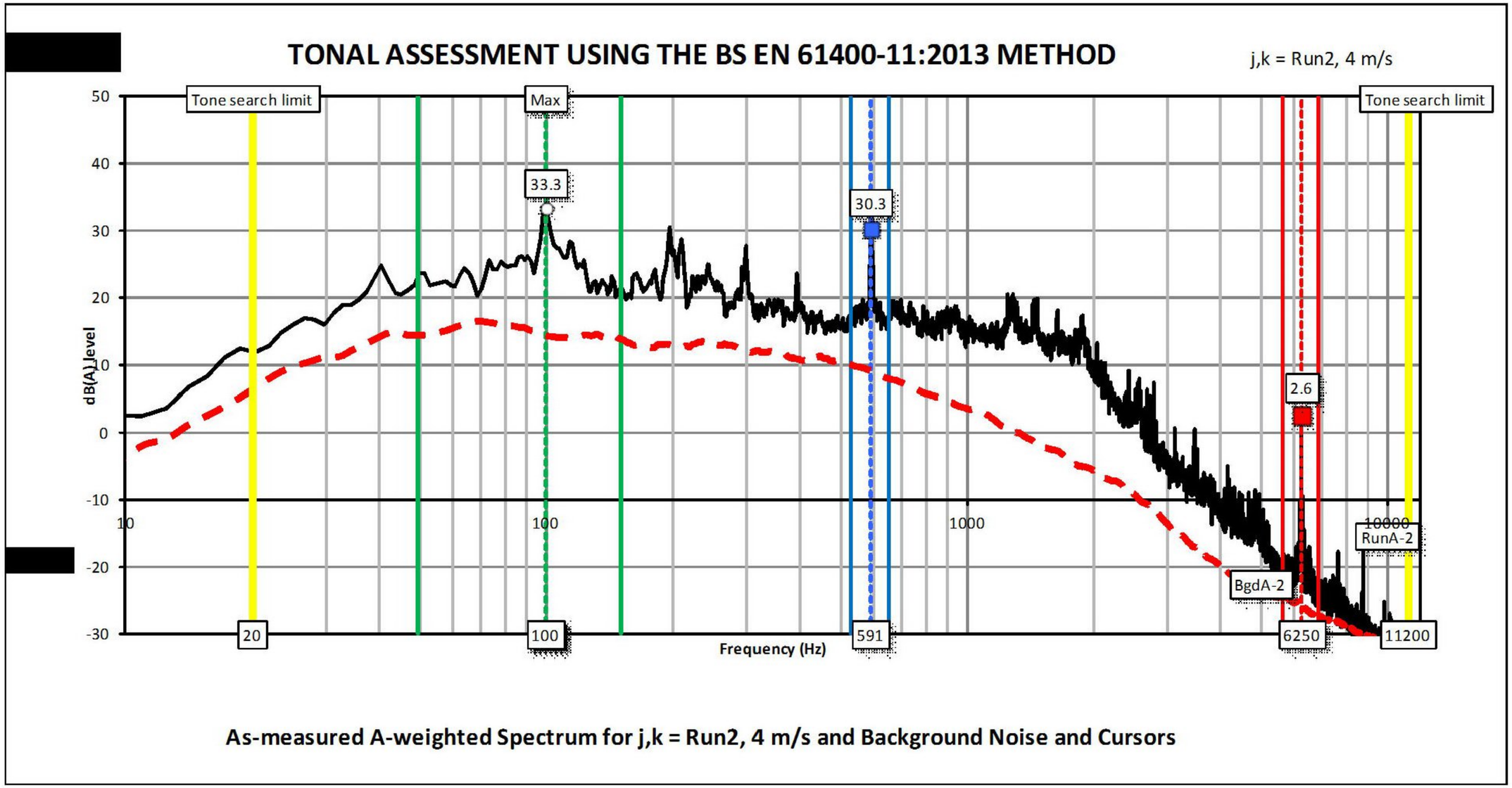


FIGURE 14a TONAL ASSESSMENT USING THE IEC 61400-11:2012 METHOD FOR THE 4 m/s HUB-HEIGHT WIND SPEED BIN

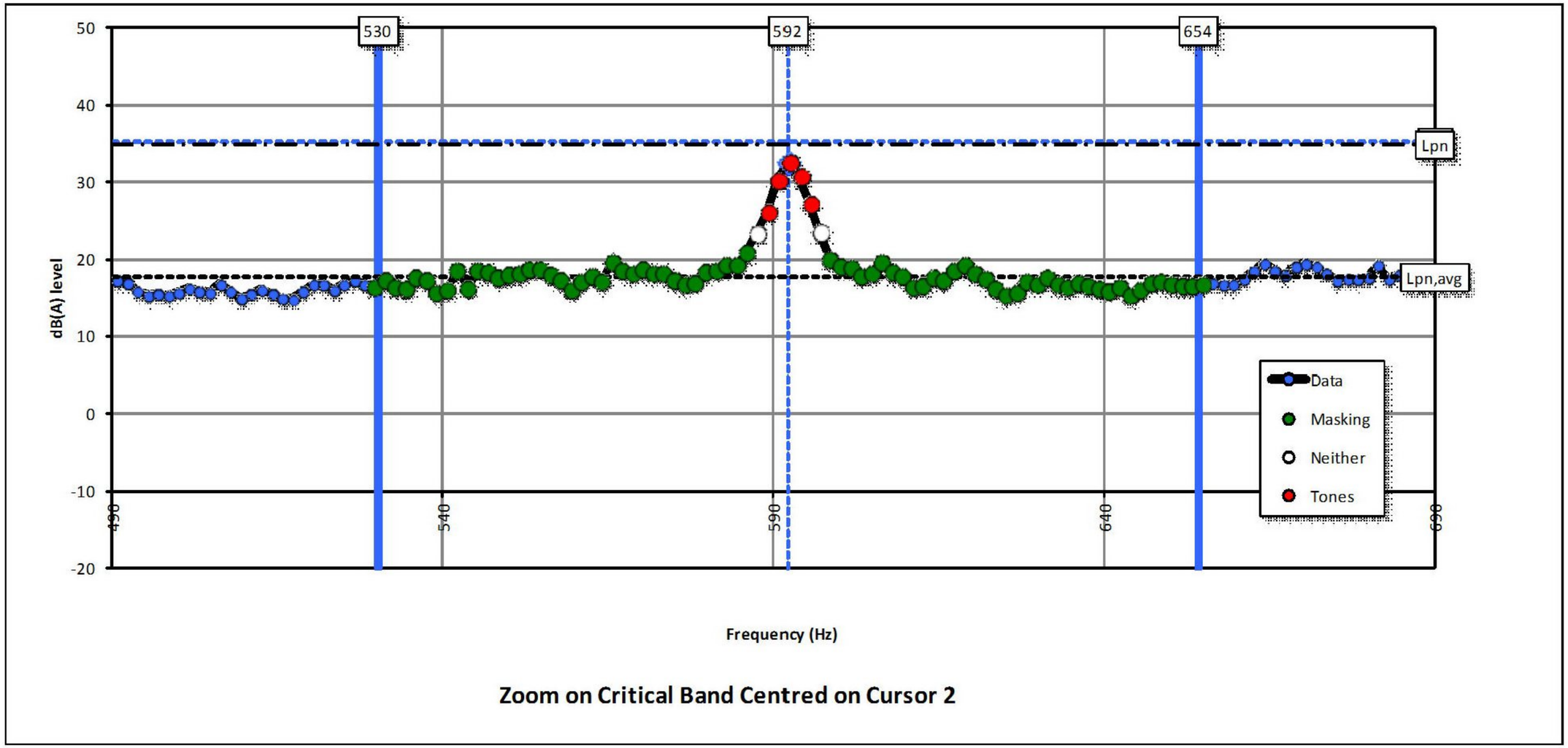


FIGURE 14b CRITICAL BAND WITH HIGHEST TONALITY SHOWING TONES AND MASKING NOISE FOR 4 m/s WIND SPEED BIN. (Tonality +2.7 dB)

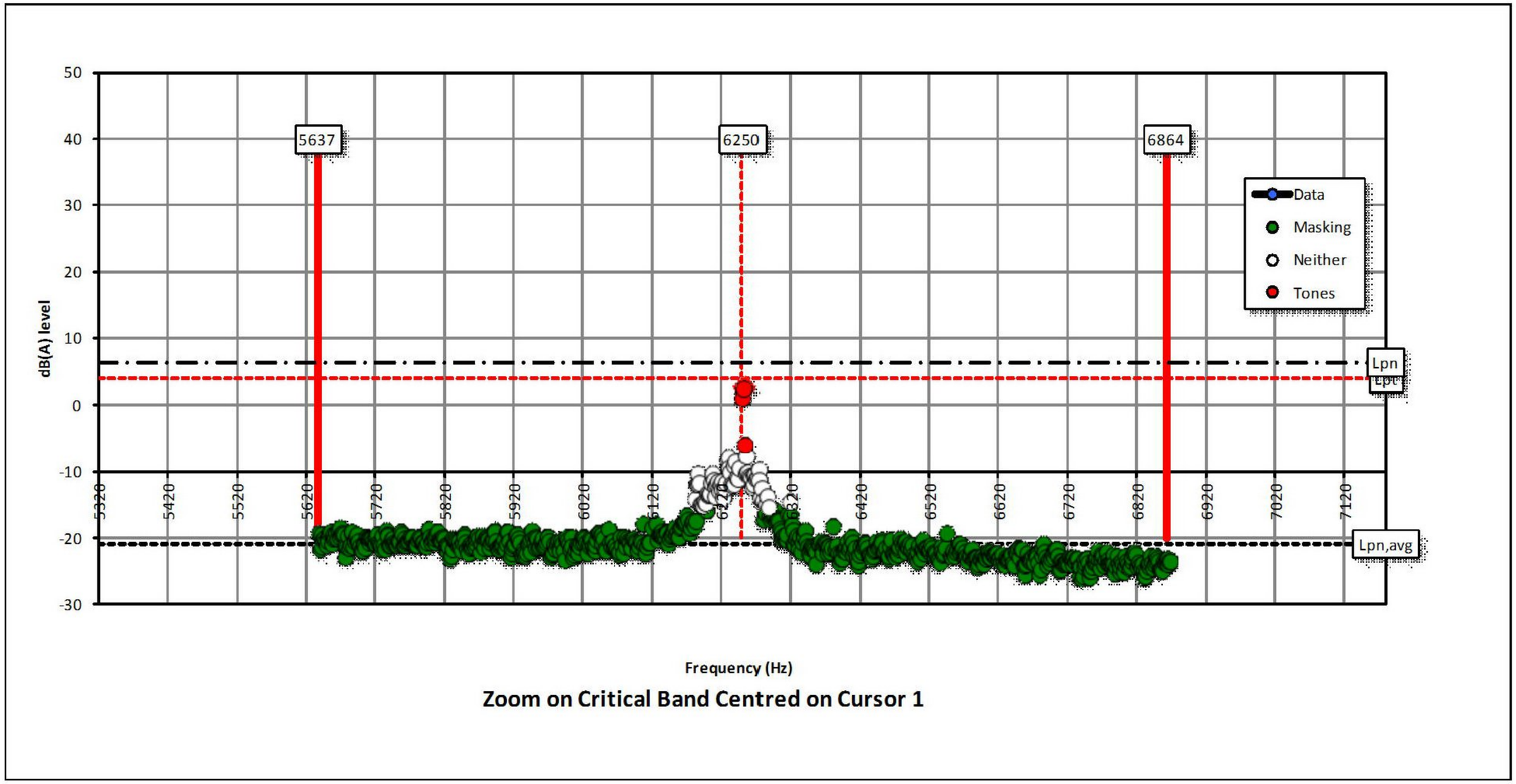


FIGURE 14c CRITICAL BAND WITH 2nd HIGHEST TONALITY SHOWING TONES AND MASKING NOISE FOR 4 m/s WIND SPEED BIN. (Tonality +2.3 dB)

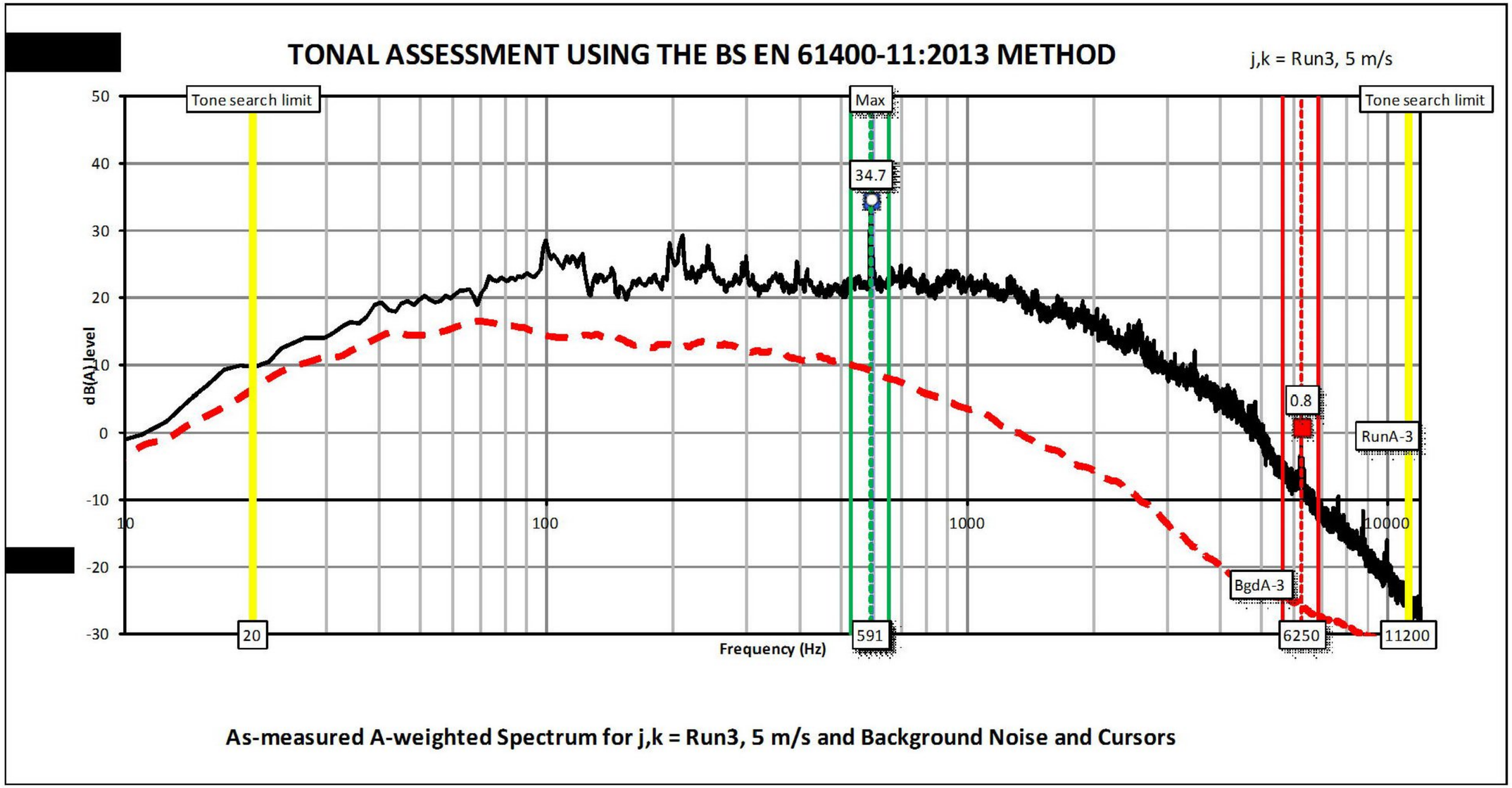


FIGURE 15a TONAL ASSESSMENT USING THE IEC 61400-11:2012 METHOD FOR THE 5 m/s HUB-HEIGHT WIND SPEED BIN

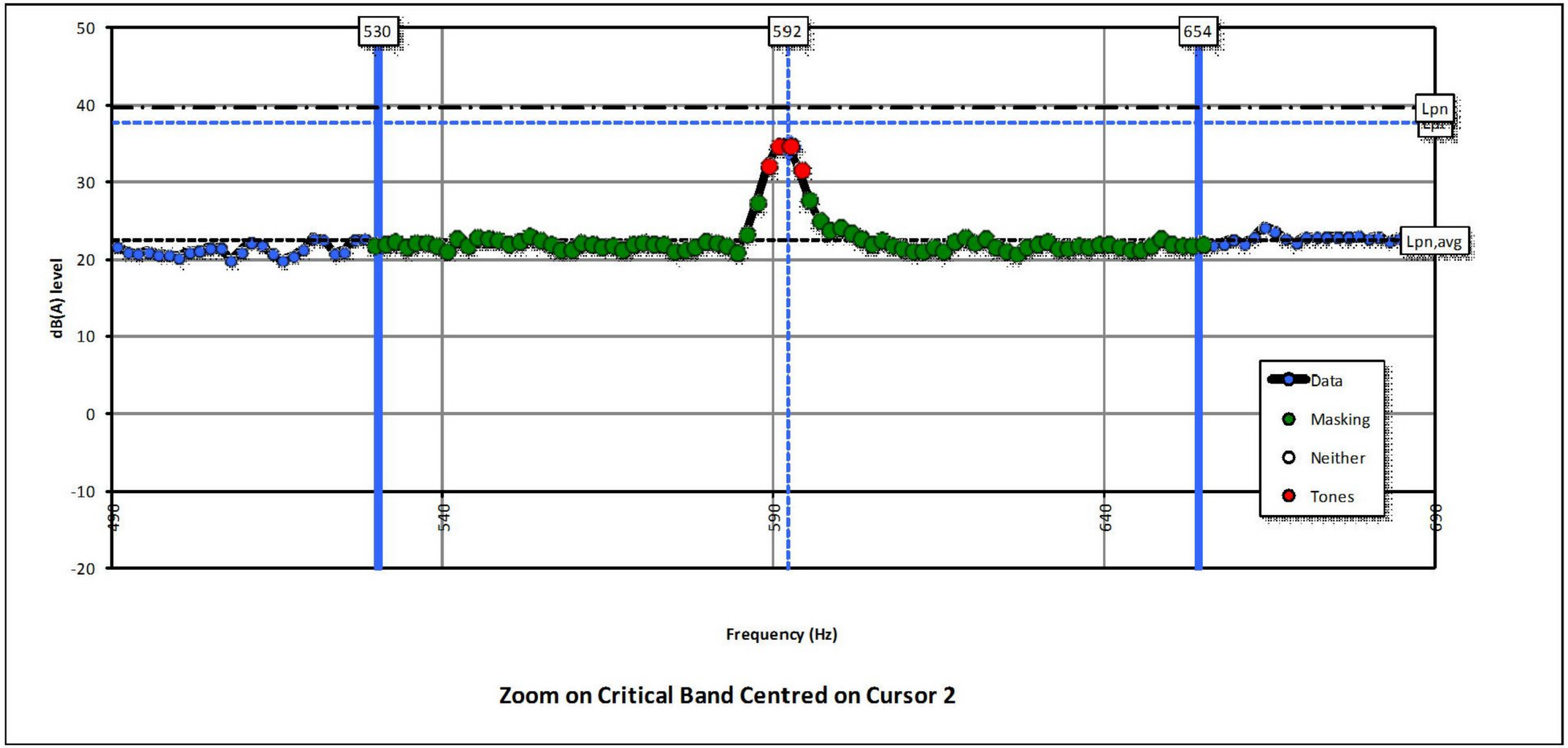


FIGURE 15b CRITICAL BAND WITH HIGHEST TONALITY SHOWING TONES AND MASKING NOISE FOR 5 m/s WIND SPEED BIN.
The Spectrum Maximum and Highest Tonality are equivalent in this case (Tonality +0.5 dB)

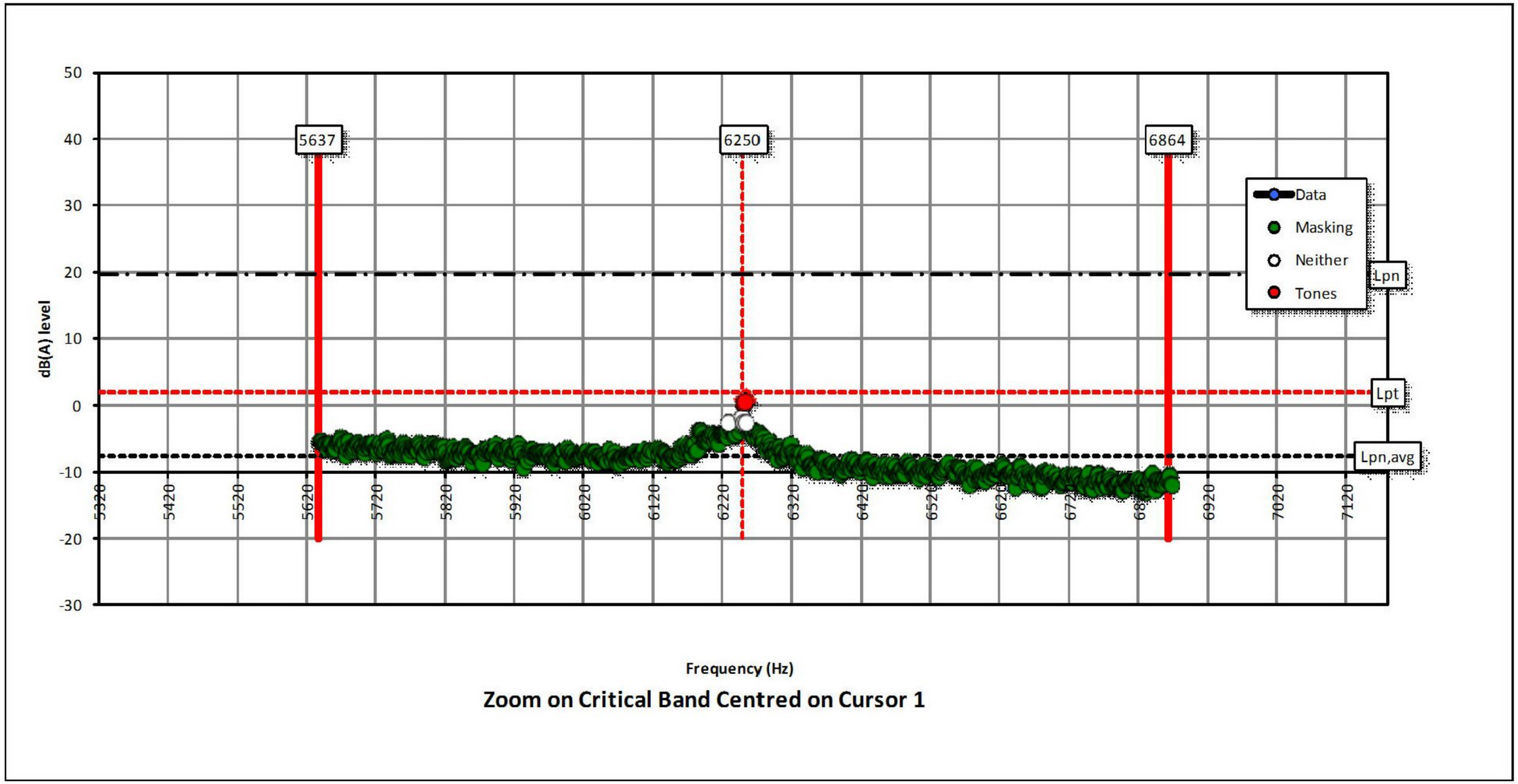


FIGURE 15c CRITICAL BAND WITH 2nd HIGHEST TONALITY SHOWING TONES AND MASKING NOISE FOR 5 m/s WIND SPEED BIN. (Tonality -13 dB)

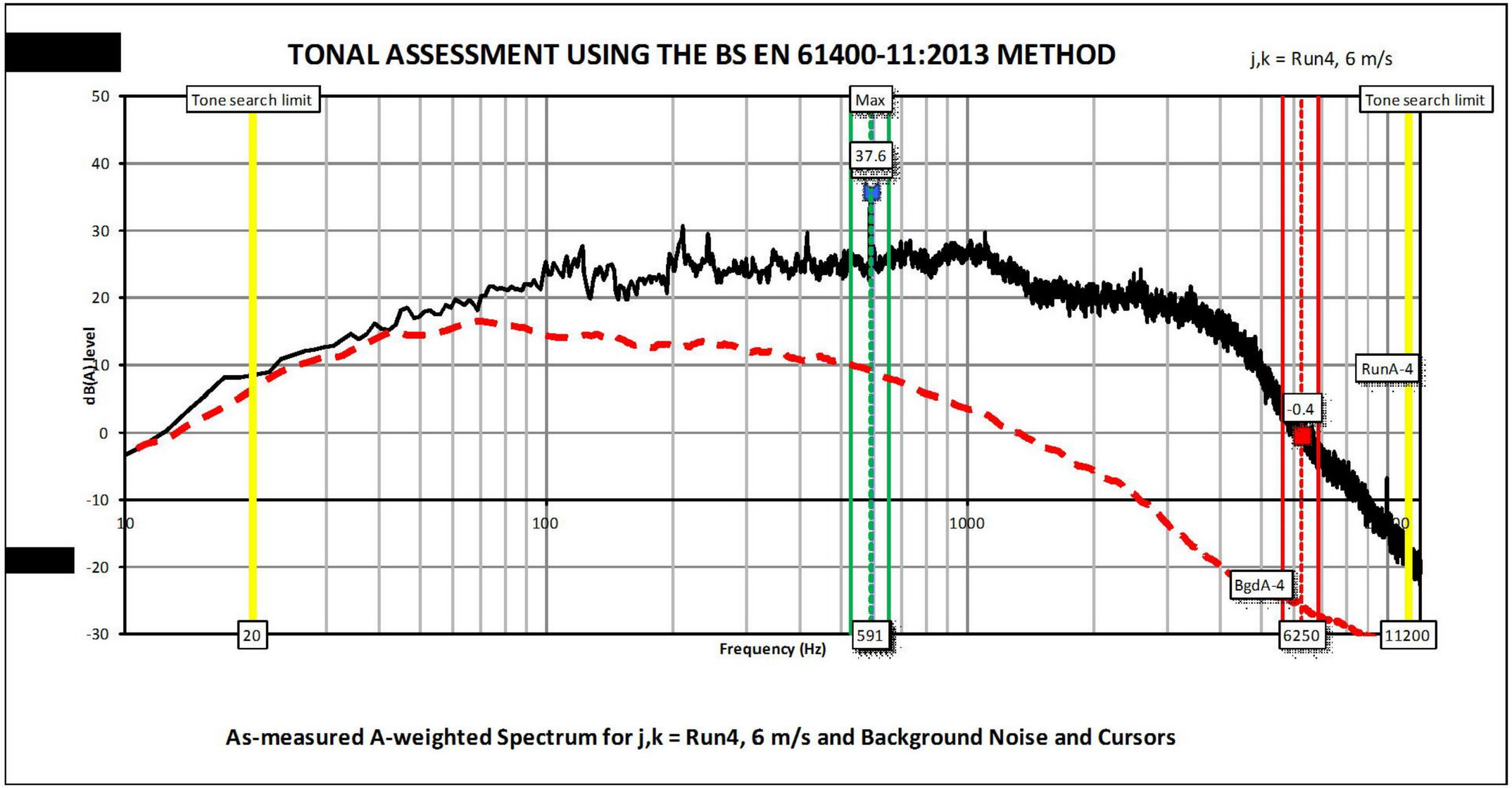


FIGURE 16a TONAL ASSESSMENT USING THE IEC 61400-11:2012 METHOD FOR THE 6 m/s HUB-HEIGHT WIND SPEED BIN

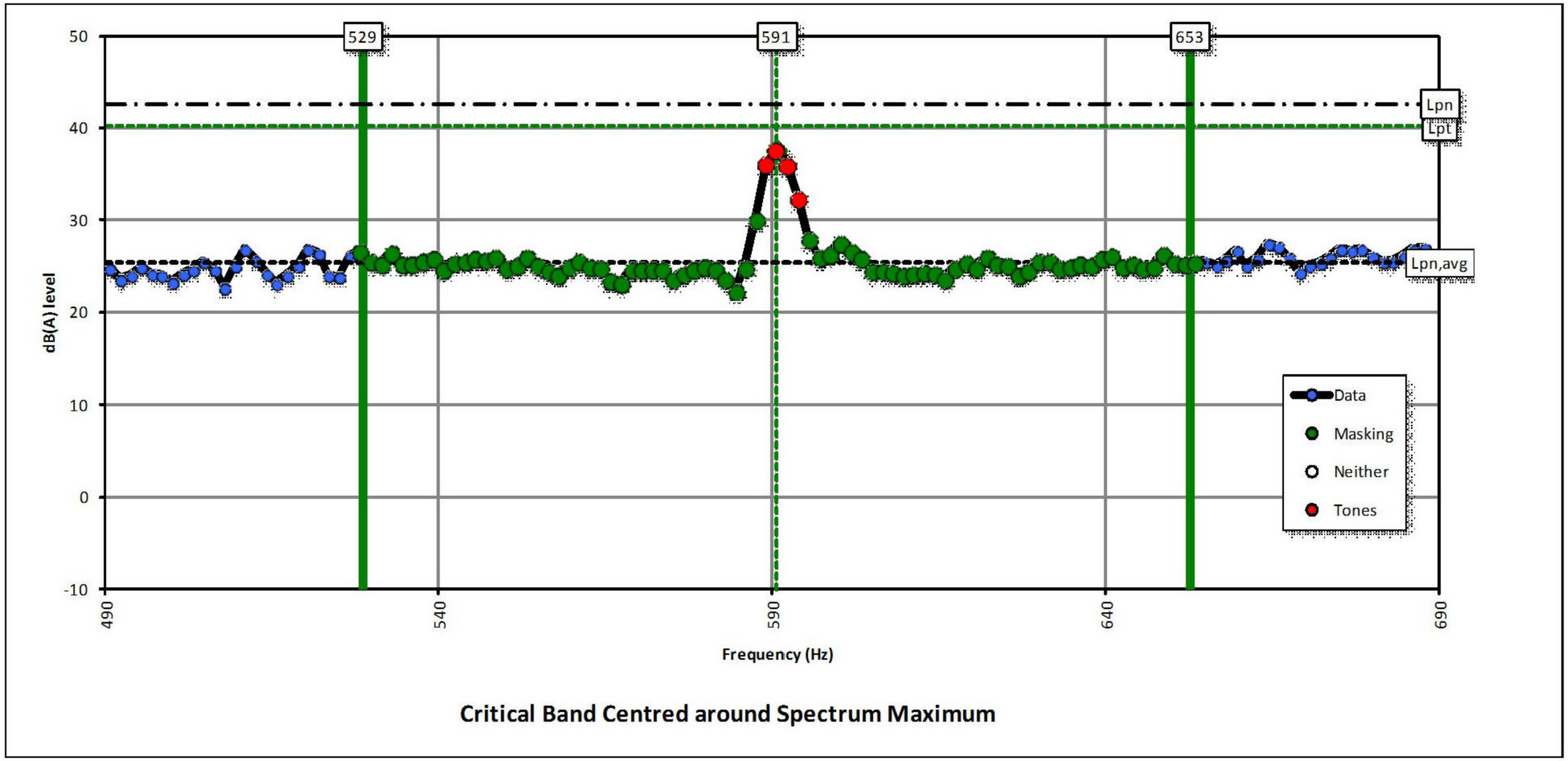


FIGURE 16b CRITICAL BAND WITH HIGHEST TONALITY SHOWING TONES AND MASKING NOISE FOR 6 m/s WIND SPEED BIN.
The Highest Tonality and Spectrum Maximum Coincide (Tonality -0.1 dB)

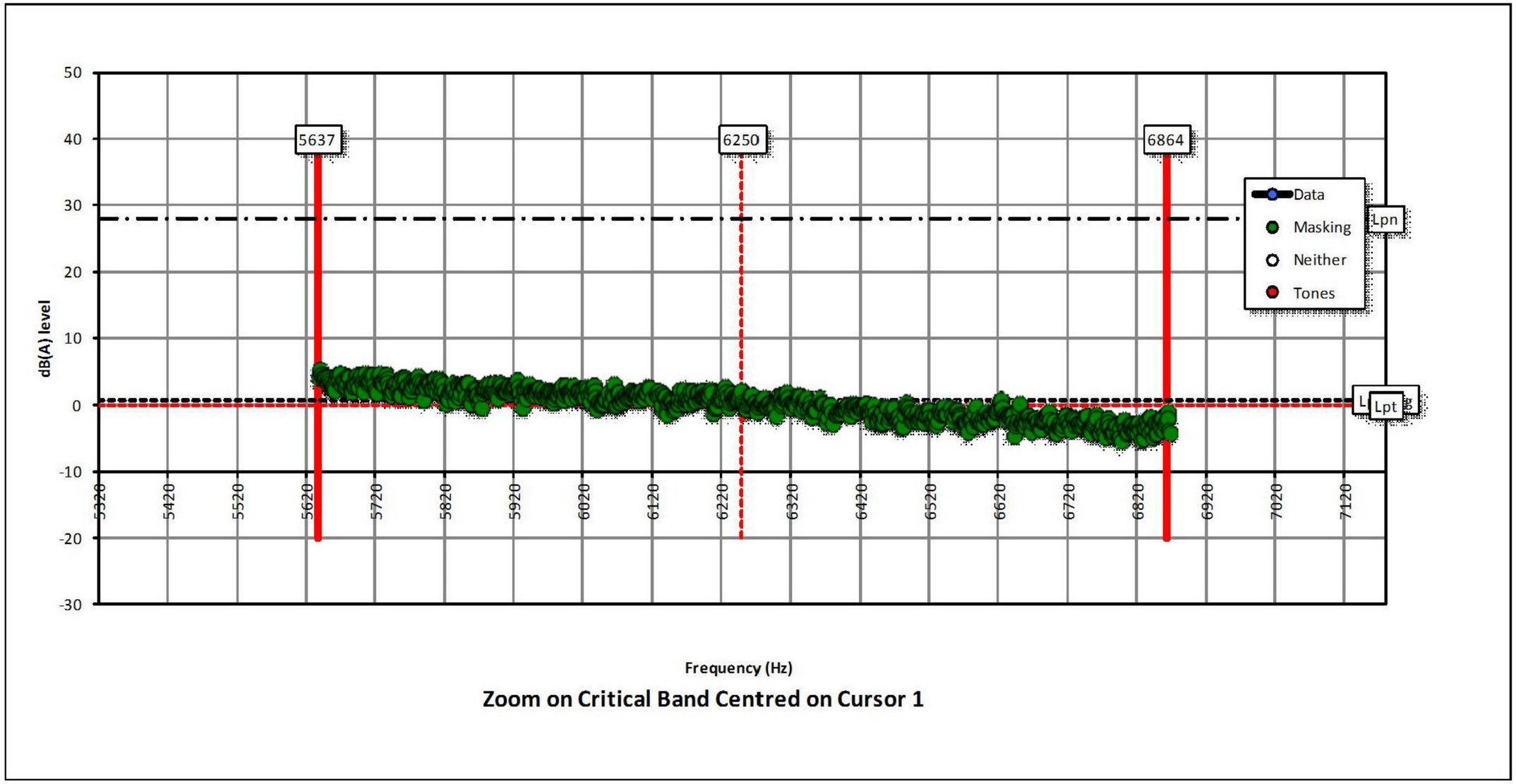


FIGURE 16c CRITICAL BAND WITH 2nd HIGHEST TONALITY SHOWING TONES AND MASKING NOISE FOR 6 m/s WIND SPEED BIN. (Tonality -22 dB)

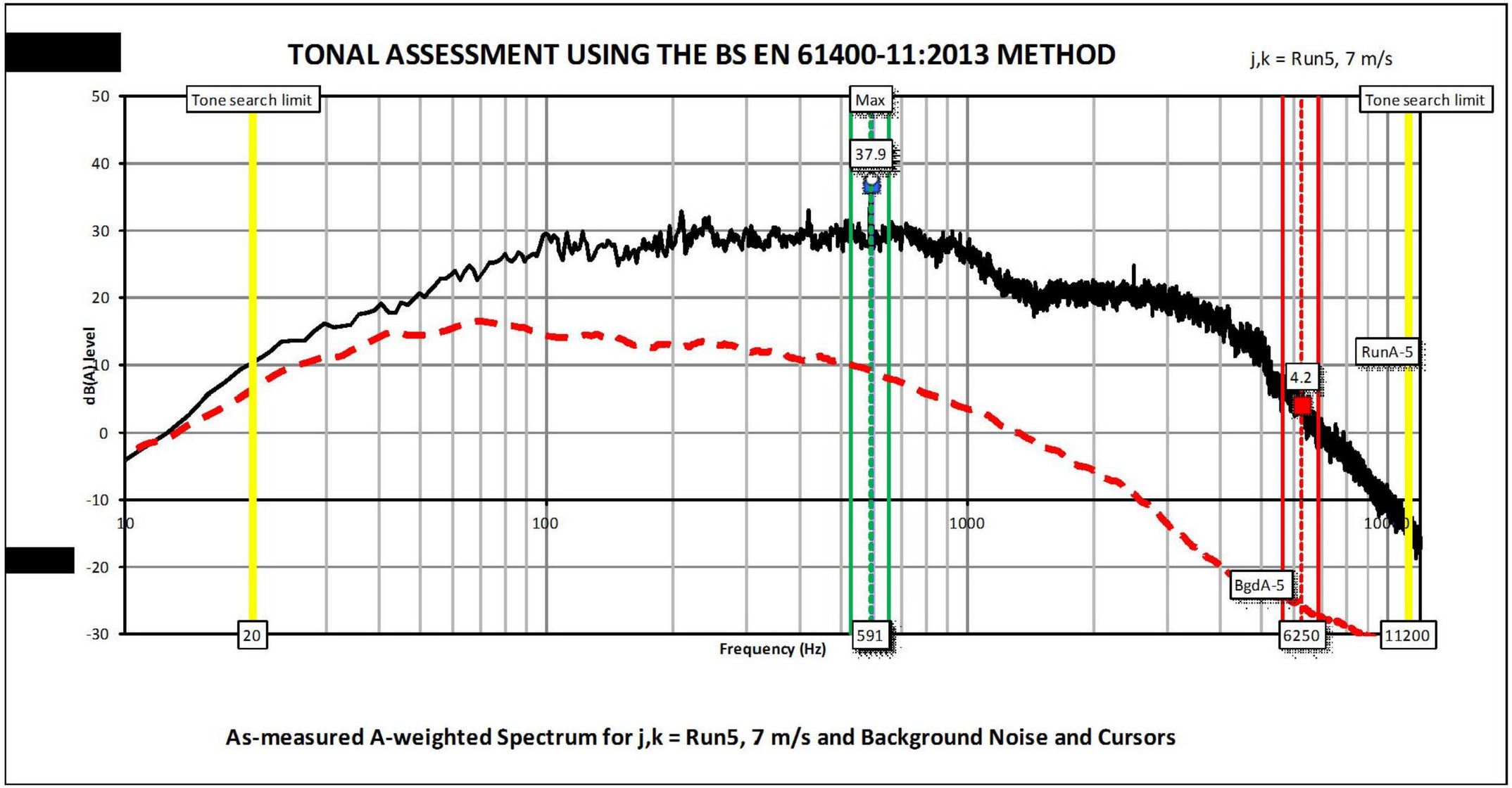


FIGURE 17a TONAL ASSESSMENT USING THE IEC 61400-11:2012 METHOD FOR THE 7 m/s HUB-HEIGHT WIND SPEED BIN

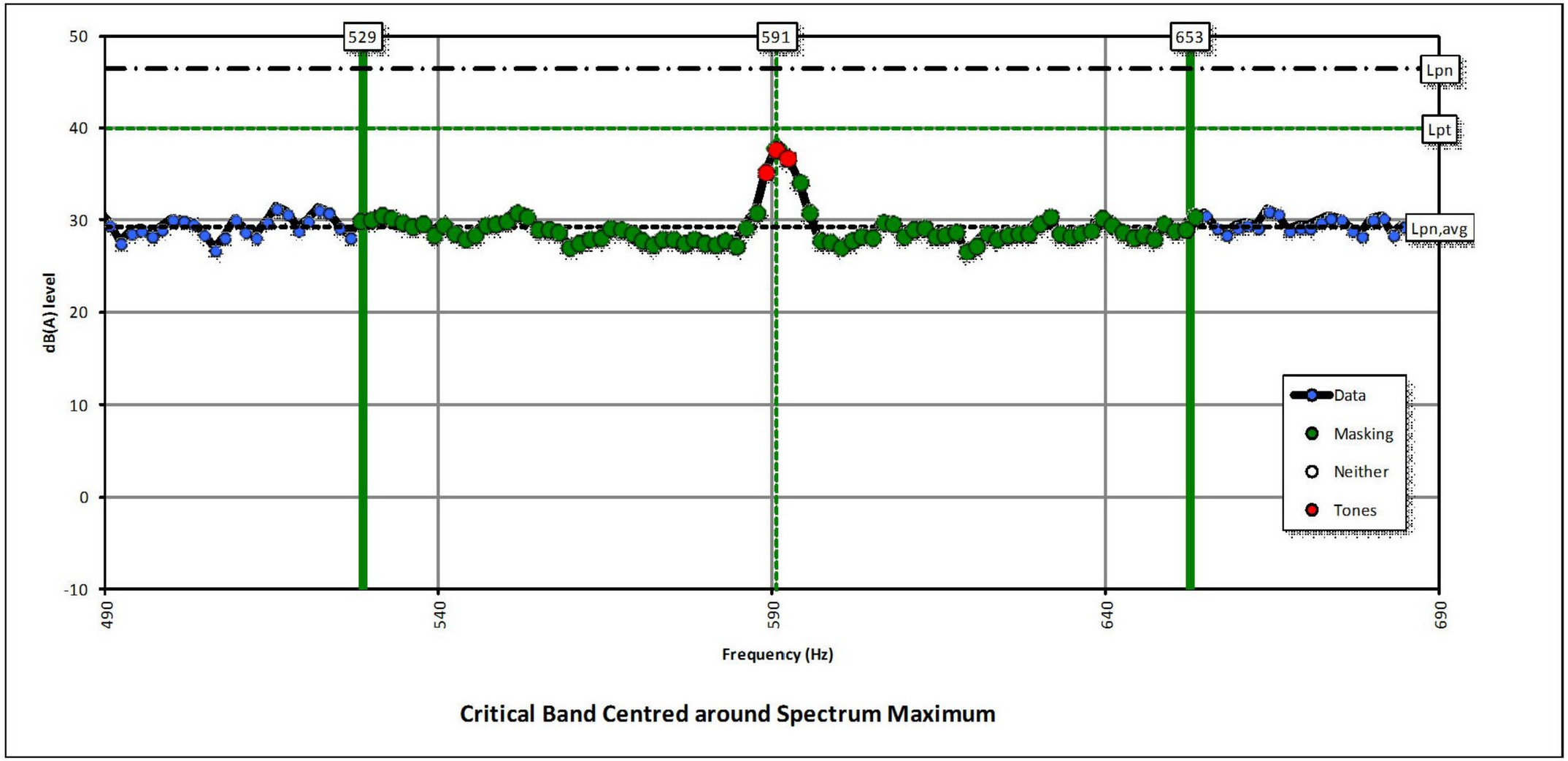


FIGURE 17b CRITICAL BAND WITH SPECTRUM MAXIMUM SHOWING TONES AND MASKING NOISE FOR 7 m/s WIND SPEED BIN. (Tonality -4.1 dB)

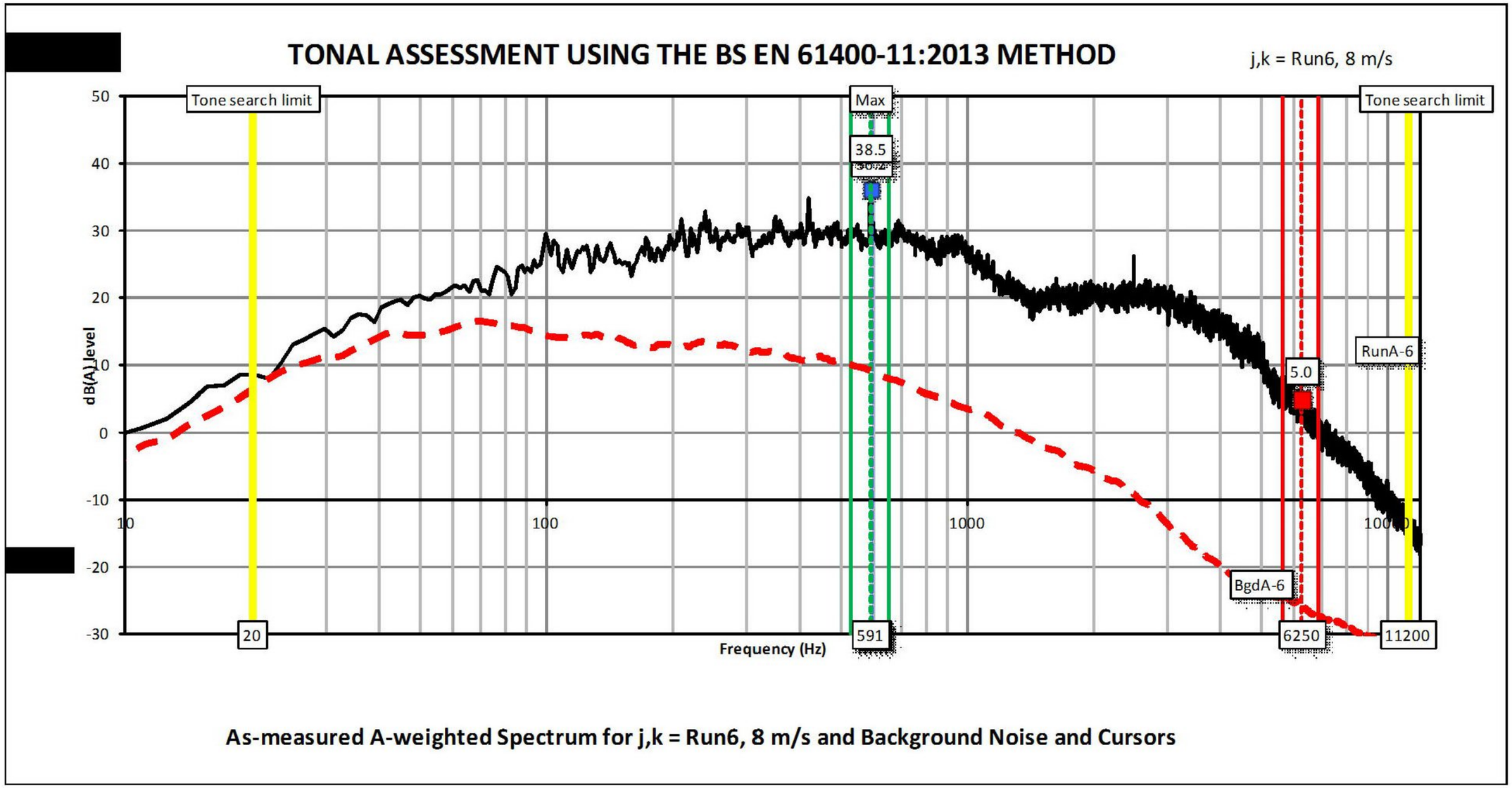


FIGURE 18a TONAL ASSESSMENT USING THE IEC 61400-11:2012 METHOD FOR THE 8 m/s HUB-HEIGHT WIND SPEED BIN

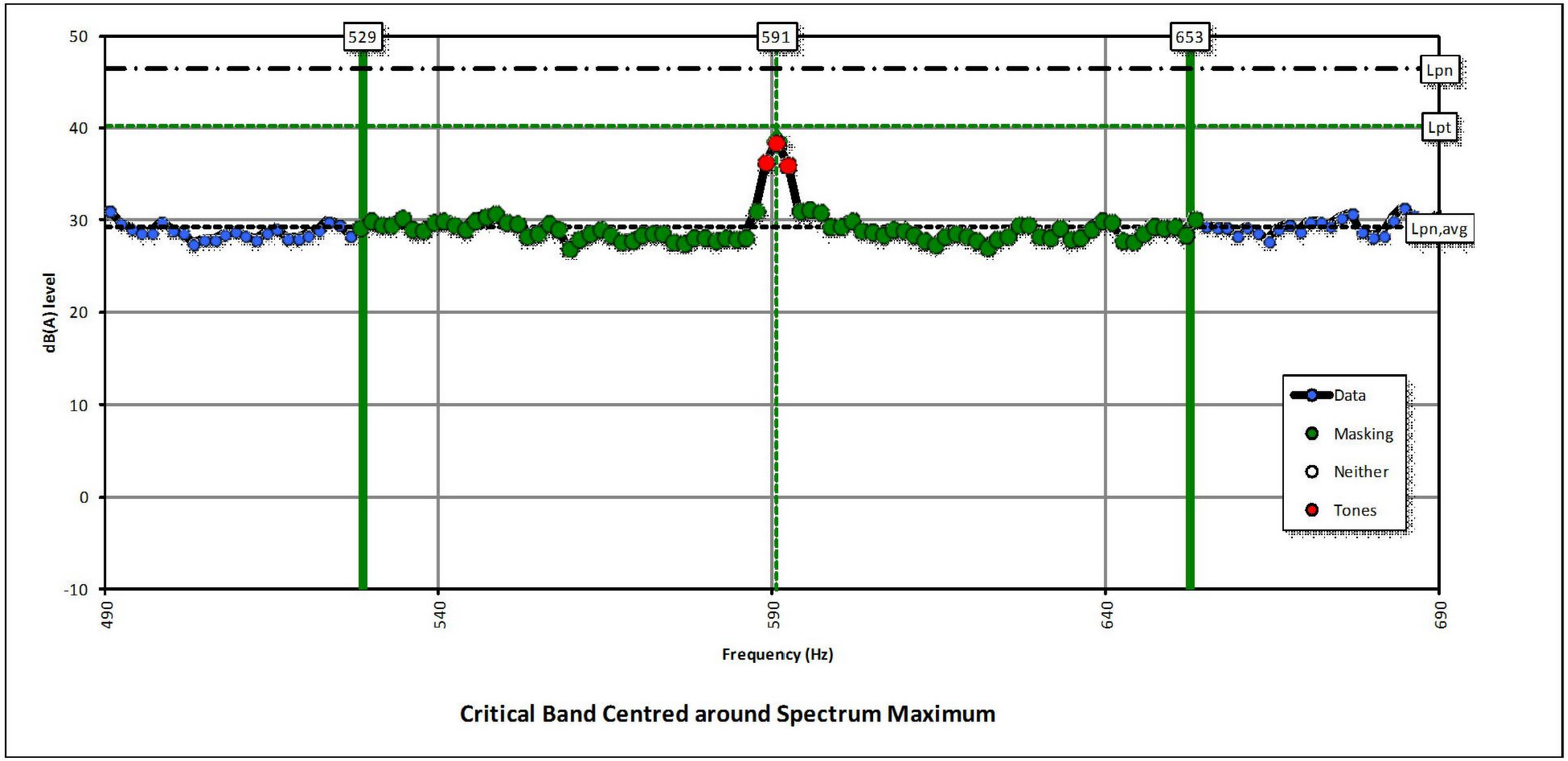


FIGURE 18b CRITICAL BAND WITH SPECTRUM MAXIMUM SHOWING TONES AND MASKING NOISE FOR 8 m/s WIND SPEED BIN. (Tonality -6.2 dB)

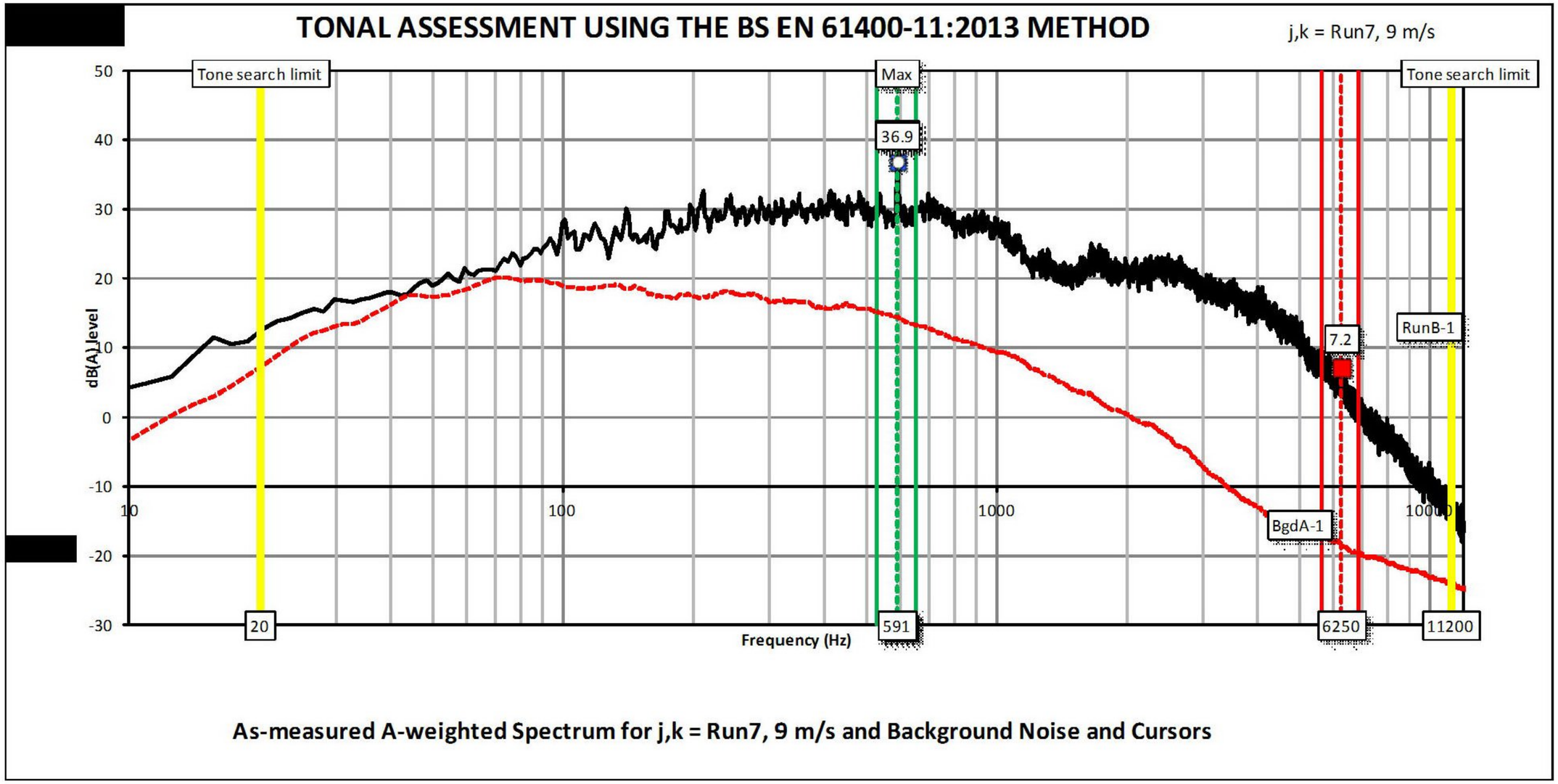


FIGURE 19a TONAL ASSESSMENT USING THE IEC 61400-11:2012 METHOD FOR THE 9 m/s HUB-HEIGHT WIND SPEED BIN

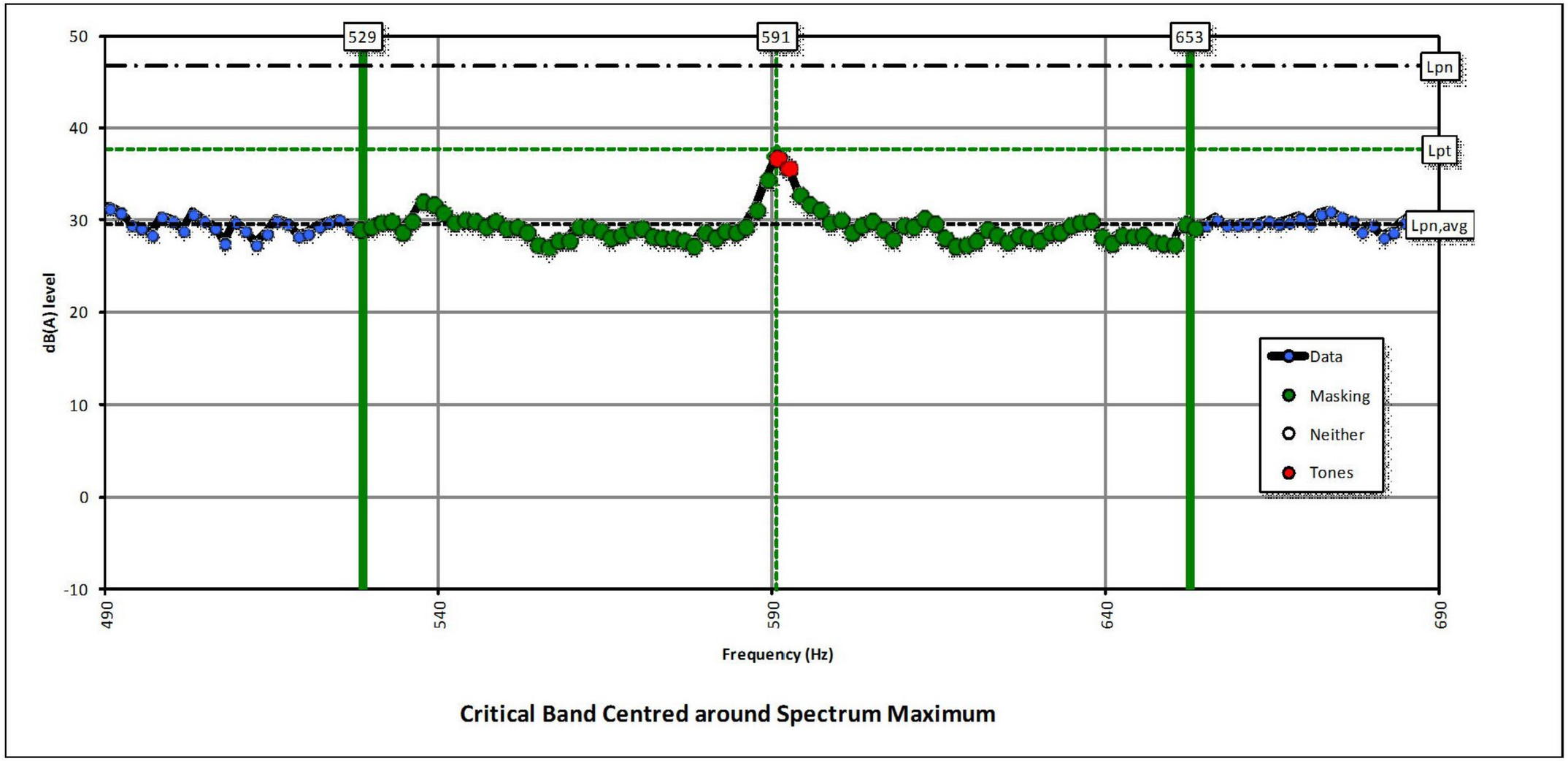


FIGURE 19b CRITICAL BAND WITH SPECTRUM MAXIMUM SHOWING TONES AND MASKING NOISE FOR 9 m/s WIND SPEED BIN. (Tonality -6.7 dB)

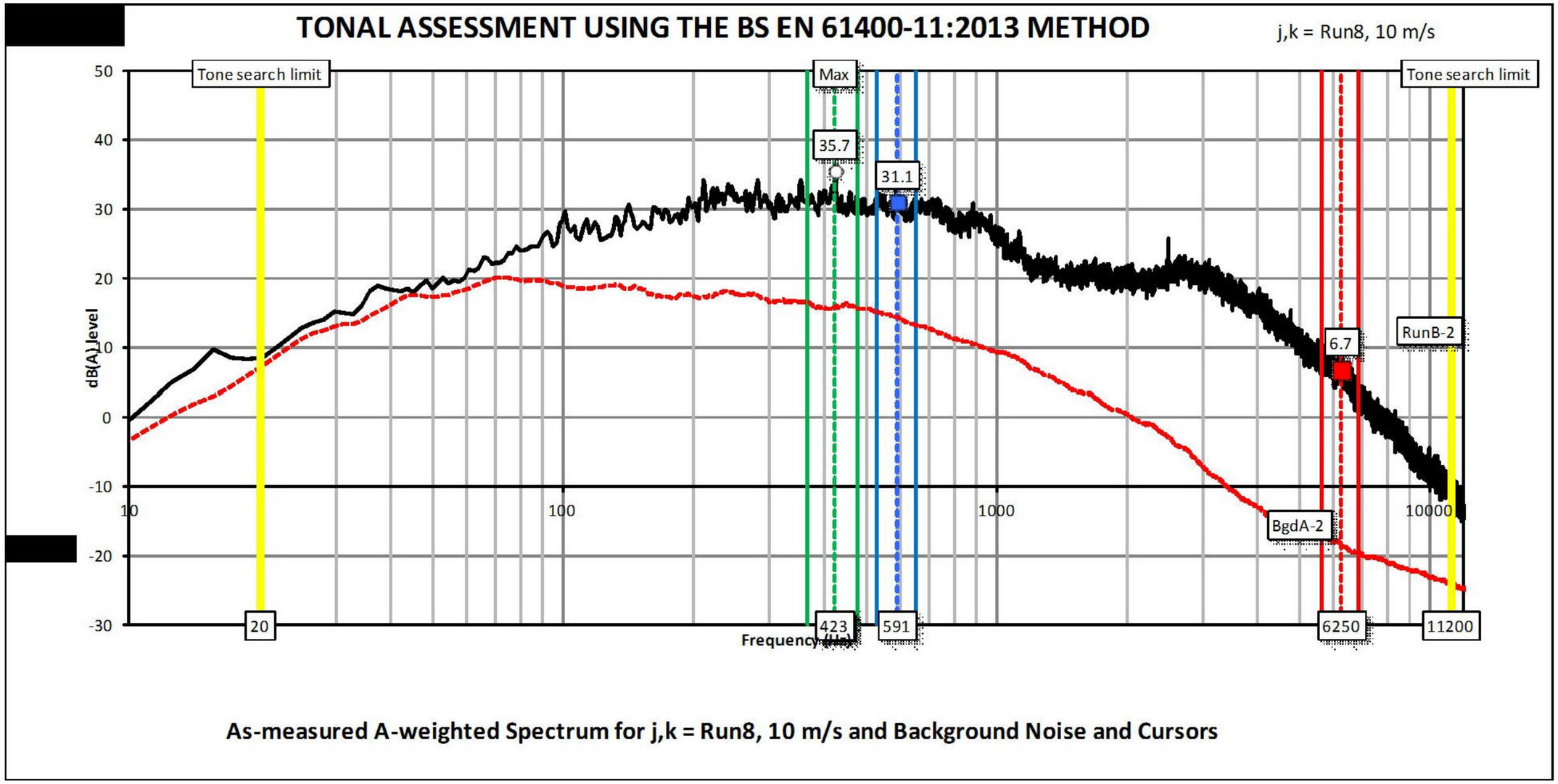


FIGURE 20a TONAL ASSESSMENT USING THE IEC 61400-11:2012 METHOD FOR THE 10 m/s HUB-HEIGHT WIND SPEED BIN

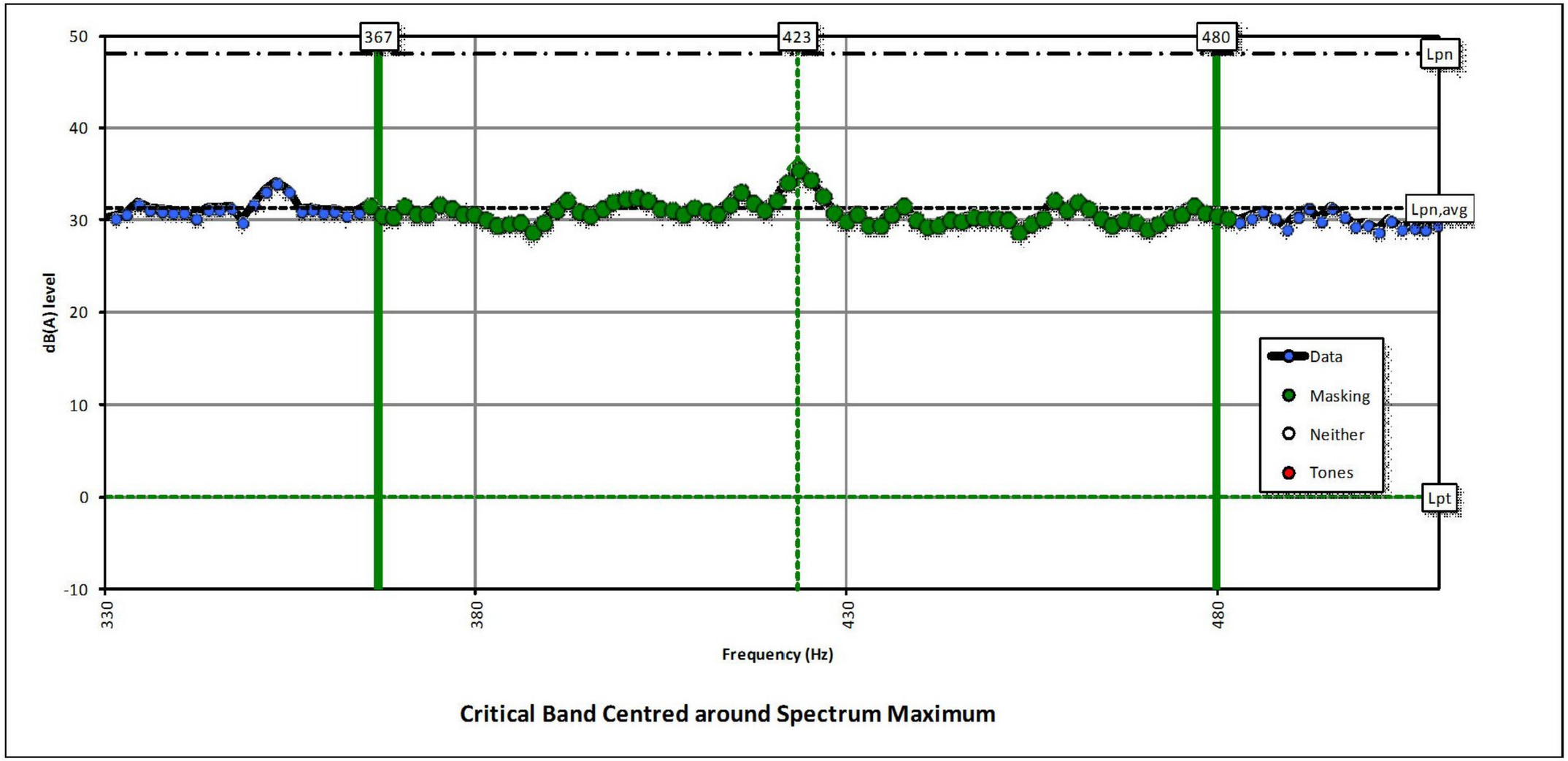


FIGURE 20b CRITICAL BAND WITH SPECTRUM MAXIMUM SHOWING TONES AND MASKING NOISE FOR 10 m/s WIND SPEED BIN. (Tonality -15 dB)

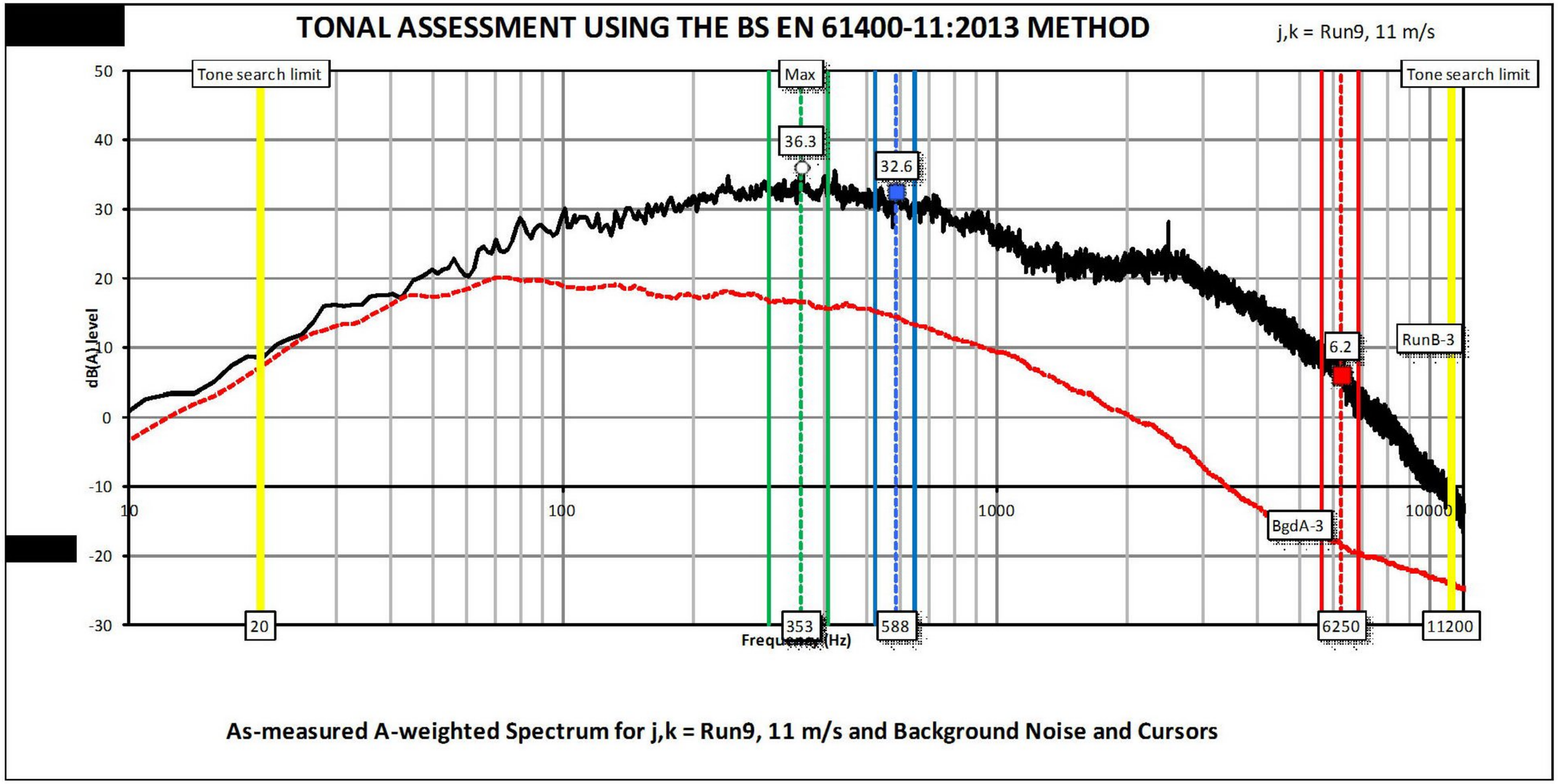


FIGURE 21a TONAL ASSESSMENT USING THE IEC 61400-11:2012 METHOD FOR THE 11 m/s HUB-HEIGHT WIND SPEED BIN

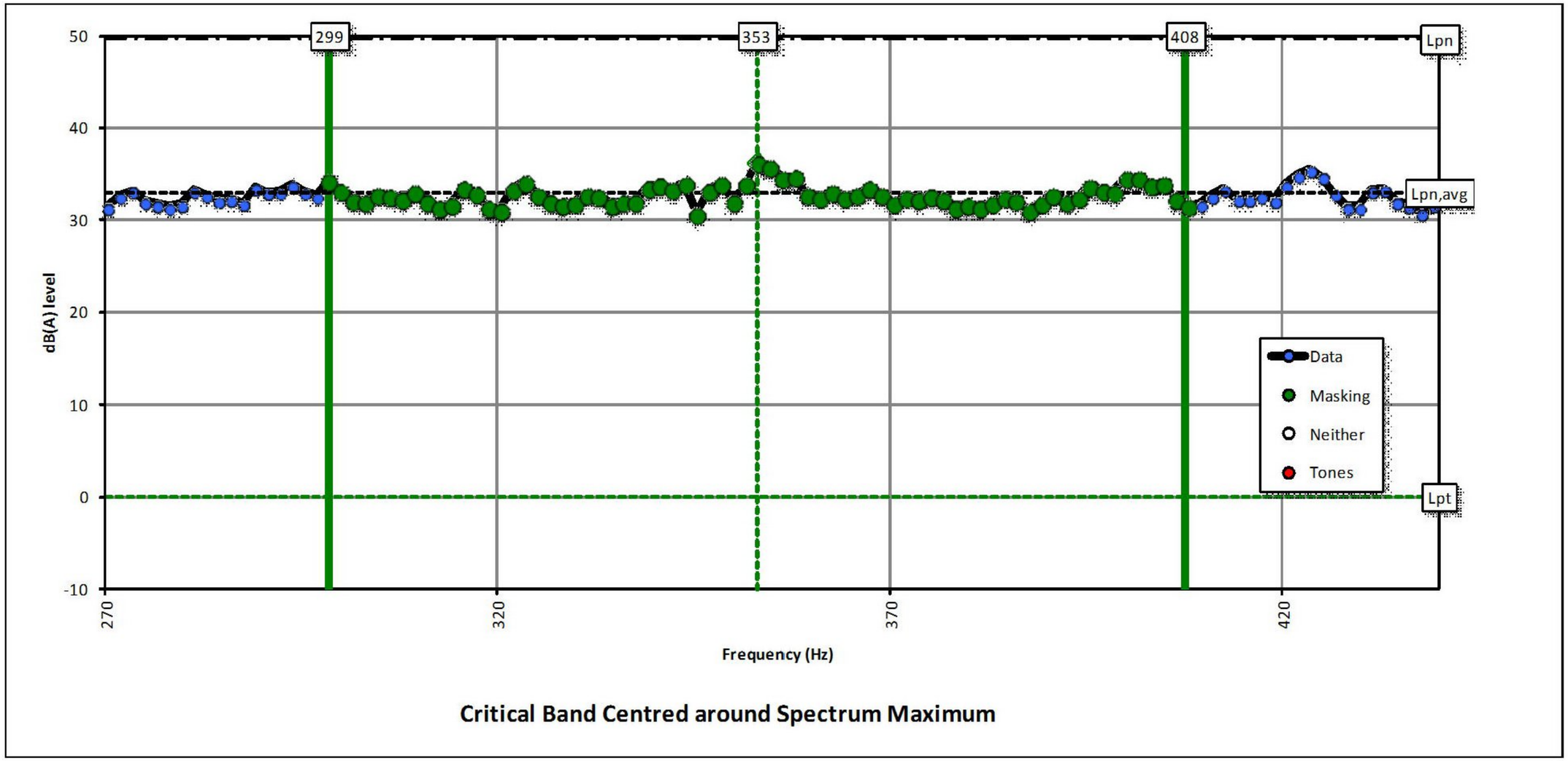


FIGURE 21b CRITICAL BAND WITH SPECTRUM MAXIMUM SHOWING TONES AND MASKING NOISE FOR 11 m/s WIND SPEED BIN. (Tonality -15 dB)

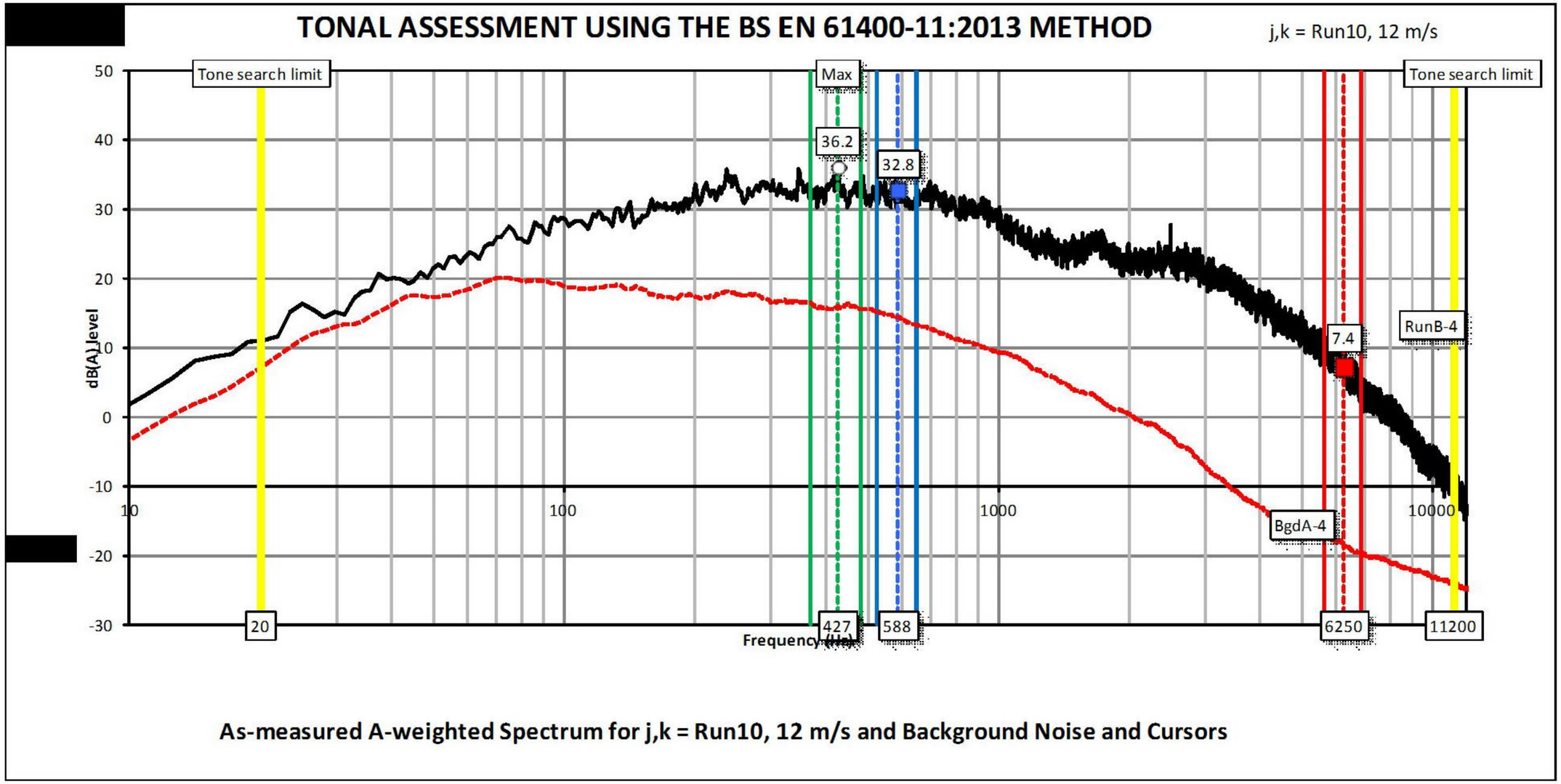


FIGURE 22a TONAL ASSESSMENT USING THE IEC 61400-11:2012 METHOD FOR THE 12 m/s HUB-HEIGHT WIND SPEED BIN

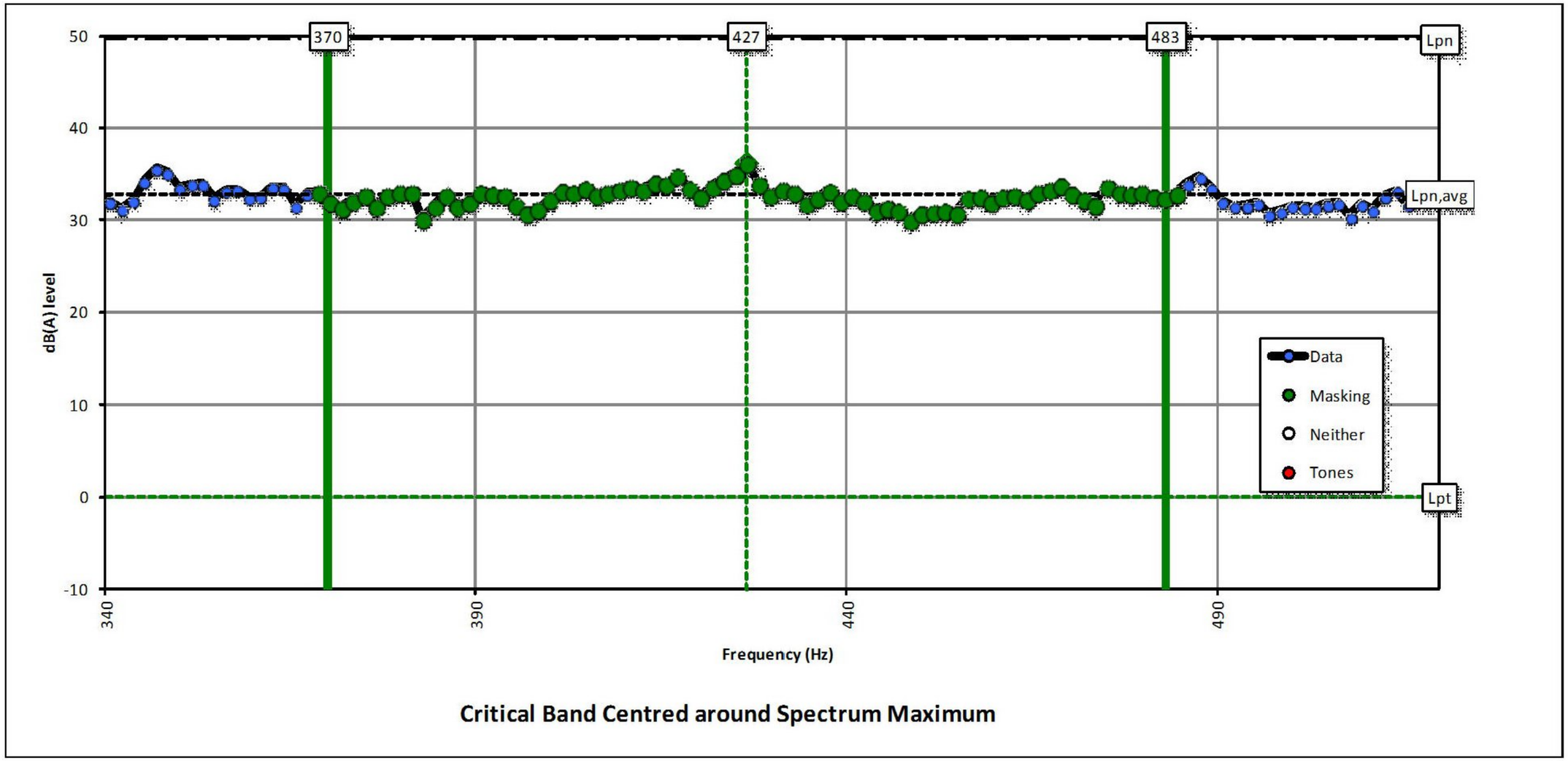


FIGURE 22b CRITICAL BAND WITH SPECTRUM MAXIMUM SHOWING TONES AND MASKING NOISE FOR 12 m/s WIND SPEED BIN. (Tonality -15 dB)

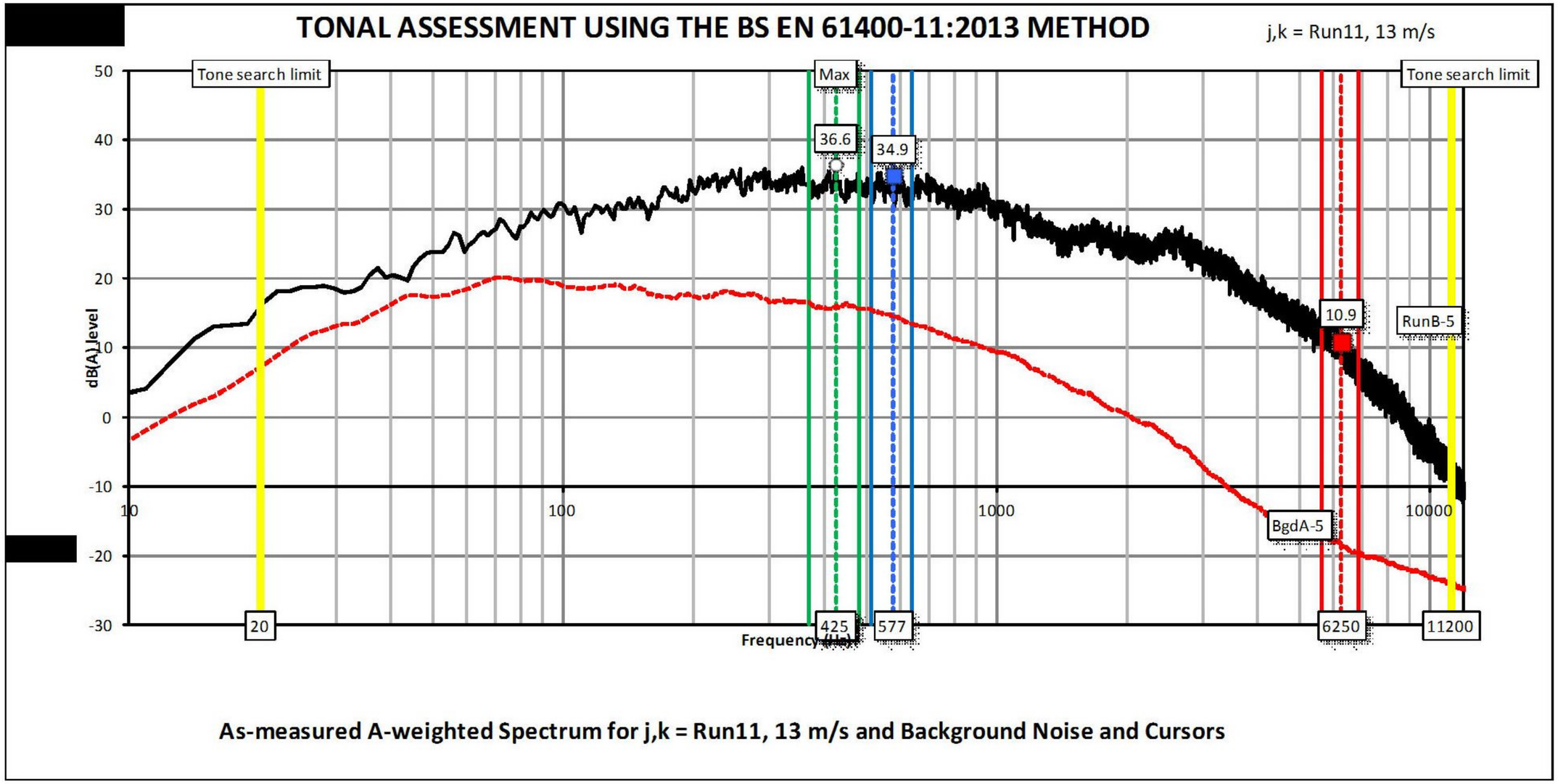


FIGURE 23a TONAL ASSESSMENT USING THE IEC 61400-11:2012 METHOD FOR THE 13 m/s HUB-HEIGHT WIND SPEED BIN

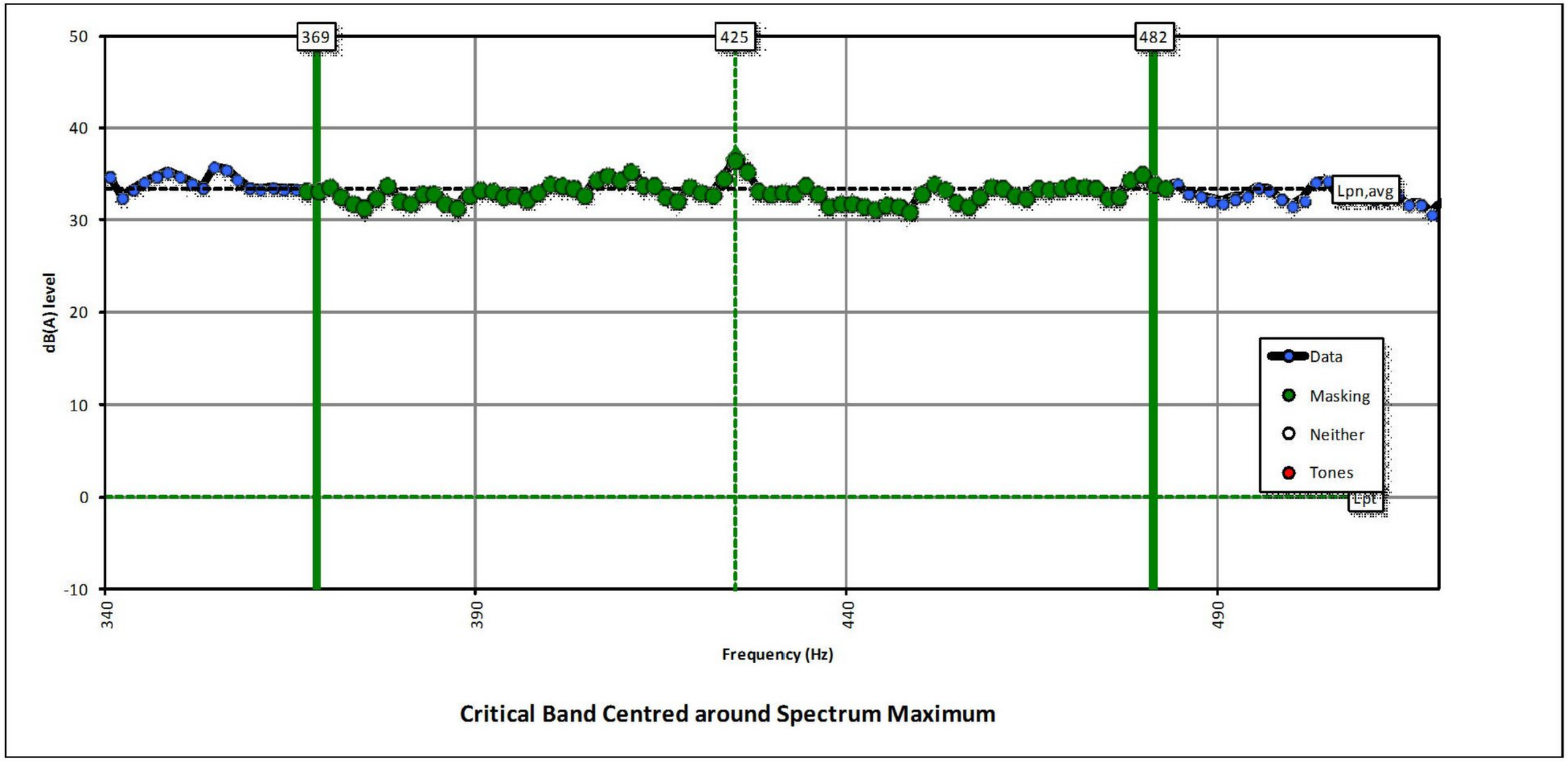


FIGURE 23b CRITICAL BAND WITH SPECTRUM MAXIMUM SHOWING TONES AND MASKING NOISE FOR 13 m/s WIND SPEED BIN. (Tonality -15 dB)

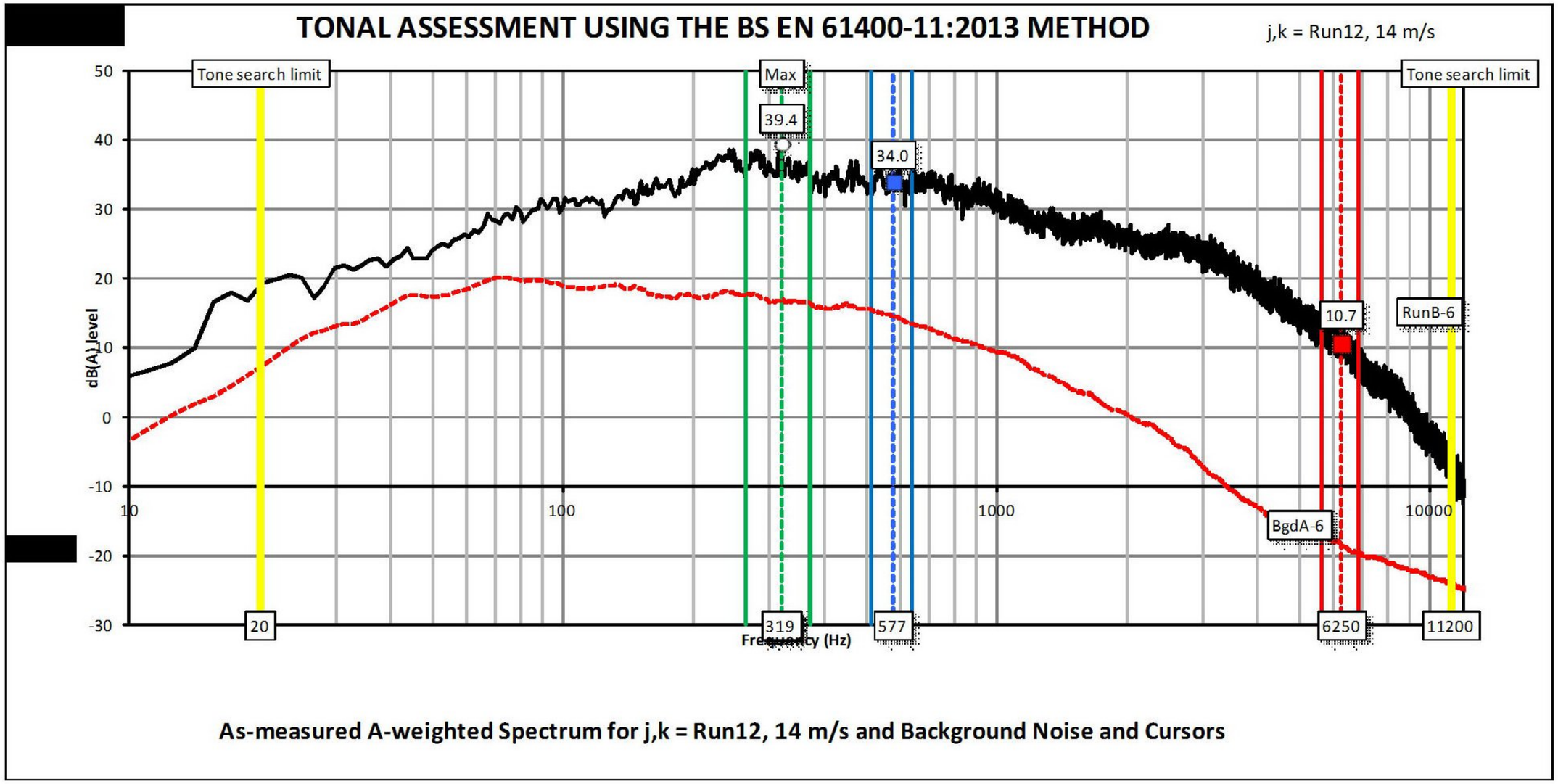


FIGURE 24a TONAL ASSESSMENT USING THE IEC 61400-11:2012 METHOD FOR THE 14 m/s HUB-HEIGHT WIND SPEED BIN

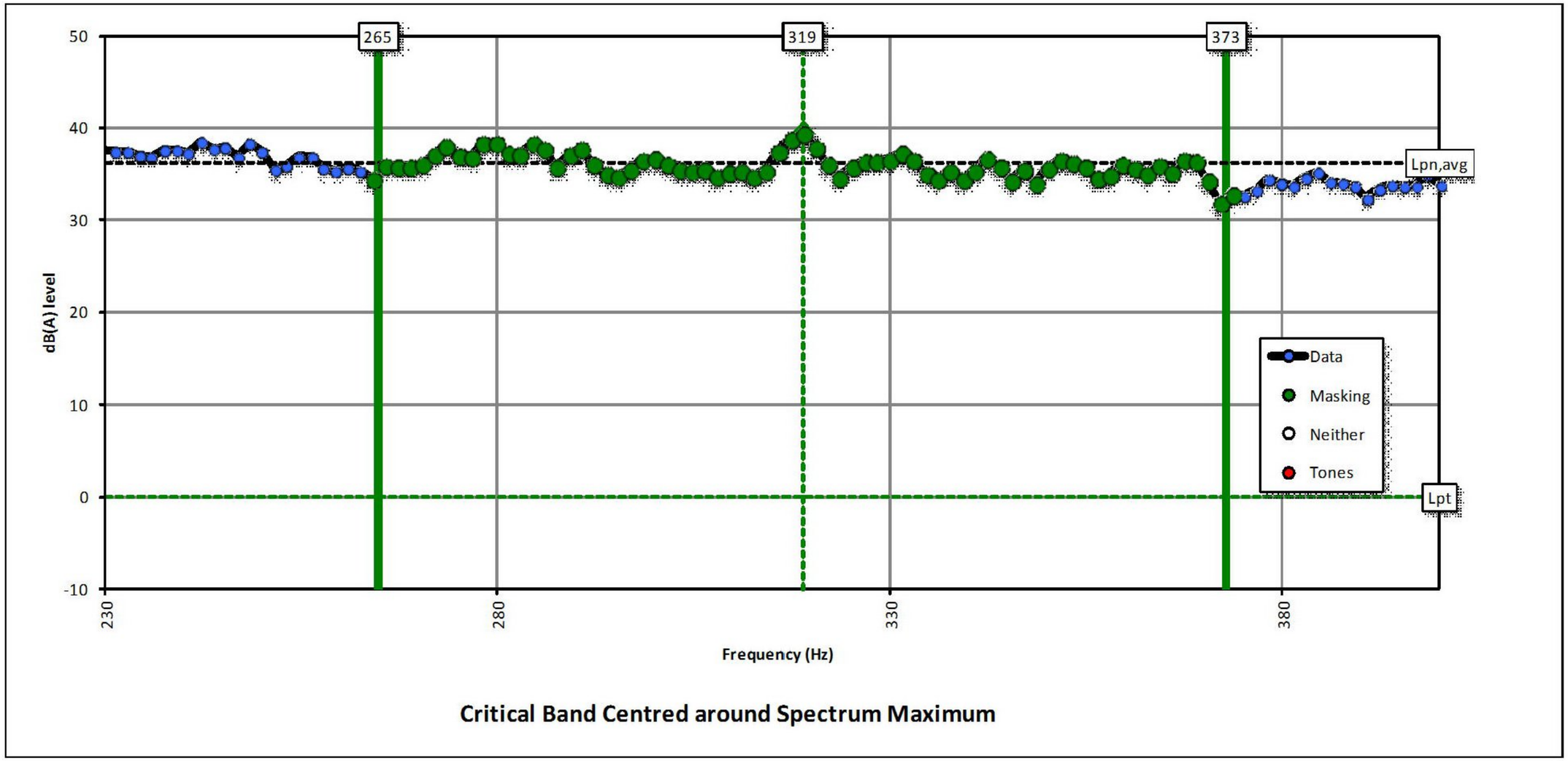


FIGURE 24b CRITICAL BAND WITH SPECTRUM MAXIMUM SHOWING TONES AND MASKING NOISE FOR 14 m/s WIND SPEED BIN. (Tonality -15 dB)

APPENDIX 1

CALIBRATION CERTIFICATES

Certificate of Calibration

Issued by University of Salford (Acoustics Calibration Laboratory)
UKAS ACCREDITED CALIBRATION LABORATORY NO. 0801

Page 1 of 3

APPROVED SIGNATORIES
Claire Lomax [x] Andy Moorhouse [ ]
Gary Phillips [ ] Danny McCaul [ ]

[redacted]

acoustic calibration laboratory
The University of Salford, Salford, Greater Manchester, M5 4WT, UK
http://www.acoustics.salford.ac.uk
t 0161 295 3030/0161 295 3319 f 0161 295 4456 e c.lomax1@salford.ac.uk

UKAS CALIBRATION 0801

University of Salford MANCHESTER

Certificate Number: 02399/2 Date of Issue: 13 May 2016

PERIODIC TEST OF A SOUND LEVEL METER to IEC 61672-3:2006

FOR:	TUV SUD Octagon House Concorde Way, Segensworth North, Fareham Hampshire
FOR THE ATTENTION OF:	Patrick Jones
PERIODIC TEST DATE:	16/03/2016
TEST PROCEDURE:	CTP12 (Laboratory Manual)

Sound Level Meter Details

Manufacturer	Bruel & Kjaer		
Model	2250		
Serial number	2653893		
Class	1		
Hardware version	3.0	Software version	BZ7222 Version 4.5.2

Associated Items	Microphone	Preamplifier	Calibrator
Manu	Bruel & Kjaer	Bruel & Kjaer	Bruel & Kjaer
Model	4189	ZC 0032	4231
Serial Number	2643613	18847	2651818
Calibrator Adaptor	-	-	UC0210

Test Engineer (initial): [redacted] Name: Gary Phillips

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to the units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full except with the prior written approval of the issuing laboratory.

Certificate of Calibration

Issued by University of Salford (Acoustics Calibration Laboratory)
UKAS ACCREDITED CALIBRATION LABORATORY NO. 0801

Certificate Number: 02399/2 Date of Issue: 13 May 2016

Procedures from IEC 61672-3: 2006 and TPS 49 Edition 2 June 2009 were used to perform the periodic tests.

The manufacturer's instruction manual was marked as follows: B&K 2250 BE 1712-15 April 2007 from hardware version 1.1.

Adjustment data used to adjust the sound levels indicated in response to the application of a multi-frequency sound calibrator to sound levels equivalent to those that would be indicated in response to plane, progressive sound waves were obtained from the manufacturer's instruction manual referred to in this certificate.

The sound level meter calibration check frequency is 1000 Hz, the reference sound pressure level is 94 dB. As this instrument only has a single range, this range is the reference level range.

The environmental conditions in the laboratory at the start of the test were:
Static pressure 102.899 kPa ± 0.015 kPa, air temperature 22.8 °C ± 0.3 °C, relative humidity 37.3 % ± 1.7%.

The initial response of the instrument to application of the associated sound calibrator was 93.9 dB (C). No adjustment of the instrument was required. This indication was obtained from the calibration certificate of the calibrator, 02399/1, and information in the manufacturer's instruction manual specified in this certificate, when the instrument is configured for use with the supplied microphone extension cable and the following instrument settings; Input: Top Socket, Transducer: 4189, Sound Field Correction: Free-field, Windscreen Auto Detect: Off, Windscreen Correction: None. The instrument was calibrated without a windshield. Consult manufacturer's instructions if using a windshield.

With the microphone replaced by the electrical input device specified in the manufacturer's instruction manual, the levels of self-generated noise were:

A:	**12.9 dB***
B:	**11.9 dB***
C:	**13.0 dB***
$Z_{LF\text{-}Normal}$:	**18.1 dB***
$Z_{LF\text{-}Extended}$:	**23.0 dB***

* Under-range indicated on instrument display.

The environmental conditions in the laboratory at the end of the test were:
Static pressure 102.888 kPa ± 0.015 kPa, air temperature 23.3 °C ± 0.3 °C, relative humidity 38.9 % ± 1.7%.

Certificate of Calibration

Issued by University of Salford (Acoustics Calibration Laboratory)
UKAS ACCREDITED CALIBRATION LABORATORY NO. 0801

Page 3 of 3

Certificate Number: 02399/2 Date of Issue: 13 May 2016

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent testing organization responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2:2003, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002, the sound level meter submitted for testing conforms to the class 1 requirements of IEC 61672-1:2002.

The microphone corrections applied as specified in 12.6 of IEC 61672-3:2006 were obtained from a frequency response measured by this Laboratory using the electrostatic actuator method. This response in isolation is not covered by our UKAS accreditation.

Instruments used in the verification procedure were traceable to *National Standards*. The multi-frequency calibrator method was employed in the acoustical tests of a frequency weighting.

The uncertainty evaluation has been carried out in accordance with UKAS requirements. All measurement results are retained at the acoustic calibration laboratory for at least four years.

Certificate of Calibration

Issued by University of Salford (Acoustics Calibration Laboratory)
UKAS ACCREDITED CALIBRATION LABORATORY NO. 0801

Page 1 of 2

APPROVED SIGNATORIES
Claire Lomax [ ] Andy Moorhouse [ ]
Gary Phillips [x] Danny McCaul [ ]

[redacted]

acoustic calibration laboratory
The University of Salford, Salford, Greater Manchester, M5 4WT, UK
http://www.acoustics.salford.ac.uk
t 0161 295 3030/0161 295 3319 f 0161 295 4456 e c.lomax1@salford.ac.uk

UKAS CALIBRATION 0801

University of Salford MANCHESTER

Certificate Number: 02399/3 Date of Issue: 13 May 2016

VERIFICATION OF A SOUND LEVEL METER / ANALYSER 1/3 OCTAVE FILTER SET MANUFACTURED TO BS EN 61260: 1996
RELATIVE ATTENUATION

FOR: TUV SUD
Octagon House
Concorde Way, Segensworth North,
Fareham
Hampshire

FOR ATTENTION OF: Patrick Jones

DESCRIPTION: Sound level meter with 1/3 octave filter set manufactured to BS EN 61260: 1996 running software BZ 7223 Version 4.5.2.

DATE OF CALIBRATION: 14th and 15th March 2016

TEST PROCEDURE: CTP19 (Laboratory Manual)

Sound Level Meter/Analyser details					
Manu:	Bruel & Kjaer	Model:	2250	Serial No:	2653893
Filter details					
Filter Base: 10			**Filter Class: 0**		

Test Engineer (initial): [redacted] Name: Claire Lomax

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to the units of measurement realized at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full except with the prior written approval of the issuing laboratory.

Certificate of Calibration

Issued by University of Salford (Acoustics Calibration Laboratory)
UKAS ACCREDITED CALIBRATION LABORATORY NO. 0801

Page 2 of 2

Certificate Number: 02399/3 Date of Issue: 13 May 2016

INSTRUMENT SET UP

The instrument was adjusted to read 93.9 dB (C) in response to the associated calibrator. This reading was obtained from the calibration certificate of the calibrator, and information in the manufacturer's instruction manual when the instrument is configured as follow: Input: Top Socket, Transd. Used: unknown, Sound Field Correction: Free-field, Windscreen Auto Detect: Off, Windscreen Correction: None. The instrument was calibrated without a windshield. Consult manufacturer's instructions if using a windshield. The instrument was set to measure SPL on the Z-weighting in each of the tested frequency bands. Exact base 10 frequencies have been applied in all of the tests.

All tests were performed on the reference level range. The test signals were applied to the instrument via the ZC 0032 preamplifier, serial number 18847, and an appropriate input adaptor.

RELATIVE ATTENUATION TESTS

The Relative Attenuation of the combination of filter set and sound level meter /analyser was tested over the following frequency ranges:-
1/3 octave filter bands from 20 Hz to 20 kHz.

The tests have been carried out using the method stated in BS EN 61260: 1996 by applying input signals at a level 1 dB below the upper limit of the linear operating range.

RELATIVE ATTENUATION TEST RESULTS

Class 0 tolerances: Table1 of BS EN 61260:1996 **Result: Pass**

Uncertainty of measurement within filter pass-band: 0.20 dB coverage factor k=2
Uncertainty of measurement outside filter pass-band: 0.21 dB coverage factor k=2

NOTE:
These results apply only to the tested filter bands and do not imply that any untested filter bands would also pass the reported test.
The results are only valid for the combination of filter set and sound level meter / analyser tested.

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k, providing a coverage probability of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

All measurement results are retained at the acoustic calibration laboratory for at least four years.

Certificate of Calibration

Issued by University of Salford (Acoustics Calibration Laboratory)
UKAS ACCREDITED CALIBRATION LABORATORY NO. 0801

Page 1 of 2

APPROVED SIGNATORIES
Claire Lomax [✓] Andy Moorhouse [ ] [redacted]
Gary Phillips [ ] Danny McCaul [ ]

acoustic calibration laboratory
The University of Salford, Salford, Greater Manchester, M5 4WT, UK
http://www.acoustics.salford.ac.uk
t 0161 295 3030/0161 295 3319 f 0161 295 4456 e c.lomax1@salford.ac.uk

UKAS CALIBRATION 0801

University of Salford MANCHESTER

Certificate Number: 02399/1 Date of Issue: 21 October 2015

CALIBRATION OF A SOUND CALIBRATOR

FOR:	TUV SUD Octagon House Concorde Way, Segensworth North, Fareham Hampshire
FOR THE ATTENTION OF:	Mark McCourt
DESCRIPTION:	Calibrator with housing for one-inch microphones and adaptor type UC 0210 for half-inch microphones.
MANUFACTURER:	Bruel & Kjaer
TYPE:	4231
SERIAL NUMBER:	2651818
DATE OF CALIBRATION:	19/10/2015
TEST PROCEDURE:	CTP06 (Laboratory Manual)

Test Engineer (initial): [redacted] Name: Gary Phillips

Calibrations marked 'Not UKAS Accredited' in this certificate have been included for completeness.

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to the units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full except with the prior written approval of the issuing laboratory.

Certificate of Calibration

Issued by University of Salford (Acoustics Calibration Laboratory)
UKAS ACCREDITED CALIBRATION LABORATORY NO. 0801

Page 2 of 2

Certificate Number: 02399/1 Date of Issue: 21 October 2015

MEASUREMENTS

The sound pressure level generated by the calibrator was measured using a calibrated, WS2P condenser microphone as specified in the certificate. The calibration was carried out with the calibrator in the half-inch configuration.

Five determinations of the sound pressure level, frequency and total distortion were made.

The results have been corrected to the reference pressure of 101.325 kPa using manufacturer's data.

RESULTS

Coupler configuration:	Half-inch
Microphone type:	GRAS 40AG
Output level (dB re 20μPa):	94.02 dB ± 0.10 dB
Frequency (Hz):	999.98 Hz ± 0.12 Hz
Total Harmonic Distortion (%):	0.36 % ± 0.15 % (Not UKAS Accredited)

Average environmental conditions at the time of measurement and maximum deviation from the stated average:

Pressure:	102.154 kPa ± 0.003 kPa
Temperature:	22.8 °C ± 0.2 °C
Relative humidity:	46.2 % ± 0.7 %

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

All measurement results are retained at the acoustic calibration laboratory for at least four years.

Data Physics Corporation

Certificate of Calibration
for System No. 21717 SignalCalc Quattro – 4C1S
Date: November 19th, 2012

Customer:

Data Physics UK / NEL (TUV SUD Ltd)
South Road, Hailsham
East Sussex BN27 3JJ
United Kingdom

Data Physics Corporation certifies that System No. 21717 of the following hardware components:

Model:	Serial No:
DP240D	D48-023
DP240A	A66-023

Has been calibrated complying with MIL-STD-45662A/ANSI/NCSL Z 540-1-1994. The calibration instrument was a Hewlett Packard digital multimeter model 34401A, Serial No.US36062207 with Testwave LLC calibration certificate No. 12N0319.

The recommended calibration interval is 6 months. Based on this interval, the calibration due date is May 19th, 2013.

Calibrated by: [redacted]

Certified by: [redacted]

1741 Technology Drive • Suite 260 • San Jose, CA 95110
TEL: 408.437.0100 • FAX: 408.437.0509 • www.dataphysics.com

Data Physics (UK) Ltd
South Road, Hailsham, East Sussex, BN27 3JJ
www.dataphysics.com sales@dataphysics.com
TEL: 01323 846464 FAX: 01323 847550

TUV SUD NEL Ltd
James Young Building
East Kilbride
Glasgow
G75 0QF

01 February 2016

Data Physics (UK) Ltd. certifies that the system number 21717 consisting of the following hardware components:

Location	Model	Serial Number	Inputs	Outputs
1	DP240	12A66023	4	1

Has been verified to be in current calibration and then re-calibrated complying with MIL-STD-45662A/ANSI/NCSL Z 540-1-1994. The calibration instrument was an Agilent DVM model 34401A serial number MY45018142 with UKAS calibration certificate number 28450 dated 19th May 2015.

Date of calibration 1 February 2016

The recommended calibration interval is 12 months

Calibrated by _____G Murphy

< 0.1 m/s 6 → 12 m/s
Drift < 0.05 m/s
UNC = 0.05 m/s

Deutsche WindGuard
Wind Tunnel Services GmbH, Varel

DEUTSCHE WINDGUARD

accredited by the / *akkreditiert durch die*

Deutsche Akkreditierungsstelle GmbH

ilac-MRA DAkkS Deutsche Akkreditierungsstelle D-K-15140-01-00

as calibration laboratory in the / *als Kalibrierlaboratorium im*

Deutschen Kalibrierdienst DKD

1612813
D-K-15140-01-00
06/2016

Calibration certificate
Kalibrierschein

Acceptable

Calibration mark
Kalibrierzeichen

Object *Gegenstand*	Cup Anemometer
Manufacturer *Hersteller*	Windspeed LTD Denbighshire LL18 2AB
Type *Typ*	A100R
Serial number *Fabrikat/Serien-Nr.*	11778 E88F
Customer *Auftraggeber*	TUV NEL Ltd UK Glasgow G75 0QU
Order No. *Auftragsnummer*	2600001270
Project No. *Projektnummer*	VT160556
Number of pages *Anzahl der Seiten*	4
Date of Calibration *Datum der Kalibrierung*	02.06.2016

This calibration certificate documents the traceability to national standards, which realize the units of measurement according to the International System of Units (SI).
The DAkkS is signatory to the multilateral agreements of the European co-operation for Accreditation (EA) and of the International Laboratory Accreditation Cooperation (ILAC) for the mutual recognition of calibration certificates. The user is obliged to have the object recalibrated at appropriate intervals.
Dieser Kalibrierschein dokumentiert die Rückführung auf nationale Normale zur Darstellung der Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI).
Die DAkkS ist Unterzeichner der multilateralen Übereinkommen der European co-operation for Accreditation (EA) und der International Laboratory Accreditation Cooperation (ILAC) zur gegenseitigen Anerkennung der Kalibrierscheine. Für die Einhaltung einer angemessenen Frist zur Wiederholung der Kalibrierung ist der Benutzer verantwortlich.

This calibration certificate may not be reproduced other than in full except with the permission of both the German Accreditation Body and the issuing laboratory. Calibration certificates without signature are not valid. This calibration certificate has been generated electronically.
Dieser Kalibrierschein darf nur vollständig und unverändert weiterverbreitet werden. Auszüge oder Änderungen bedürfen der Genehmigung sowohl der Deutschen Akkreditierungsstelle als auch des ausstellenden Kalibrierlaboratoriums. Kalibrierscheine ohne Unterschrift haben keine Gültigkeit. Dieser Kalibrierschein wurde elektronisch erzeugt.

Date *Datum*	Head of the calibration laboratory *Leiter des Kalibrierlaboratoriums*	Person in charge *Bearbeiter*
02.06.2016	[redacted]	
	Dipl. Phys. Dieter Westermann	Techniker Dirk Henninges

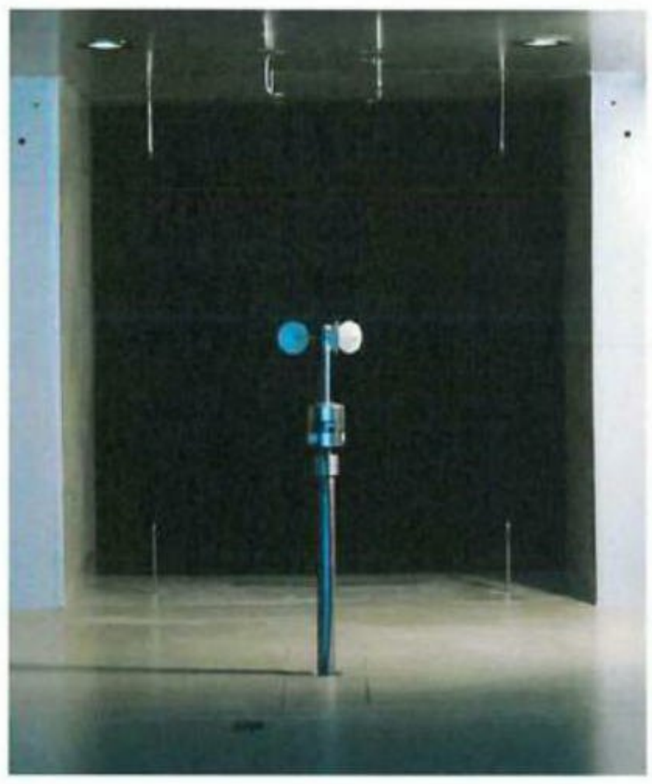
2 Instrumentation

Pos.	Sensor	Manufa.	Identification	Year
1	Pitot static tube	Airflow	483/8 Nr. 000142	02
2	Pitot static tube	Airflow	483/8 Nr. 000143	02
3	Pitot static tube	Airflow	483/8 Nr. 000144	02
4	Pitot static tube	Airflow	483/8 Nr. 000145	02
5	Pressure transducer	Setra	C 239 Nr. 1688081	02
6	Pressure transducer	Setra	C 239 Nr. 1688082	02
7	Pressure transducer	Setra	C 239 Nr. 1688083	02
8	Pressure transducer	Setra	C 239 Nr. 1688084	02
9	El. Barometer	Vaisala	100 A Nr. X2010004	02
10	El. Thermometer	Galltec	KPK 1/6-ME	02
11	El. Humidity sensor	Galltec	KPK 1/6-ME	02
12	Wind tunnel control	-	-	-
13	CAN-BUS / PC	esd	-	04
14	Anemometer		-	
15	Universal Isolator	Knick	P2700 - 98430	05

Table 1 Description of the data acquisition system

Remark: Last Re-accreditation see page 2

3 Photo of the calibration set-up



Calibration set-up of the anemometer calibration in the wind tunnel of Deutsche WindGuard, Varel. The anemometer shown is of the same type as the calibrated one.

Remark: The proportion of the set-up are not true to scale due to imaging geometry.

4 Deviation to MEASNET procedure

The calibration procedure is in all aspects in accordance with the IEC 61400-12-1 Procedure

5 References

[1] D. Westermann, 2009 - Verfahrensanweisung DKD-Kalibrierung von Windgeschwindigkeitssensoren
[2] IEC 61400-12-1 12/2005 - Wind Turbine Power Performance Testing
[3] ISO 3966 1977 - Measurement of fluid flow in closed conduits
[4] MEASNET 09 1997 - Cup Anemometer Calibration Procedure

Deutsche WindGuard Wind Tunnel Services GmbH
Oldenburger Str. 65
26316 Varel ; Tel. ++49 (0)4451 9515 0

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D-K-15140-01-00
06/2016

Calibration result
Kalibrierergebnis

Sensor out	Tunnel speed	Uncertainty (k=2)
Hz	m/s	m/s
3.055	4.009	0.050
4.545	5.945	0.051
6.164	7.975	0.051
7.764	10.014	0.052
9.355	12.038	0.052
10.893	13.980	0.054
12.464	15.984	0.053
11.673	14.962	0.053
10.115	13.032	0.052
8.540	11.006	0.051
6.940	8.968	0.051
5.388	7.015	0.051
3.777	4.970	0.050

File: 1612813

Statistical analysis	Slope	1.26951 (m/s)/(Hz) ±0.00156 (m/s)/(Hz)
	Offset	0.1608 m/s ±0.013 m/s
	Standard error (Y)	0.013 m/s
	Correlation coefficient	0.999992
Remarks	The calibrated sensor complies with the demanded linearity of MEASNET	

Deutsche WindGuard Wind Tunnel Services GmbH - measnet

Deutsche WindGuard
Wind Tunnel Services GmbH, Varel

DEUTSCHE WINDGUARD

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Graphical representation of the result
Grafische Darstellung des Ergebnisses

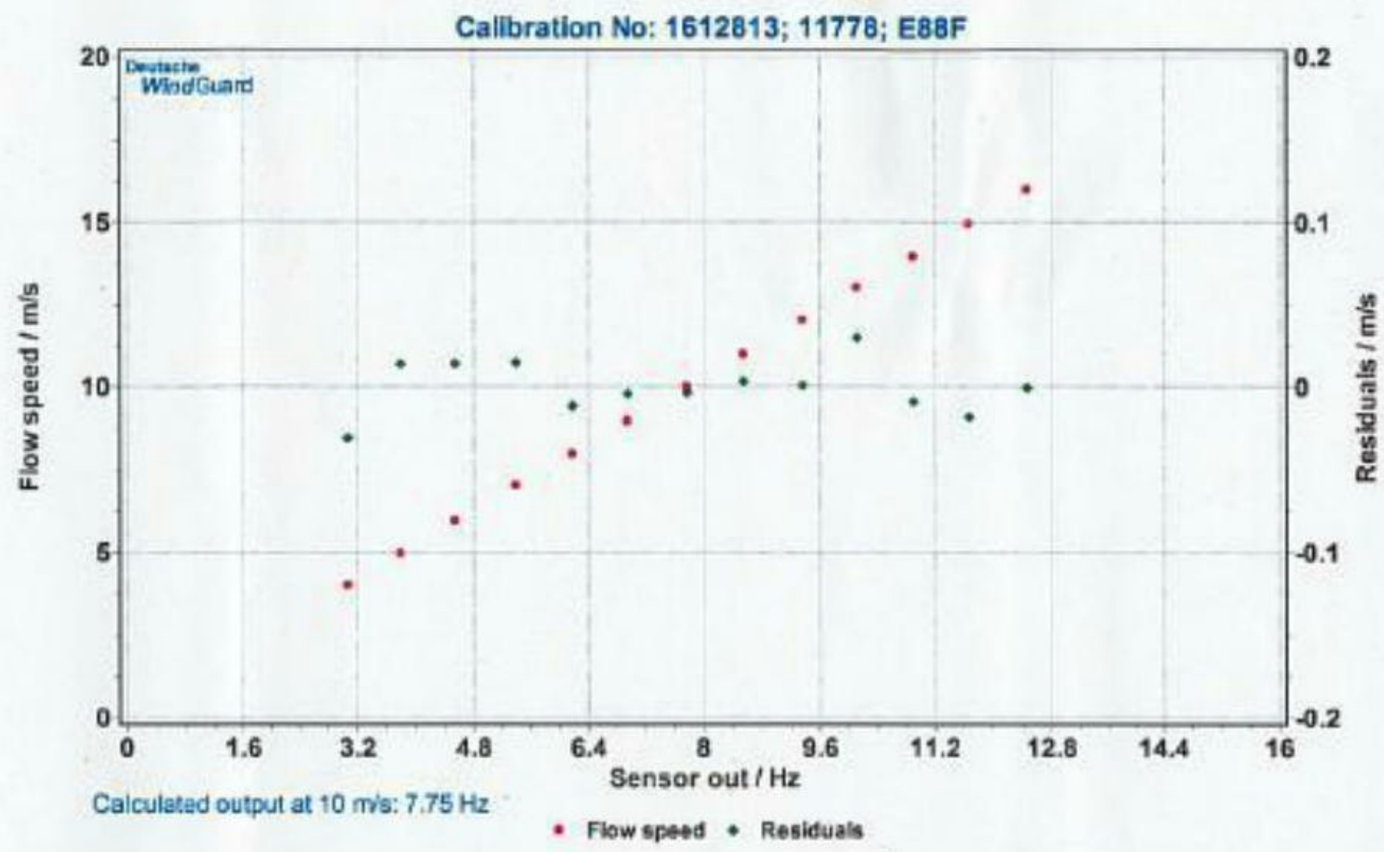
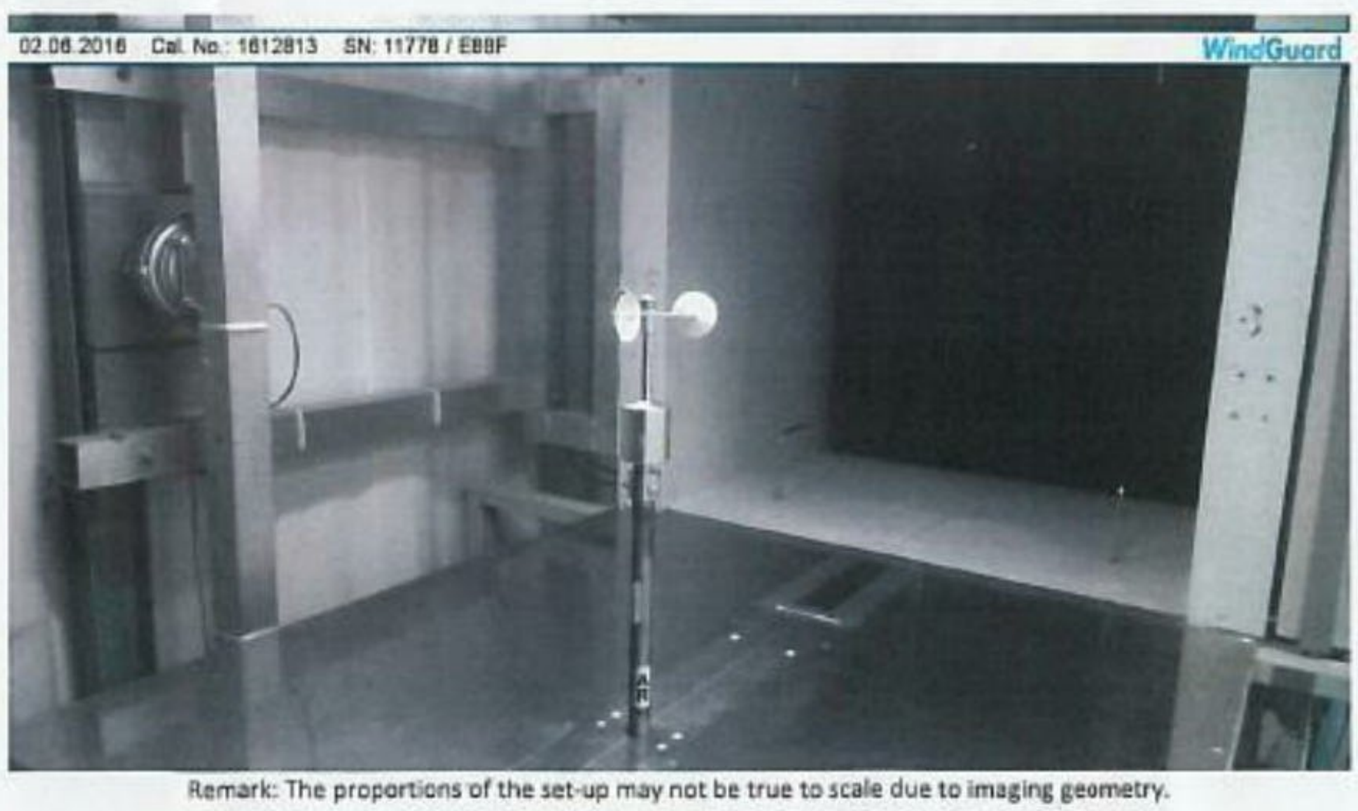


Photo of the measurement setup
Foto des Messaufbaus



Remark: The proportions of the set-up may not be true to scale due to imaging geometry.

Deutsche WindGuard
Wind Tunnel Services GmbH, Varel

DEUTSCHE WINDGUARD

CERTIFICATE OF CALIBRATION

ISSUED BY **ANTECH**

DATE OF ISSUE 03 June 2016 CERTIFICATE NUMBER: U80137-16

UKAS CALIBRATION 0439

Antech Calibration Services
Hewett Road
Gapton Hall Industrial Estate
Great Yarmouth
Norfolk NR31 0NN
Telephone: +44 (0) 1493 440600 Facsimile: +44 (0) 1493 440606
e-mail: sales@antech.org.uk

APPROVED SIGNATORY [redacted]

CUSTOMER DETAILS **ANTECH REF: 12395.1-16-A**

Company	:	TUV SUD UK Ltd
Address	:	James Young Goods Receiving Store Scottish Technology Park East Kilbride G75 0QF
Order Number	:	2600001286

INSTRUMENT CALIBRATED

Manufacturer	:	Setra
Model	:	278
Serial No.	:	4288972
Date Inst. Received	:	02 June 2016
Date Calibrated	:	03 June 2016

LABORATORY CONDITIONS : 20 °C ± 1 °C

CALIBRATION PROCEDURE : 10206

The instrument to be calibrated is an absolute mode pressure transmitter. The instrument was not adjusted.

Approved Signatory : D. Highton ( ) S.J. Hagg ( )

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CERTIFICATE OF CALIBRATION

ANTECH

UKAS ACCREDITED CALIBRATION LABORATORY No. 0489

CERTIFICATE NUMBER
U89137-16

Page 1 of 2

Instrument Details

Calibrated Range	**900 mbar to 1100 mbar absolute mode**
Calibration Configuration	The instrument was calibrated in a horizontal position. The pressure reference was taken as the horizontal axis through the input pressure connection. The pressure medium was dry, filtered nitrogen.
Calibration Sequence	The instrument was energised in the laboratory for 30 minutes prior to commencing calibration with a 24 volt dc stabilized power supply. The instrument was cycled to its maximum range three times before commencing the calibration.
Measurement Results	Results recorded were read from a digital multimeter provided by Antech Calibration Services.

Acceptable
L D. Smith

[redacted]

CALIBRATION RESULTS

Applied Pressure mbar	Instrument Output V	Expected Output V	Error % FS	Measurement Uncertainty ± mbar	Measurement Uncertainty ± V
900.00	1.5025	1.5000	0.1002	0.101	0.00004
950.00	1.7527	1.7500	0.1072	0.101	0.00005
1000.00	2.0029	2.0000	0.1176	0.101	0.00005
1050.00	2.2534	2.2500	0.1364	0.101	0.00006
1100.00	2.5042	2.5000	0.1675	0.101	0.00006
1050.00	2.2534	2.2500	0.1365	0.101	0.00006
1000.00	2.0030	2.0000	0.1182	0.101	0.00005
950.00	1.7527	1.7500	0.1070	0.101	0.00005
900.00	1.5025	1.5000	0.0997	0.101	0.00004

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor $k = 2$, providing a level of confidence of approximately 95 %. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

END OF CERTIFICATE

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CERTIFICATE OF CALIBRATION

ISSUED BY ANTECH

DATE OF ISSUE 3 June 2016 CERTIFICATE NUMBER : U80150-16

UKAS CALIBRATION 0489

Antech Calibration Services
Hewett Road
Gapton Hall Industrial Estate
Great Yarmouth
Norfolk NR31 0NN
Telephone: +44 (0) 1493 440600 Facsimile: +44 (0) 1493 440606
e-mail: sales@antech.org.uk

APPROVED SIGNATORY [redacted]

CUSTOMER DETAILS **ANTECH REF: 12395-2.16/A**

Company	:	TUV SUD UK Ltd
Address	:	James Young Goods Receiving Store Scottish Technology Park East Kilbride G75 0QF
Order Number	:	2600001286

UNIT CALIBRATED

Manufacturer	:	Vaisala (Campbell Scientific)
Model	:	HMP45 AC Temperature and Humidity probe.
Serial No.	:	E3350007
Plant No.	:	- -
Date Inst. Received	:	2 June 2016
Date Calibrated	:	3 June 2016

AMBIENT TEMPERATURE : 20°C ± 5°C

CALIBRATION PROCEDURE : PROC30800

Approved Signatory : J.L.Gunn ( ) A Oxborough (✓)

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CERTIFICATE OF CALIBRATION

ANTECH

UKAS ACCREDITED CALIBRATION LABORATORY No. 0489

CERTIFICATE NUMBER
U80150-16

Calibration details:

The UUT was calibrated by inter-comparison with working standard PRT's in an environmental test chamber.

At each generated condition a time of not less than 90 minutes was allowed for temperature to equilibrate. A set of 10 readings recorded at 1-minute intervals was then taken from the instrument under test, and the value recorded as the average of these 10 measurements.

During the calibration all instruments were maintained at laboratory conditions of 20 °C ± 5 °C, <70% rh.

The transmitter range is -39.2°C to +60 °C / 0.008 to 1 Vdc output.

The transmitter supply voltage was 12 volts dc.

The transmitter analogue output was measured using a six and a half digit multimeter.

No adjustment was made to the instrument.

The uncertainties of measurement quoted are true at the time of calibration and are not indicative of the UUT to maintain its calibration with time.

TEMPERATURE MEASUREMENT RESULTS

Standard Mean Temperature °C	UUT Output Vdc	Equivalent Temperature °C
-10.03	0.3016	-9.84
20.00	0.5996	19.96
40.07	0.7988	39.88

Acceptable ±0.9°C [redacted]

Uncertainty of measurement ± 0.30°C

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

END OF CERTIFICATE

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APPENDIX 2

DESCRIPTION OF TYBE 'B' UNCERTAINTIES

Type B uncertainties

For these measurements all the type B measurement uncertainty components as specified in IEC 61400-11:2012 are given in Table 6. For all of the Type B uncertainties mentioned here, a rectangular distribution of possible values is assumed for simplicity with a range described as "±a". The standard deviation for such a distribution is:

$$U = \frac{a}{\sqrt{3}}$$

Table 6 - Type B measurement uncertainty components

Parameter	Value
Calibration, U_{cal}	0.2 dB
Instrument, U_{BI}	0.1 dB
Ground Board, U_{BG}	0.3 dB
Wind screen insertion loss, U_{BW}	N/A – primary screen with no secondary windscreen
Distance and direction of microphone, U_{BD}	0.1 dB
Air absorption (impedence), U_{BA}	0.2 dB
Weather, U_{BW}	0.5 dB
Wind speed (measured), U_{BS}	0.2 m/s
Wind speed (derived), U_{BS}	N/A for small wind turbines tested according to testing option as per Annex F of IEC 61400-11:2012 standard
Wind speed from power curve, U_{BS}	N/A for small wind turbines tested according to testing option as per Annex F of IEC 61400-11:2012 standard

Before calculating the sound power level uncertainty the average wind speed and uncertainty per bin needs to be considered. Specifications are given in IEC 61400-11:2012
The values per bin shall be averaged arithmetically as:

$$\overline{V}_k = \frac{1}{N} \cdot \sum_{j=1}^{N} V_{j,k}$$

where

N is the number of measurements in wind speed bin k;
V_{jk} is the average value of wind speed at measurement period j in wind speed bin k.

The Type A uncertainty of the average wind speed per bin k is calculated as:

$$s_{V_k} = \sqrt{\frac{\sum_{j=1}^{N} \left(V_{jk} - \overline{V}_k\right)^2}{N \cdot (N-1)}}$$

where

V_{jk} is the average value of wind speed at measurement period j;
$\overline{V}_k$ is the average wind speed in wind speed k.

The Type B uncertainty on the wind speed for each measurement period j, u_{Bj} is calculated as:

$$u_{Bj} = \sqrt{\sum_{q=1}^{8} u_{Bj,q}^2}$$

where

$u_{Bj,q}$ is the Type B uncertainty from source q on the average wind speed for each measurement j

Information about the sources are given in Table 6.

The Type B uncertainty on average wind speed in bin k, u_{Bk} is calculated as:

$$u_{Bk} = \sqrt{\frac{1}{N} \cdot \sum_{j=1}^{N} u_{Bj}^2}$$

The combined uncertainty $u_{comb,Bk}$ can be expressed as:

$$u_{comb,Bk} = \sqrt{s^2_{Bk} + u^2_{Bk}}$$

Uncertainty of average sound spectra

For each 1/3-octave band i the average sound pressure level is averaged energetically as:

$$\overline{L}_{i,k} = 10 \cdot \log\left[\frac{1}{N} \cdot \sum_{j=1}^{N} 10^{\left(\frac{L_{ij,k}}{10}\right)}\right]$$

where

N is the number of measurements in wind speed bin k;
$L_{ij,k}$ is the und pressure level of 1/3-octave band I measurement period j, in wind speed bin k.

The Type A standard uncertainty of the average wind speed per bin k is calculated as:

$$s_{L_{i,k}} = \sqrt{\frac{\sum_{j=1}^{N} \left(L_{ij,k} - \overline{L}_{i,k}\right)^2}{N \cdot (N-1)}}$$

Where

$\overline{L}_{i,k}$ is the average sound pressure spectrum in wind speed bin k

The Type B uncertainty on the energy averaged sound pressure level of 1/3-octave band i, for each measurement period j is calculated as:

$$u_{Lij} = \sqrt{\sum_{q=1}^{7} u_{Lij,q}^2}$$

where

$u_{Lij,q}$ is the Type B uncertainty from source q on the average sound pressure level of 1/3-octave band for each measurement period j.

The Type B uncertainty on the average sound pressure level of 1/3-octave band I in wind speed bin k is calculated as:

$$u_{Li,k} = \sqrt{\left[\frac{1}{N} \cdot \sum_{j=1}^{N} u^2_{Lij,k}\right]} = u_{Lij,k}$$

The combined uncertainty can be expressed as:

$$u_{comb,Li,k} = \sqrt{s^2_{Li,k} + u^2_{Li,k}}$$

Uncertainty of noise levels at bin centres

The sound pressure level for both total noise and background noise at bin centre has to be calculated. This has to be done at each 1/3- octave band i and at every bin centre of wind speeds. Using linear interpolation the estimated sound pressure level at wind speed v is given as:

$$L_i(t) = (1-t) \cdot \overline{L}_k + t \cdot \overline{L}_{k+1}$$

where

$\overline{v}_k \le v < \overline{v}_{k+1}$

The t value at a certain wind speed v is given as:

$$t = \frac{(v - \overline{v}_k)}{(\overline{v}_{k+1} - \overline{v}_k)}$$

To fulfil an entire statistical evaluation according to IEC 61400-11:2012 a corresponding covariance is calculated as:

$$cov_{Li,i,k} = \frac{1}{N-1} \cdot \sum_{j=1}^{N} (v_{j,k} - \overline{v}_k) \cdot (L_{ij,k} - \overline{L}_{i,k})$$

The corresponding covariance is used to calculate the uncertainty on the sound pressure level at bin centre wind speed v using:

$$U_{C,L_F}(t) = \sqrt{U_L^2(t) - \frac{\mathrm{cov}_{LF}^2(t)}{U_v^2(t)}}$$

where

$$U_L^2(t) = (1-t)^2 \cdot U_{C,L,k}^2 + t^2 \cdot U_{C,L,k+1}^2$$

$$\mathrm{cov}_{LF}(t) = (1-t)^2 \cdot \frac{\mathrm{cov}_{LF,k}}{N_k} + t^2 \cdot \frac{\mathrm{cov}_{LF,k+1}}{N_{k+1}}$$

$$U_v^2(t) = (1-t)^2 \cdot U_{C,v,k}^2 + t^2 \cdot U_{C,v,k+1}^2$$

and

N_k is the number of measurements in wind speed bin k

APPENDIX 3

TONALITY AUDIBILITY SUMMARY FOR EACH INTEGER WIND SPEED BIN

BS EN 61400-11:2013 - Tonal Audibility Calculation Summary - For Windspeed Bins 3.0 through 8.0 m/s

Speed, k (m/s)	Running, 3 m/s to 8 m/s bins							
Spectrum, j	CB Centre	Lpn,avg	Lpt	Lpn	ΔLtn	ΔL_a	Report?	ΔL_a Energy
1__3 m/s	98.4	23.3	35.0	39.6	-4.6	-2.6	YES	0.55
2__4 m/s	100.0	24.3	35.6	40.7	-5.1	-3.0	NO	0.50
3__5 m/s	100.0	23.3	None	39.6	-16.3	-14.2	NO	
4__6 m/s	121.9	23.0	None	39.4	-16.4	-14.3	NO	
5__7 m/s	121.9	27.2	None	43.6	-16.4	-14.3	NO	
6__8 m/s	100.0	25.1	None	41.5	-16.3	-14.2	NO	
7__3 m/s	193.8	21.7	31.7	38.2	-6.5	-4.4	NO	0.36
8__etc	196.9	22.9	30.5	39.3	-8.9	-6.8	NO	0.21
9__	210.9	24.0	None	40.5	-16.5	-14.3	NO	
10__	210.9	24.5	30.7	41.0	-10.3	-8.1	NO	0.15
11__	209.4	29.0	None	45.5	-16.5	-14.3	NO	
12__8 m/s	209.4	28.4	None	44.8	-16.5	-14.3	NO	
13	390.6	16.9	None	33.7	-16.8	-14.4	NO	
14	393.8	17.9	None	34.6	-16.8	-14.4	NO	
15	393.8	22.1	None	38.9	-16.8	-14.4	NO	
16	415.6	24.8	None	41.7	-16.8	-14.5	NO	
17	418.8	29.0	None	45.9	-16.8	-14.5	NO	
18	418.8	29.8	None	46.6	-16.8	-14.5	NO	
19	590.6	16.9	33.3	34.1	-0.8	1.6	AUD	1.4
20	592.2	17.7	35.3	35.0	0.3	2.7	AUD	1.9
21	592.2	22.5	37.8	39.7	-1.9	0.5	AUD	1.1
22	590.6	25.4	40.2	42.7	-2.5	-0.1	YES	1.0
23	590.6	29.2	39.9	46.5	-6.5	-4.1	NO	0.39
24	590.6	29.2	40.2	46.4	-6.2	-3.8	NO	0.42
25	6250	-21.8	1.9	5.4	-3.4	1.3	AUD	1.3
26	6250	-20.8	4.0	6.4	-2.4	2.3	AUD	1.7
27	6250	-7.5	1.9	19.7	-17.7	-12.9	NO	0.05
28	6250	0.8	None	28.0	-27.2	-22.3	NO	
29	6250	4.0	None	31.2	-27.2	-22.3	NO	
30	6250	3.9	None	31.1	-27.2	-22.3	NO	
Mode & Average	6250	21.7		4000	Avg. $\Delta L_{a,k}$	-1.0		

Speed, k (m/s)							
Spectrum, j	CB Centre	Lpn,avg	Lpt	Lpn	ΔLtn	ΔL_a	Report?
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							

BS EN 61400-11:2013 Tonal Audibility Summary - General method

Wind speed bin, k (m/s)	Condition	Spectra examined	No of Spectra with Identified Tones: Identified	Percentage	AUDible	Background proximity ?	Average $\Delta L_{a,k}$	Report Tonal Audibility as	
3 - 8	Running	30	14	47%	5		-1.0	$\Delta L_{a,k}$ (dB)	-1.0
	Background	0						Centre (Hz)	6250
								CBW (Hz)	1227
								Background ?	

Annex F - Small Wind Turbines (12 spectra per bin)			
Tonality ΔL_k	-9.8	Report Tonal Audibility	
Audibility $\Delta L_{a,k}$	-7.8	$\Delta L_{a,k}$ (dB)	No relevant Tones
		Centre (Hz)	6250
		CBW (Hz)	101

Comment on Method used

Runnning: Auto tone search carried out on all spectra.

Parked: Tonality calculation on all parked spectra based on CB set at mode tone frequency whilst running

Note: although background noise levels may be well below dB(A) totals, background might still be high enough to affect the Masking noise levels in a given Critical Band. The text "BG Too High" indicates this has occurred. Note however: as stated in the Standard's clause 9.5.9, no correction is made for broadband background noise.

BS EN 61400-11:2013_tonality_summary DWC_tonality_v11_IEC2012.xlsm

BS EN 61400-11:2013 - Tonal Audibility Calculation Summary - For Windspeed Bins 9.0 through 14.0 m/s

Speed, k (m/s)	Running, 9 m/s to 14 m/s bins							
Spectrum, j	CB Centre	Lpn,avg	Lpt	Lpn	ΔLtn	ΔL_a	Report?	ΔL_a Energy
1__9 m/s	210.9	28.9	None	45.4	-16.5	-14.4	NO	
2_10 m/s	210.9	30.9	None	47.4	-16.5	-14.4	NO	
3_11 m/s	210.9	31.5	None	48.0	-16.5	-14.4	NO	
4_12 m/s	201.6	32.0	None	48.5	-16.4	-14.4	NO	
5_13 m/s	196.9	32.9	None	49.3	-16.4	-14.4	NO	
6_14 m/s	200	35.4	None	51.8	-16.4	-14.4	NO	
7__9 m/s	414.1	30.1	None	46.9	-16.8	-14.6	NO	
8__etc	423.4	31.3	None	48.1	-16.8	-14.6	NO	
9__	423.4	32.6	None	49.4	-16.8	-14.6	NO	
10__	426.6	32.8	None	49.6	-16.8	-14.6	NO	
11__	425	33.4	None	50.2	-16.8	-14.6	NO	
12_14 m/s	426.6	34.5	None	51.3	-16.8	-14.6	NO	
13	*590.6*	*29.6*	*37.7*	*46.8*	*-9.1*	*-6.7*	*NO*	*0.2*
14	587.5	30.3	None	47.5	-17.2	-14.8	NO	
15	587.5	30.8	None	48.0	-17.2	-14.8	NO	
16	585.9	31.9	None	49.1	-17.2	-14.8	NO	
17	576.6	33.0	None	50.2	-17.2	-14.8	NO	
18	576.6	34.2	None	51.4	-17.2	-14.8	NO	
19	2500	21.5	None	43.6	-22.2	-18.4	NO	
20	2500	20.7	None	42.9	-22.2	-18.4	NO	
21	2500	22.2	None	44.4	-22.2	-18.4	NO	
22	2500	22.8	None	45.0	-22.2	-18.4	NO	
23	2500	25.2	None	47.4	-22.2	-18.4	NO	
24	2500	25.1	None	47.2	-22.2	-18.4	NO	
25	6250	5.0	None	32.2	-27.2	-22.5	NO	
26	6250	6.4	None	33.6	-27.2	-22.5	NO	
27	6250	6.3	None	33.5	-27.2	-22.5	NO	
28	6250	7.6	None	34.8	-27.2	-22.5	NO	
29	6250	10.1	None	37.3	-27.2	-22.5	NO	
30	6250	10.9	None	38.1	-27.2	-22.5	NO	
Mode & Average	2500	25.3	Spec.Line#	1600	Avg. $\Delta L_{a,k}$	-6.7		

Speed, k (m/s)	Parked, 14 m/s bin						
Spectrum, j	CB Centre	Lpn,avg	Lpt	Lpn	ΔLtn	ΔL_a	Report?
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
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16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							

BS EN 61400-11:2013 Tonal Audibility Summary - General method

Wind speed bin, k (m/s)	Condition	Spectra examined	No of Spectra with Identified Tones			Background proximity ?	Average $\Delta L_{a,k}$	Report Tonal Audibility as	
			Identified	Percentage	AUDible				
9 - 14	Running	30	1	3%	0		-6.7	$\Delta L_{a,k}$ (dB)	No relevant Tones
	Background	0						Centre (Hz)	
								CBW (Hz)	
								Background ?	

Annex F - Small Wind Turbines (12 spectra per bin)			
Tonality ΔL_k	-16.6	Report Tonal Audibility	
Audibility $\Delta L_{a,k}$	-14.5	$\Delta L_{a,k}$ (dB)	No relevant Tones
		Centre (Hz)	
		CBW (Hz)	

Comment on Method used

Runnning: Auto tone search carried out on all spectra.

Parked: Tonality calculation on all parked spectra based on CB set at mode tone frequency whilst running

Note: although background noise levels may be well below dB(A) totals, background might still be high enough to affect the Masking noise levels in a given Critical Band. The text "BG Too High" indicates this has occurred.

Note however: as stated in the Standard's clause 9.5.9, no correction is made for broadband background noise.

(Test data: v7 {Argosy} files 6A thru 8A for running & BG6 thru BG10 for background + some bgd repeats BG8 & BG7)

BS EN 61400-11:2013_tonality_summary

DWC_tonality_v11_IEC2012.xlsm

APPENDIX 4

IMMISSION NOISE MAP FOR WIND SPEEDS
10 m above ground level / 0.1 roughness length

ACOUSTIC NOISE LEVELS

Turbine Make:	Orenda	Model:	Skye (49 kW)

IEC 61400-11:2012 NOISE EMISSION LEVELS

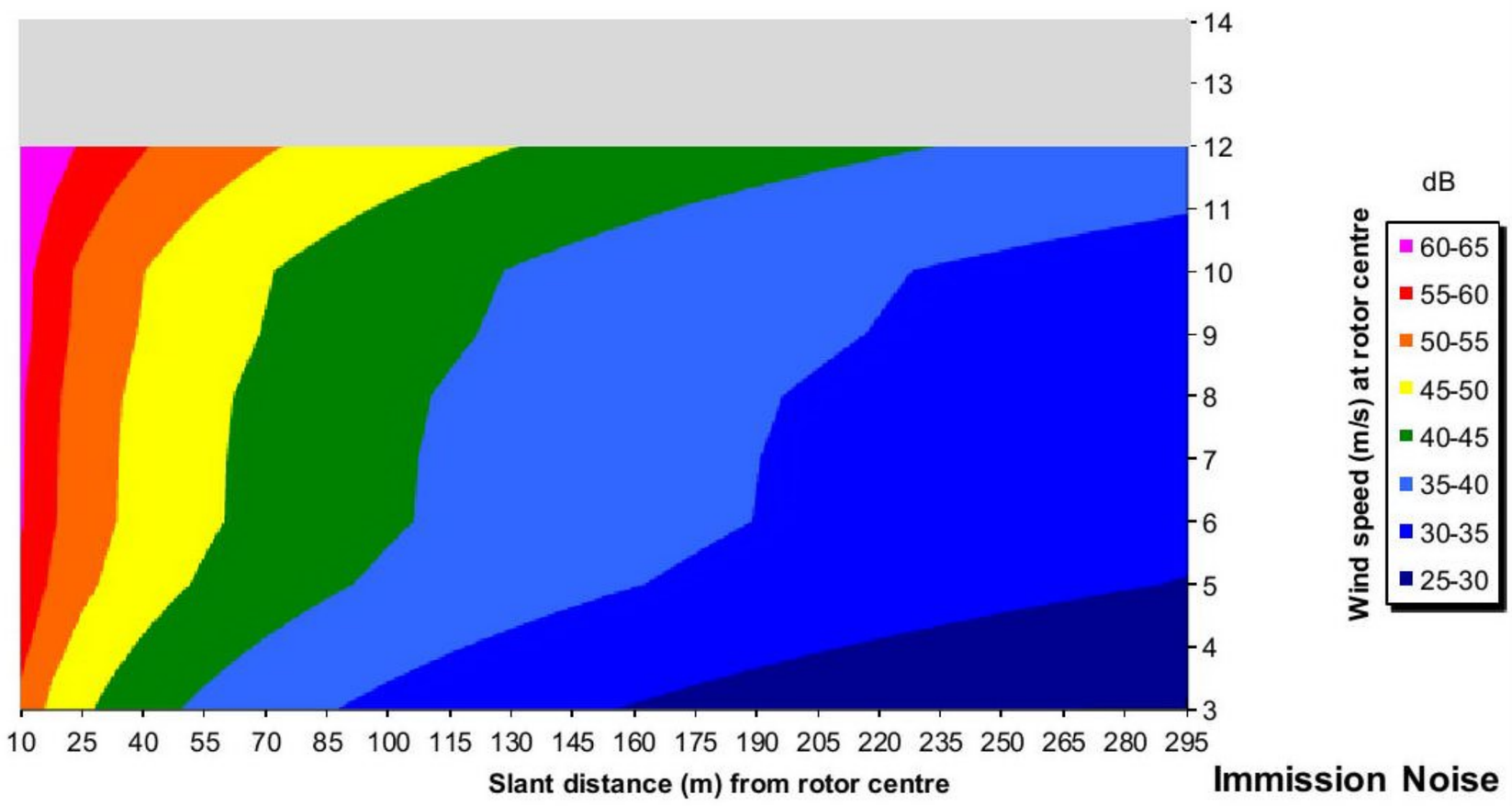
Wind Speed (m/s) at 10 m Height	2	3	4	5	6	7	8	9	10	11	12	13
Apparent Sound Power Level, L_{WA}, dB(A) re 10^{-12}W	-	84.8	87.5	90.2	91.5	91.6	91.8	92.7	93.1	95.6	98.4	-
Combined Uncertainty, U_c, dB	-	1.01	0.72	0.64	0.63	0.62	0.62	0.63	0.63	0.65	0.75	-
Declared Sound Power Level, L_{Wd}, dB(A) re 10^{-12}W	-	86.6	88.9	91.3	92.6	92.7	92.9	93.8	94.2	96.7	99.7	-

IEC 61400-11:2012 TONALITY

General Comment	0-20 kHz narrow-band analysis using Δf = 1.5625 Hz											
Wind Speed (m/s) at 10 m Height	2	3	4	5	6	7	8	9	10	11	12	13
Critical Band Centre Frequency (Hz)	-	591	591	591	-	-	-	-	-	-	-	-
Tonal Audibility, ΔL_a	-	+2.0	+1.5	+0.1	-	-	-	-	-	-	-	-

ESTIMATED NOISE IMMISSION LEVELS (dB(A) at a distant observer location)

Note: based on 'Apparent' Sound Power Level at Hub-height and 'Spherical' propagation.



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General Comment	0-20 kHz narrow-band analysis using Δf = 1.5625 Hz											
Wind Speed (m/s) at 10 m Height	2	3	4	5	6	7	8	9	10	11	12	13
Critical Band Centre Frequency (Hz)	-	6250	-	-	-	-	-	-	-	-	-	-
Tonal Audibility, ΔL_a	-	+1.6	-	-	-	-	-	-	-	-	-	-

IEC 61400-11:2012 TONALITY

General Comment	0-20 kHz narrow-band analysis using Δf = 1.5625 Hz											
Wind Speed (m/s) at 10 m Height	2	3	4	5	6	7	8	9	10	11	12	13
Critical Band Centre Frequency (Hz)	-	99	-	-	-	-	-	-	-	-	-	-
Tonal Audibility, ΔL_a	-	-2.7	-	-	-	-	-	-	-	-	-	-

A roughness length of 0.1 was used, derived from Eqn. (D2) with historical site data.

NOISE ASSESSMENT REPORT

INSTALLATION OF A 49kw WIND TURBINE AT
FIELDHEAD FARM

Turbine Location:
TURBINE 1 – 341618 853248

OCTOBER 2017

Disclaimer

In receiving this report, the Client accepts that Adele Ellis trading as AE Associates can in no way be held responsible for the application or use of the results and findings reported herein either now or in the future. The Client is, and remains, responsible for the use of such information and any consequences thereof.

The results presented in this report, whilst following standard industry practice, cannot be claimed to be “bankable” as no bank engineers’ approval has been sought.

Noise Assessment Report –Fieldhead

1. Introduction

AE Associates is assisting in the development of a site in the Moray Council area which requires an assessment for potential operational noise and has compiled the following report in support of the application.

1.2. Details of the site

The site lies within an area of land associated with Fieldhead Farm. The Farm is situated within an area known as Aultmore which has a serios of unclassified public roads. The turbine position lies in the region of 313m North, 212m West, 1.08km south and 670m South West of the aforementioned unclassified roadways. The B9017 lies in the region of 1.5km to the South, the B9016 lies 1.29km to the West and the A96 1.85km to the West. Keith lies 2.2km to the south and Newmill 1.7km to the south east. Lying 4.5km south East of the proposed development site lies Mill Wood (SSSI), the only designated site within 5km of the proposed turbine.

The proposed location for the wind turbine sits at a height above sea level of approximately 190m AOD. The landowner occupies this premises known as Fieldhead Farm and will receive financial benefit from the development therefore an allowance for owner/occupier has been allocated. There are a number of residential properties within the locale and we have undertaken a review of the noise level impacts towards these properties.

We have identified the properties which may be affected by noise impact and have included these noise sensitive areas within the calculations. The properties are known as Auchairn and Killiesmont. None of these properties are believed to be within the landowners control and none will receive a financial benefit from the development.

It is noted that there are two C & F 20kw turbines within the vicinity which have been taken into account within the calculations. These turbines are associated with Loanhead Farm and Killiesmont Farm. It is noted that noise level conditions where attached to the nearest non associated noise sensitive properties on these consents. This condition relates to the same property which is known as Yondertown.

2. Data supplied

2.1. Project Description

A single turbine location is proposed. The turbine has the following physical characteristics:

Turbine location: 341618 853248
Tower - 23.4m
Rotor diameter - 18.9m
Tip height - 33.5m
Type: Orenda Skye

It should be noted that noise will also be created as a result of both the construction and decommissioning phases of this development, but this noise will be short-lived and similar to other construction industry noise sources. Such noise emissions are dealt with in this report.

Construction

Depending on weather conditions, the turbine could take in the region of six weeks to build. The construction process will consist of the following principal activities:

Week 1

- Site survey, preparation and installation of any temporary storage facilities
  - Duration – c. 1 day.
  - Vehicles – works van to transport construction workers
- Excavate turbine foundations and construct the turbine and transformer bases
  - Duration - 1 week
  - Vehicles required – 1 x digger, 1 x dumper truck, 1 x standard size articulated lorry to transport the digger and dumper truck to and from the site, 2 x concrete wagons, making c. 7 trips to site over a period of c. 3 days, 1 x aggregate wagon, 1 x works van to transport construction workers to site

Weeks 2 – 5

- No activity as concrete base is left to set

Week 6

- Excavate cable trench and lay the power and instrumentation cables
  - Duration: c. 1 day
  - Vehicles required: 1 x digger, 1 x dumper
- Install the grid connection
- Wind turbine component deliveries and turbine erection
  - Duration: 1 day
  - Vehicles required:

4 x standard-size articulated lorries to transport turbine components including tower sections, 1 x works van to transport construction workers to site

- Testing and commissioning the wind turbine
- Site restoration of disturbed areas
  - Duration: 1 day
  - Vehicles required: digger and dumper truck

Vehicle Sound Power levels

Excavator	105 dB(A)
Tipper	113 dB(A)
Concrete mixer	108 dB(A)
Compressor	100 dB(A)
Water pumps	109 dB(A)

Excavate and lay site cable

Excavator	105 dB(A)
Dumper	102 dB(A)

Erect turbine

No requirement for Crane due to hydraulic tower.

The highest volume of delivery trucks and noise generation is likely to be contained within week 1. There is no requirement for new access road or concrete pads for cranes as the turbine has a hydraulic tower.

The appropriate calculation is equation F.6 from BS 5228-1:2009:
LAeq,12hr = LWA – 33 + 10log10Q – 10log10V – 10log10R
Where,
LWA is the sound power level of the trucks;
Q is the number of vehicles per hour;
V is the average vehicle speed in km/hr; and
R is the distance from property.
Assuming 240kW articulated delivery lorries, with an SPL of 110dB(A) (BS 5228-1:2009 Table D.11-50), 1 vehicle passing an hour at 35km/hr, 415m from the nearest property.

A conservative value for the total LAeq,12hr for construction and traffic at the nearest property is comfortably below the 65dB(A) limit of significance.

Conclusion
Construction phase noise has been assessed based on typical construction activities associated with a development of this scale. Please note that this is NOT a large scale wind turbine development and works are limited and short lived.
It is concluded that the construction phase of the development would have an acceptable impact on the noise amenity of local residents based on current guidance.
It is not anticipated that there will be any issues regarding construction noise with regard to the development throughout the construction phase.

It should further be noted that the use in the assessment of a particular turbine type does not imply acceptance by the turbine supplier that either the site or layout are suitable for such a turbine nor does it imply that every turbine type will meet all environmental constraints on the site. Confirmation should be sought from suppliers that warranties will be provided for their machines if used on this site.

3. Noise assessment at Fieldhead

3.1. Noise
Wind turbines are noise sources. The principle sources are the machinery in the nacelle at the top of the tower (gearbox, generator, cooling fans, pitch gear, yaw gear and yaw brakes), and the aerodynamic sound of the blades passing through the air1.

The proposed turbine location was selected to be as far as reasonably practicable from domestic dwellings yet close to a grid connection, clear of power lines and microwave links and have an adequate wind resource.

The noise characteristics of the proposed turbine are as follows:

Standardised windspeed at 10m above ground (m/s)	L_{WA} (dB)	Tonal penalty (dB)
4	88.9	1.5

5	91.3	0.1
6	92.6	0
7	92.7	0
8	92.9	0
9	93.8	0
10	94.2	0
11	96.7	0
12	99.7	0

ACOUSTIC NOISE LEVELS

Turbine Make:	Orenda	Model:	Skye (49 kW)

IEC 61400-11:2012 NOISE EMISSION LEVELS

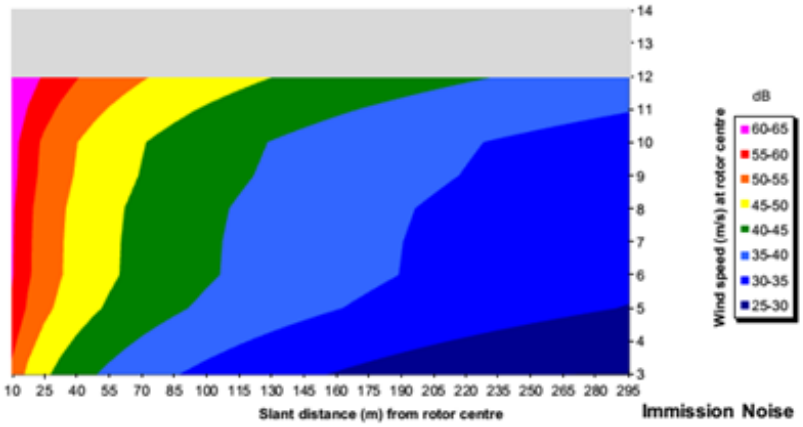
Wind Speed (m/s) at 10 m Height	2	3	4	5	6	7	8	9	10	11	12	13
Apparent Sound Power Level, L_{WA}, dB(A) re 10^{-12}W	-	84.8	87.5	90.2	91.5	91.6	91.8	92.7	93.1	95.6	98.4	-
Combined Uncertainty, U_c, dB	-	1.01	0.72	0.64	0.63	0.62	0.62	0.63	0.63	0.65	0.75	-
Declared Sound Power Level, L_{Wd}, dB(A) re 10^{-12}W	-	86.6	88.9	91.3	92.6	92.7	92.9	93.8	94.2	96.7	99.7	-

IEC 61400-11:2012 TONALITY

General Comment	0-20 kHz narrow-band analysis using Δf = 1.5625 Hz											
Wind Speed (m/s) at 10 m Height	2	3	4	5	6	7	8	9	10	11	12	13
Critical Band Centre Frequency (Hz)	-	591	591	591	-	-	-	-	-	-	-	-
Tonal Audibility, ΔL_a	-	+2.0	+1.5	+0.1	-	-	-	-	-	-	-	-

ESTIMATED NOISE IMMISSION LEVELS (dB(A) at a distant observer location)

Note: based on 'Apparent' Sound Power Level at Hub-height and 'Spherical' propagation.



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General Comment	0-20 kHz narrow-band analysis using Δf = 1.5625 Hz											
Wind Speed (m/s) at 10 m Height	2	3	4	5	6	7	8	9	10	11	12	13
Critical Band Centre Frequency (Hz)	-	6250	-	-	-	-	-	-	-	-	-	-
Tonal Audibility, ΔL_a	-	+1.6	-	-	-	-	-	-	-	-	-	-

IEC 61400-11:2012 TONALITY

General Comment	0-20 kHz narrow-band analysis using Δf = 1.5625 Hz											
Wind Speed (m/s) at 10 m Height	2	3	4	5	6	7	8	9	10	11	12	13
Critical Band Centre Frequency (Hz)	-	99	-	-	-	-	-	-	-	-	-	-
Tonal Audibility, ΔL_a	-	-2.7	-	-	-	-	-	-	-	-	-	-

A roughness length of 0.1 was used, derived from Eqn. (D2) with historical site data.

This data is derived from documents published by the manufacturer of the turbine, extracts of which are shown. This data is an updated, Version 2 noise report directly from the manufacturers and having been approved by NEL. The data are test data, with measurement uncertainty is quoted. Following the advice of the Institute of Acoustics Best Practice Guidelines2 ("IoA BPG"), an uncertainty of 1.645 times the stated measurement uncertainty is included in the figures shown above.

1 Rogers, A.L., Manwell, J.F, Wright, S.W. "Wind Turbine Acoustic Noise", RERL, University of Massachusetts, 2006. (http://www.minutemanwind.com/pdf/Understanding Wind Turbine Acoustic Noise.pdf) [Accessed 05/12/2016]

The data shown includes octave band data and these are used in the analysis reported here.

ETSU-R-973 states that a "tonal penalty" may be added to the sound power level in cases where the turbine emits specific tones in its noise characteristics. From the test results provided as a separate document (Table 5), the proposed turbine has been deemed to exhibit such tones at windspeeds of 2.5 - 5.1m/s (10m standardised windspeeds) and hence the appropriate tonal penalty is applicable as shown in the table above.

3.2. Policy Considerations Scottish Planning Policy (2010) 4 does not explicitly state methods or levels of acceptability, it simply directs developers to take account of noise in the design and assessment of projects.

For the Fieldhead project, the ETSU-R-97 and IoA GPG methods will be followed. The ISO 9613-2 propagation model will be used.

The cumulative results follow at the end of the repot.

2 http://www.ioa.org.uk/sites/default/files/IOA Good Practice Guide on Wind Turbine Noise - May 2013.pdf [Accessed 05/12/2016]. 3 ETSU-R-97: The Assessment and Rating of Noise from Wind Farms, http://webarchive.nationalarchives.gov.uk/+/http:/www.berr.gov.uk/files/file20433.pdf [Accessed 05/12/2016] 4 The Scottish Government. [Online] Available from: http://www.scotland.gov.uk/Publications/2010/02/03132605/8 [Accessed 05/12/2016]

3.3. Assessment of Noise

3.3.1. Methodology

The assessment has been desk-based. The magnitude of predicted noise and its variation with windspeed have been calculated using the DECIBEL module of EMD's WindPRO software5. The software, which is typical of those in use in the wind energy industry, creates a mathematical model of the proposed project, its location, the surrounding terrain and the locations of noise-sensitive properties. The following factors are taken into account in the calculation:

Turbine location
Turbine source noise (data supplied by turbine suppliers).
Topography, including valley and screening effects.
Locations of houses/buildings (data from property curtilage)

3.3.1.1. limits

As no background noise has been measured, the simple 35.0dB LA90, 10 min will be used for properties with no financial interest whilst properties within the landowners control who is receiving benefit will be allocated a 40dB level. The property known as Fieldhead farm is within the landowners control and will receive financial benefit and as such is assessed accordingly.

3.3.1.2. IoA GPG recommendations
The IoA GPG provides recommendations for the calculation of noise from wind turbine projects in the UK. The paper recommended:
* the use of the ISO 9613-2 propagation model with receiver height of 4.0m, 10°C and 70% relative humidity (§4.3.8);
* documentary support for the wind turbine source noise data used in the calculation (manufacturer-supplied data);
* ground porosity factor, G, of 0 where wind turbine data was of test or measured quality, and 0.5 where the data were warranted by the manufacturer or where test data is supplemented by measurement uncertainty (§4.3.6). In this case, all turbine data includes the appropriate levels of measurement uncertainty (as per IoA guidance), hence a value of 0.5 is considered appropriate;
* Valley effect (§4.3.9) - 3dB penalty applied where applicable;
* Screening effect due to terrain (§4.3.11) - 2dB benefit applied where applicable;

The DECIBEL module in windPRO has been used with these settings in the calculation of the results presented in this report. The ISO 9613-2 model has been found to be a robust method for the assessment of turbine-generated noise.

3.3.1.3. Quantification of the effects
The noise levels have been quantified as follows:
Variation in turbine-produced noise with 10m agl windspeed at each noise-sensitive property;
A contour plot of noise at a specific windspeed (10m/s equivalent at 10m above ground)

3.3.2. Assessment of results
The assessment concludes that the development will not exceed the simplified ETSU limits, namely 35.0dB to 10m/s assuming no financial involvement and also at 12m/ as requested by EH, (40db for involved properties) of any property in the vicinity of the project.

No Valley Penalty has been applied due to the location and no screening effect has been applied to the calculations in order to provide a worse case scenario.

The properties assessed are listed in Table 2.

	Grid reference	Financial Involvement	IoA Valley Penalty	IoA Screening Benefit
A Auchairn	**341275 853439**	No	No	No
B Killiesmont	**341026 852928**	No	No	No
C Fieldhead	**341530 853032**	Yes	No	No

	10m agl windspeed (m/s)								
	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s
Auchairn	25.4	26.4	27.6	27.7	27.9	28.8	29.2	31.7	34.7
Killiesmont	19.9	20.9	22.1	22.2	22.4	23.3	23.7	26.2	29.2
Fieldhead	30.4	31.4	32.6	32.7	32.9	33.8	34.2	36.7	39.7

Table 3. Predicted noise levels (LA90, 10 min) at neighbouring properties due to the proposed turbine

	10m agl windspeed (m/s)								
	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s
Auchairn	-09.6	-08.6	-07.4	-07.3	-07.1	-06.2	-05.8	-03.3	-0.3
Killiemont	-15.1	-14.1	-12.9	-12.8	-12.6	-11.7	-11.3	-8.8	-05.8
Fieldhead	-09.6	-08.6	-07.4	-07.3	-07.1	-06.2	-05.8	-3.3	-0.3

Table 4. Exceedance of limits (LA90, 10 min) at neighbouring properties due to the proposed turbine (negative values show no exceedance).

The detailed results shown in Tables 3 and 4 show noise is predicted to be below 35.0dB (or 40dB) at 10m/s, thus meeting the simplified conditions of ETSU-R-97. Detailed results are shown in Appendix B, along with 10m/s contour plot of noise of predicted noise.

3.3.4. Summary

The predicted noise levels are such that background noise measurements will not be required as compliance has been achieved within existing limits.

3.4. Mitigation

The results of the assessment indicate mitigation will not be required.

3.5. Residual effects

The modelled effects show that the maximum potential for turbine-produced noise is within the limits stated in ETSU-R-97 at 10m/s for properties around the proposed turbine locations with or without financial involvement in the project and there is no need for the measurement of background noise.

3.6. Cumulative noise assessment

A cumulative noise assessment is not required, according to IoA §5.1.2, where the proposed wind farm produces noise levels 10dB lower than the limits set for an existing wind turbine/farm and there is no potential for cumulative noise impacts to breach ETSU-R-97 limits.

Furthermore, §5.4.6-5.4.7 states that consented noise limits should be used and it should be assumed that the operator of the existing wind turbine/farm has the right to produce noise up to their consented limits.

With these criteria in mind, those operational or consented are considered most critical in the cumulative case as they lie closest to the proposed project:

Project Status	Distance and direction	Planning Reference &	Nature of development	Conditioned Limits (non-involved)
Loanhead	710m S	11/01061/APP/ Operational	One turbine	38dB @8m/s to non-associated sensitive
Killiesmont	799m SW	11/01389/APP Operational	One turbine	38dB @8m/s to non-associated Sensitive

Table 5. Nearest cumulative project

Each project is considered in turn in the following pages.

Figures accompanying each project show the relevant properties and turbine locations. The figures clearly show that in each case, the prediction does not reach the controlling property for each of the projects. As each controlling property is defined by a 40dB limit, this means that in accordance with IoA GPG §5.1.2, where the proposed wind farm produces noise levels 10dB lower than the limits set for an existing wind turbine/farm and there is no potential for cumulative noise impacts to breach ETSU-R-97 limits.

Although it is considered that this argument alone is sufficient to prove compliance, nevertheless, analysis and reporting of headroom calculations for each project is presented in the following pages.

Where headroom is calculated to be more than 10dB, the value has been capped at 10dB, the upper limit of significance (IoA GPG §5.4.11) as there is “no realistic prospect of the existing wind farm producing noise levels up to the total ETSU-R-97 limits”.

Loanhead 11/01061/APP
The property known as Yonderstown is assessed as being the closest dwelling to the Loanhead turbine in the direction of the proposed development. A level of 38db ‘ 8m/s has been allocated to this property as being the closest non associated dwelling to the turbine as per the approval of the turbine.

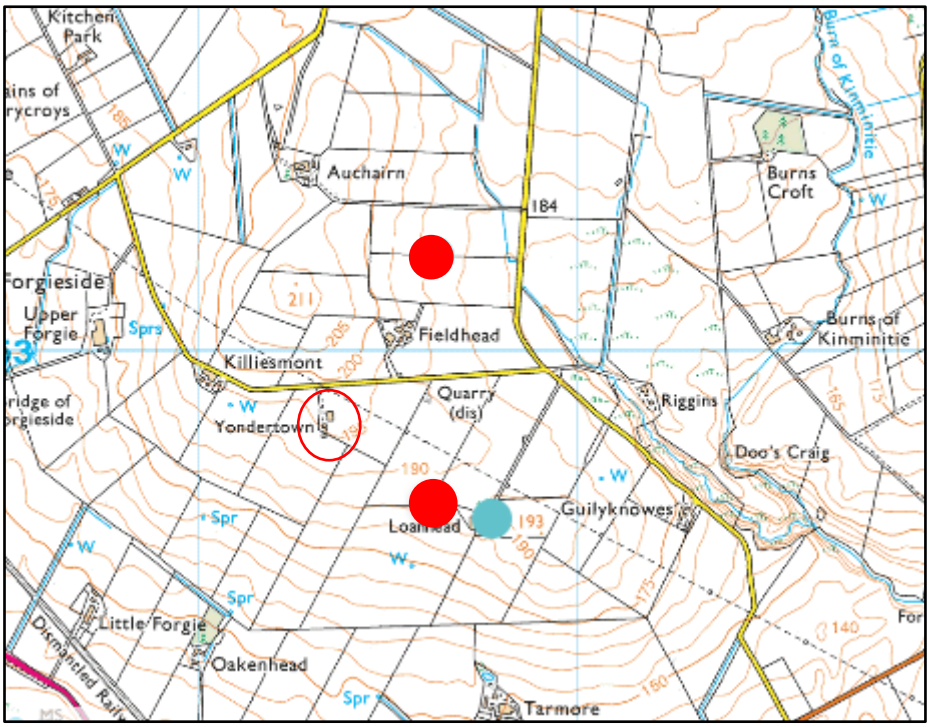

Figure 1 shows the relative locations of the Loanhead turbine as consented, the Fieldhead proposal and relevant properties along with the 38db prediction

Table 6 shows the results of the headroom analysis at Loanhead, and the application of the headroom to the next nearest property, Yonderstown. In this case, the predictions for the turbine (as consented) are considered.

Windspeed at 10m agl (m/s)	4.0	5.0	6.0	7.0	8.0	9.0	10.0
Loanhead Source (dB)	75	77.5	81.8	84.3	87.5	90.2	91.0
Loanhead Tonal Penalty (dB)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Yonderstown due to L/Head(dB)	10.8	13.3	17.6	20.1	23.3	26.0	26.8
Headroom (capped to 10dB)	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Yonderstown due to F/head(dB)	22.6	23.6	24.8	24.9	25.1	26.0	26.4
Combined (dB)	22.9	24.0	25.5	26.1	27.3	29.0	30.8
Combined plus headroom(dB)	32.9	34.0	35.5	36.1	**37.3**	39.0	39.8

The calculation plus headroom show that at 8m/s a level of 38dB or below has been met.

These results do not take account of any directional attenuation (IoA GPG §4.4) in which the properties may be cross- or upwind of one of the projects at various times due to wind direction changes, so should be seen as a “worst case”.

Killiesmont 11/01389/APP

The property known as Yondertown is assessed as being the closest dwelling to the Killiesmont turbine in the direction of the proposed development. A level of 38dB @ 8m/s

has been allocated to this property as being the closest dwelling to the turbine as per the approval of the turbine.

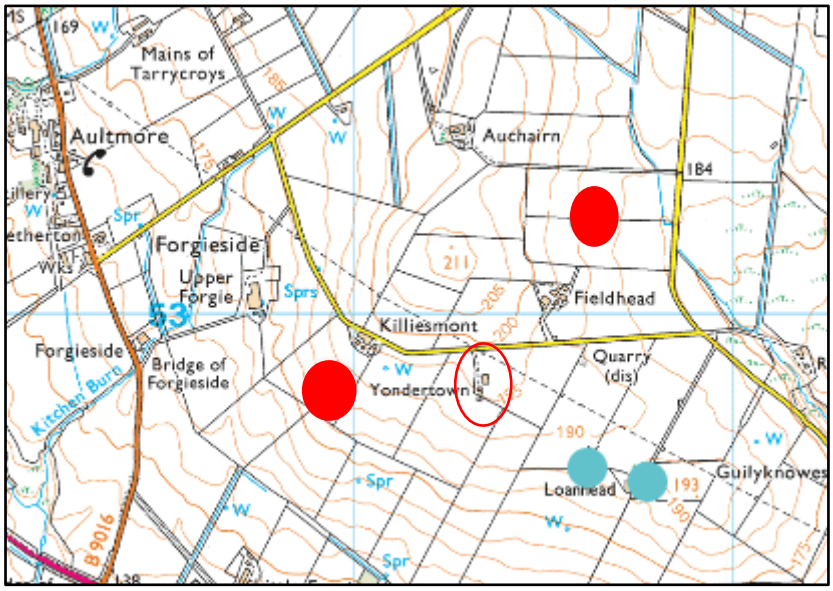

Table 7 shows the results of the headroom analysis at Killiesmont, and the application of the headroom to the next nearest property, also Yonderston. In this case, the predictions for the turbine (as consented) are considered.

Windspeed at 10m agl (m/s)	4.0	5.0	6.0	7.0	8.0	9.0	10.0
Killiesmont Source (dB)	75	77.5	81.8	84.3	87.5	90.2	91.0
Killiesmont Tonal Penalty (dB)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Yondertown due to Killiesmont (dB)	10.0	14.5	16.8	19.3	22.5	25.2	28.0
Headroom (capped to 10dB)	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Yondertown due toFieldhead(dB)	22.6	23.6	24.8	24.9	25.1	26.0	26.4
Combined (dB)	22.8	23.9	25.4	25.9	27.0	28.6	29.2
Combined plus headroom(dB)	32.8	33.9	35.4	35.9	**37.0**	38.6	39.2

The calculation plus headroom show that at 8m/s a level of 38dB or below has been met.

These results do not take account of any directional attenuation (IoA GPG §4.4) in which the properties may be cross- or upwind of one of the projects at various times due to wind direction changes, so should be seen as a “worst case”.

4. Conclusions

The potential for operational turbine-produced noise occurring around the proposed wind turbine site named Fieldhead has been assessed on behalf of the developer.

The results have been based on a desk-top study using industry-standard tools.

Results have been assessed using:

- the ISO 9613-2 propagation model

- manufacturer-supplied source noise data including measurement uncertainty
- atmospheric conditions of 10°C and 70% RH
- ground porosity of 0.5 (semi-porous ground - applicable as source noise data include measurement uncertainty)
- screening effect - 2dB applied where there is no line of sight from turbine to receptor – Not applicable to this site.
- valley effect - 3dB penalty applied where applicable – Not applicable in this site specific

The proposed development at Fieldhead meets the limits as set out in local and national guidance in its own right.

An analysis of the cumulative situation with other operational and proposed turbines in the area shows that the development, due to headroom additions, does comply with local and national guidance.

The calculations do not take account of any directional attenuation (IoA GPG §4.4) in which one or other of the properties may be cross- or upwind of one of the projects at various times due to wind direction changes.

Appendix A. Noise assessment assumptions for calculation

Project:
Oxwell

Description:
Installation of an orenda wind turbine

Licensed user:
Orenda Energy Solutions Ltd
c/o MacRoberts, Excel House 30 Semple Street
GB-EDINBURGH EH3 8BL

Adele / ae.associates@btinternet.com
Calculated:
10/10/2017 14:39/3.1.617

DECIBEL - Assumptions for noise calculation

Calculation: Fieldhead Noise Anaysis

Noise calculation model:
ISO 9613-2 United Kingdom
Wind speed:
4.0 m/s - 12.0 m/s, step 1.0 m/s
Ground attenuation:
General, fixed, Ground factor: 0.5
Meteorological coefficient, C0:
0.0 dB
Type of demand in calculation:
3: WTG noise is compared to ambient noise plus margin (UK, AT etc.)
Noise values in calculation:
All noise values are 90% exeedance values (L90)
Pure tones:
Fixed penalty added to source noise of WTGs with pure tones: 0.0 dB(A)
Height above ground level, when no value in NSA object:
4.0 m Don't allow override of model height with height from NSA object
Deviation from "official" noise demands. Negative is more restrictive, positive is less restrictive.:
0.0 dB(A)
Octave data required
Air absorption

63	125	250	500	1,000	2,000	4,000	8,000
[db/km]	[db/km]	[db/km]	[db/km]	[db/km]	[db/km]	[db/km]	[db/km]
0.1	0.4	1.0	1.9	3.7	9.7	32.8	117.0

WTG: Orenda 51 19.1 !O!
Noise: Runtime input

Status	Hub height [m]	Wind speed [m/s]	LwA,ref [dB(A)]	Pure tones	Penalty [dB]		Octave data 63 [dB]	125 [dB]	250 [dB]	500 [dB]	1000 [dB]	2000 [dB]	4000 [dB]	8000 [dB]
User value	24.5	4.0	88.9	Yes	1.5	Generic data	70.5	77.5	80.9	83.5	83.3	80.4	75.6	66.1
User value	24.5	5.0	91.3	Yes	0.1	Generic data	72.9	79.9	83.3	85.9	85.7	82.8	78.0	68.5
User value	24.5	6.0	92.6	No		Generic data	74.2	81.2	84.6	87.2	87.0	84.1	79.3	69.8
User value	24.5	7.0	92.7	No		Generic data	74.3	81.3	84.7	87.3	87.1	84.2	79.4	69.9
User value	24.5	8.0	92.9	No		Generic data	74.5	81.5	84.9	87.5	87.3	84.4	79.6	70.1
User value	24.5	9.0	93.8	No		Generic data	75.4	82.4	85.8	88.4	88.2	85.3	80.5	71.0
User value	24.5	10.0	94.2	No		Generic data	75.8	82.8	86.2	88.8	88.6	85.7	80.9	71.4
User value	24.5	11.0	96.7	No		Generic data	78.3	85.3	88.7	91.3	91.1	88.2	83.4	73.9
User value	24.5	12.0	99.7	No		Generic data	81.3	88.3	91.7	94.3	94.1	91.2	86.4	76.9

NSA: Auchairn-A
Predefined calculation standard:
Imission height(a.g.l.): Use standard value from calculation model

Ambient noise:

4.0 [m/s]	5.0 [m/s]	6.0 [m/s]	7.0 [m/s]	8.0 [m/s]	9.0 [m/s]	10.0 [m/s]	11.0 [m/s]	12.0 [m/s]
25.9 dB(A)	26.7 dB(A)	27.8 dB(A)	29.3 dB(A)	31.0 dB(A)	33.1 dB(A)	35.0 dB(A)	35.0 dB(A)	35.0 dB(A)

Margin or Allowed additional exposure: 0.0 dB(A)
Sound level always accepted: 35.0 dB(A)
No distance demand

NSA: Killiesmont-B
Predefined calculation standard:
Imission height(a.g.l.): Use standard value from calculation model

Ambient noise:

4.0 [m/s]	5.0 [m/s]	6.0 [m/s]	7.0 [m/s]	8.0 [m/s]	9.0 [m/s]	10.0 [m/s]	11.0 [m/s]	12.0 [m/s]
25.9 dB(A)	26.7 dB(A)	27.8 dB(A)	29.3 dB(A)	31.0 dB(A)	33.1 dB(A)	35.0 dB(A)	35.0 dB(A)	35.0 dB(A)

Margin or Allowed additional exposure: 0.0 dB(A)
Sound level always accepted: 35.0 dB(A)
No distance demand

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GB-EDINBURGH EH3 8BL

Adele / ae.associates@btinternet.com
Calculated:
10/10/2017 14:39/3.1.617

DECIBEL - Assumptions for noise calculation

Calculation: Fieldhead Noise Anaysis
NSA: Fieldhead-C
Predefined calculation standard:
Imission height(a.g.l.): Use standard value from calculation model

Ambient noise:

4.0 [m/s]	5.0 [m/s]	6.0 [m/s]	7.0 [m/s]	8.0 [m/s]	9.0 [m/s]	10.0 [m/s]	11.0 [m/s]	12.0 [m/s]
25.9 dB(A)	26.7 dB(A)	27.8 dB(A)	29.3 dB(A)	31.0 dB(A)	33.1 dB(A)	35.0 dB(A)	35.0 dB(A)	35.0 dB(A)

Margin or Allowed additional exposure: 0.0 dB(A)
Sound level always accepted: 40.0 dB(A)
No distance demand

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c/o MacRoberts, Excel House 30 Semple Street
GB-EDINBURGH EH3 8BL

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Calculated:
10/10/2017 14:39/3.1.617

DECIBEL - Assumptions for noise calculation

Calculation: Fieldhead Noise Anaysis
NSA: Fieldhead-C
Predefined calculation standard:
Imission height(a.g.l.): Use standard value from calculation model

Ambient noise:

4.0 [m/s]	5.0 [m/s]	6.0 [m/s]	7.0 [m/s]	8.0 [m/s]	9.0 [m/s]	10.0 [m/s]	11.0 [m/s]	12.0 [m/s]
25.9 dB(A)	26.7 dB(A)	27.8 dB(A)	29.3 dB(A)	31.0 dB(A)	33.1 dB(A)	35.0 dB(A)	35.0 dB(A)	35.0 dB(A)

Margin or Allowed additional exposure: 0.0 dB(A)
Sound level always accepted: 40.0 dB(A)
No distance demand

Appendix B. Noise assessment – maximum noise predictions around the development

Project:
Oxwell

Description:
Installation of an orenda wind turbine

Licensed user:
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GB-EDINBURGH EH3 8BL

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Calculated:
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DECIBEL - Map 10.0 m/s

Calculation: Fieldhead Noise Anaysis

0 500 1000 1500 2000 m

Map: Bitmap map: NJ.tif , Print scale 1:40,000, Map center British TM-OSGB36/Airy (GB/IE) East: 341,618 North: 853,248

New WTG Noise sensitive area

Noise calculation model: ISO 9613-2 United Kingdom. Wind speed: 10.0 m/s
Height above sea level from active line object

Project:
Oxwell

Description:
Installation of an orenda wind turbine

Licensed user:
Orenda Energy Solutions Ltd
c/o MacRoberts, Excel House 30 Semple Street
GB-EDINBURGH EH3 8BL

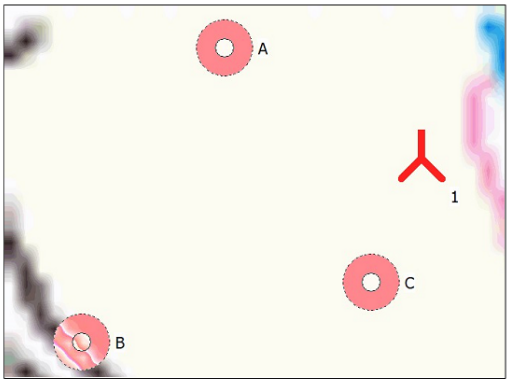
Adele / ae.associates@btinternet.com
Calculated:
10/10/2017 14:39/3.1.617

DECIBEL - Main Result

Calculation: Fieldhead Noise Anaysis

Noise propagation model:
ISO 9613-2 United Kingdom
Wind speed:
4.0 m/s - 12.0 m/s, step 1.0 m/s
Ground attenuation:
General, fixed, Ground factor: 0.5
Type of demand in calculation:
WTG noise is compared to ambient noise plus 5dB margin with the option of a floor setting (e.g. 35dB)
Noise values in calculation:
All noise values are 90% exeedence values (L90) designed to show compliance with ETSU-R-97 limits
Pure tones:
Fixed penalty added to source noise of WTGs with pure tones: 0.0 dB(A)
Calculation height above ground level:
4.0 m
Octave band data required

All coordinates are in
British TM-OSGB36/Airy (GB/IE)



Scale 1:10,000
New WTG Noise sensitive area

WTGs

	Easting	Northing	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Noise data Creator	Name	First wind speed	LwaRef	Last wind speed	LwaRef	Pure tones
			[m]					[kW]	[m]	[m]			[m/s]	[dB(A)]	[m/s]	[dB(A)]	
1	341,618	853,248	190.0	Fieldhead	Yes	Orenda	-51	51	19.1	24.5	USER	Runtime input	4.0	88.9	12.0	99.7	2 dB h

h) Generic octave distribution used

Calculation Results

Sound level

Noise sensitive area No.	Name	Easting	Northing	Z	Imission height	Most critical demand Wind speed	Demand	Predicted sound level WTG noise	Max exceedence	Distance to noise demand	Demands fulfilled ? Noise
				[m]	[m]	[m/s]	[dB(A)]	[dB(A)]	[dB(A)]	[m]	
A	Auchairn	341,275	853,439	200.0	4.0	12.0	35.0	34.7	-0.3	13	Yes
B	Killiesmont	341,026	852,928	195.3	4.0	12.0	35.0	29.2	-5.8	294	Yes
C	Fieldhead	341,530	853,032	195.7	4.0	12.0	40.0	39.7	-0.3	8	Yes

Distances (m)

	WTG
NSA	1
A	393
B	673
C	233

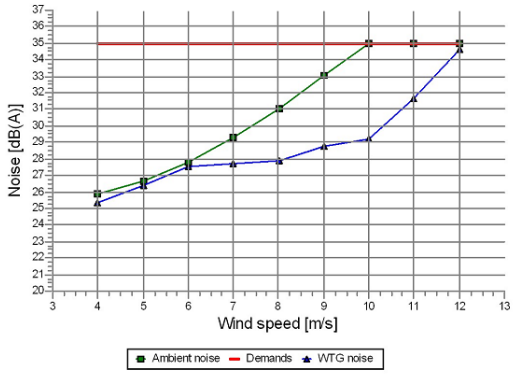
Licensed user:
Orenda Energy Solutions Ltd
c/o MacRoberts, Excel House 30 Semple Street
GB-EDINBURGH EH3 8BL

Adele / ae.associates@btinternet.com
Calculated:
10/10/2017 14:39/3.1.617

DECIBEL - Detailed results, graphic

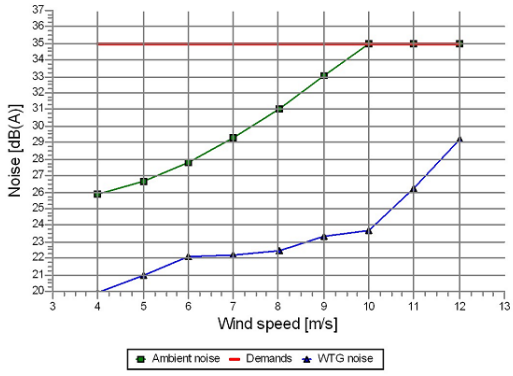
Calculation: Fieldhead Noise Anaysis**Noise calculation model:** ISO 9613-2 United Kingdom

Auchairn (A)



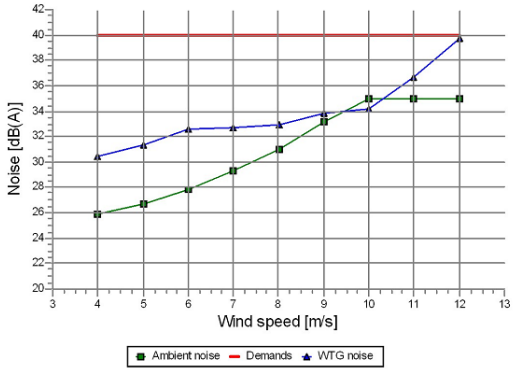
Wind speed	Ambient noise	Demands Margin	Demands Demands	Sound level WTG noise	Demands fulfilled ?
[m/s]	[dB(A)]	[dB(A)]	[dB(A)]	[dB(A)]	
4.0	25.9	0.0	35.0	25.4	Yes
5.0	26.7	0.0	35.0	26.4	Yes
6.0	27.8	0.0	35.0	27.6	Yes
7.0	29.3	0.0	35.0	27.7	Yes
8.0	31.0	0.0	35.0	27.9	Yes
9.0	33.1	0.0	35.0	28.8	Yes
10.0	35.0	0.0	35.0	29.2	Yes
11.0	35.0	0.0	35.0	31.7	Yes
12.0	35.0	0.0	35.0	34.7	Yes

Killiesmont (B)



Wind speed	Ambient noise	Demands Margin	Demands Demands	Sound level WTG noise	Demands fulfilled ?
[m/s]	[dB(A)]	[dB(A)]	[dB(A)]	[dB(A)]	
4.0	25.9	0.0	35.0	19.9	Yes
5.0	26.7	0.0	35.0	20.9	Yes
6.0	27.8	0.0	35.0	22.1	Yes
7.0	29.3	0.0	35.0	22.2	Yes
8.0	31.0	0.0	35.0	22.4	Yes
9.0	33.1	0.0	35.0	23.3	Yes
10.0	35.0	0.0	35.0	23.7	Yes
11.0	35.0	0.0	35.0	26.2	Yes
12.0	35.0	0.0	35.0	29.2	Yes

Fieldhead (C)



Wind speed	Ambient noise	Demands Margin	Demands Demands	Sound level WTG noise	Demands fulfilled ?
[m/s]	[dB(A)]	[dB(A)]	[dB(A)]	[dB(A)]	
4.0	25.9	0.0	40.0	30.4	Yes
5.0	26.7	0.0	40.0	31.4	Yes
6.0	27.8	0.0	40.0	32.6	Yes
7.0	29.3	0.0	40.0	32.7	Yes
8.0	31.0	0.0	40.0	32.9	Yes
9.0	33.1	0.0	40.0	33.8	Yes
10.0	35.0	0.0	40.0	34.2	Yes
11.0	35.0	0.0	40.0	36.7	Yes
12.0	35.0	0.0	40.0	39.7	Yes

Project:
Oxwell

Description:
Installation of an orenda wind turbine

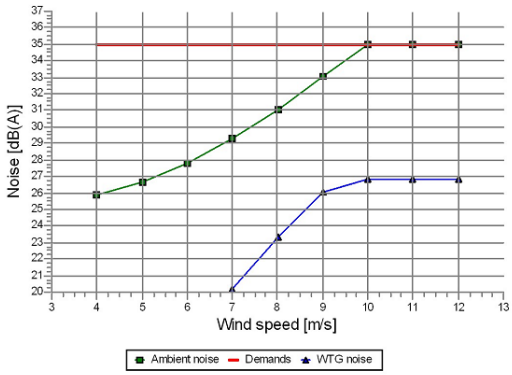
Licensed user:
Orenda Energy Solutions Ltd
c/o MacRoberts, Excel House 30 Semple Street
GB-EDINBURGH EH3 8BL

Adele / ae.associates@btinternet.com
Calculated:
10/10/2017 14:58/3.1.617

DECIBEL - Detailed results, graphic

Calculation: Yondertown with Loanhead**Noise calculation model:** ISO 9613-2 United Kingdom

cumulative NSA (A)



Wind speed [m/s]	Ambient noise [dB(A)]	Demands Margin [dB(A)]	Demands Demands [dB(A)]	Sound level WTG noise [dB(A)]	Demands fulfilled ?
4.0	25.9	0.0	35.0	10.8	Yes
5.0	26.7	0.0	35.0	13.3	Yes
6.0	27.8	0.0	35.0	17.6	Yes
7.0	29.3	0.0	35.0	20.1	Yes
8.0	31.0	0.0	35.0	23.3	Yes
9.0	33.1	0.0	35.0	26.0	Yes
10.0	35.0	0.0	35.0	26.8	Yes
11.0	35.0	0.0	35.0	26.8	Yes
12.0	35.0	0.0	35.0	26.8	Yes

Project:
Oxwell

Description:
Installation of an orenda wind turbine

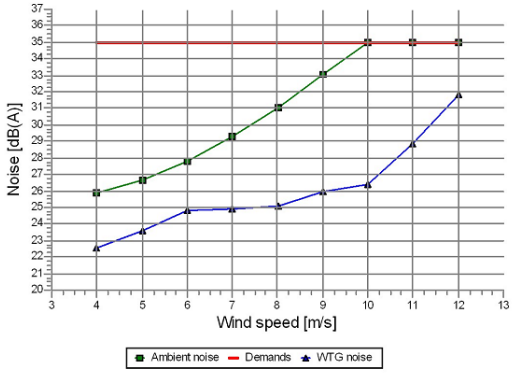
Licensed user:
Orenda Energy Solutions Ltd
c/o MacRoberts, Excel House 30 Semple Street
GB-EDINBURGH EH3 8BL

Adele / ae.associates@btinternet.com
Calculated:
10/10/2017 18:14/3.1.617

DECIBEL - Detailed results, graphic

Calculation: Fieldhead & Yonderston**Noise calculation model:** ISO 9613-2 United Kingdom

cumulative NSA (A)



Wind speed [m/s]	Ambient noise [dB(A)]	Demands Margin [dB(A)]	Demands Demands [dB(A)]	Sound level WTG noise [dB(A)]	Demands fulfilled ?
4.0	25.9	0.0	35.0	22.6	Yes
5.0	26.7	0.0	35.0	23.6	Yes
6.0	27.8	0.0	35.0	24.8	Yes
7.0	29.3	0.0	35.0	24.9	Yes
8.0	31.0	0.0	35.0	25.1	Yes
9.0	33.1	0.0	35.0	26.0	Yes
10.0	35.0	0.0	35.0	26.4	Yes
11.0	35.0	0.0	35.0	28.9	Yes
12.0	35.0	0.0	35.0	31.9	Yes

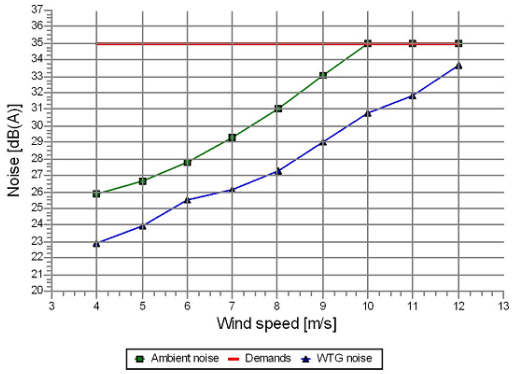
Licensed user:
Orenda Energy Solutions Ltd
c/o MacRoberts, Excel House 30 Semple Street
GB-EDINBURGH EH3 8BL

Adele / ae.associates@btinternet.com
Calculated:
10/10/2017 15:06/3.1.617

DECIBEL - Detailed results, graphic

Calculation: Yondertown, Loanhead & Fieldhead**Noise calculation model:** ISO 9613-2 United Kingdom

cumulative NSA (A)



Wind speed [m/s]	Ambient noise [dB(A)]	Demands Margin [dB(A)]	Demands [dB(A)]	Sound level WTG noise [dB(A)]	Demands fulfilled ?
4.0	25.9	0.0	35.0	22.9	Yes
5.0	26.7	0.0	35.0	24.0	Yes
6.0	27.8	0.0	35.0	25.5	Yes
7.0	29.3	0.0	35.0	26.1	Yes
8.0	31.0	0.0	35.0	27.3	Yes
9.0	33.1	0.0	35.0	29.0	Yes
10.0	35.0	0.0	35.0	30.8	Yes
11.0	35.0	0.0	35.0	31.9	Yes
12.0	35.0	0.0	35.0	33.6	Yes

Project:
Oxwell

Description:
Installation of an orenda wind turbine

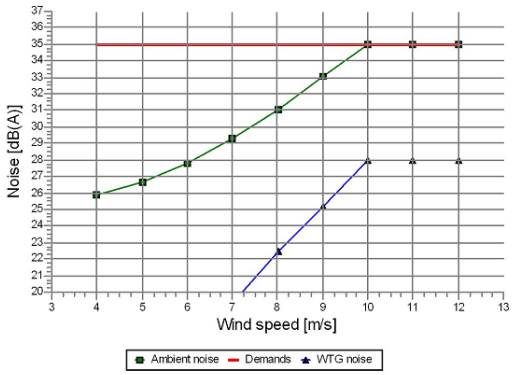
Licensed user:
Orenda Energy Solutions Ltd
c/o MacRoberts, Excel House 30 Semple Street
GB-EDINBURGH EH3 8BL

Adele / ae.associates@btinternet.com
Calculated:
10/10/2017 15:13/3.1.617

DECIBEL - Detailed results, graphic

Calculation: Yondertown and Killiesmont**Noise calculation model:** ISO 9613-2 United Kingdom

cumulative NSA (A)



Wind speed [m/s]	Ambient noise [dB(A)]	Demands Margin [dB(A)]	Demands Demands [dB(A)]	Sound level WTG noise [dB(A)]	Demands fulfilled ?
4.0	25.9	0.0	35.0	10.0	Yes
5.0	26.7	0.0	35.0	14.5	Yes
6.0	27.8	0.0	35.0	16.8	Yes
7.0	29.3	0.0	35.0	19.3	Yes
8.0	31.0	0.0	35.0	22.5	Yes
9.0	33.1	0.0	35.0	25.2	Yes
10.0	35.0	0.0	35.0	28.0	Yes
11.0	35.0	0.0	35.0	28.0	Yes
12.0	35.0	0.0	35.0	28.0	Yes

Project:
Oxwell

Description:
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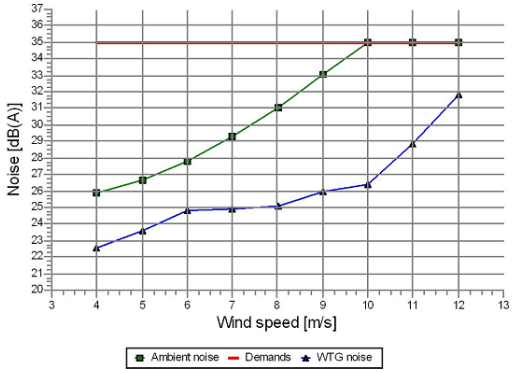
Adele / ae.associates@btinternet.com
Calculated:
10/10/2017 18:14/3.1.617

DECIBEL - Detailed results, graphic

Calculation: Fieldhead & Yonderston**Noise calculation model:** ISO 9613-2 United Kingdom

cumulative NSA (A)



Wind speed [m/s]	Ambient noise [dB(A)]	Demands Margin [dB(A)]	Demands Demands [dB(A)]	Sound level WTG noise [dB(A)]	Demands fulfilled ?
4.0	25.9	0.0	35.0	22.6	Yes
5.0	26.7	0.0	35.0	23.6	Yes
6.0	27.8	0.0	35.0	24.8	Yes
7.0	29.3	0.0	35.0	24.9	Yes
8.0	31.0	0.0	35.0	25.1	Yes
9.0	33.1	0.0	35.0	26.0	Yes
10.0	35.0	0.0	35.0	26.4	Yes
11.0	35.0	0.0	35.0	28.9	Yes
12.0	35.0	0.0	35.0	31.9	Yes

Licensed user:
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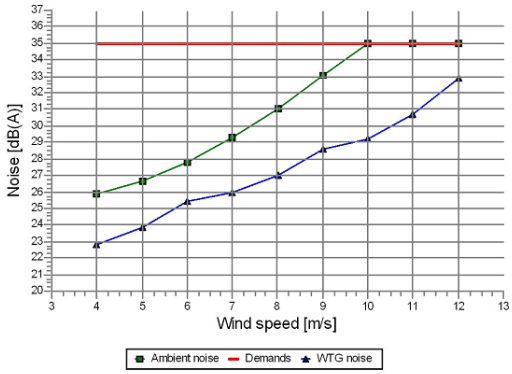
c/o MacRoberts, Excel House 30 Semple Street
GB-EDINBURGH EH3 8BL

Adele / ae.associates@btinternet.com
Calculated:
10/10/2017 15:20/3.1.617

DECIBEL - Detailed results, graphic

Calculation: Yonderstown with Kiliiesmont & Fieldhead**Noise calculation model:** ISO 9613-2 United Kingdom

cumulative NSA (A)



Wind speed [m/s]	Ambient noise [dB(A)]	Demands Margin [dB(A)]	Demands [dB(A)]	Sound level WTG noise [dB(A)]	Demands fulfilled ?
4.0	25.9	0.0	35.0	22.8	Yes
5.0	26.7	0.0	35.0	23.9	Yes
6.0	27.8	0.0	35.0	25.4	Yes
7.0	29.3	0.0	35.0	25.9	Yes
8.0	31.0	0.0	35.0	27.0	Yes
9.0	33.1	0.0	35.0	28.6	Yes
10.0	35.0	0.0	35.0	29.2	Yes
11.0	35.0	0.0	35.0	30.7	Yes
12.0	35.0	0.0	35.0	32.9	Yes

Impact on acoustic assessment of change to Orenda 49kW Wind Turbine

ORENDA
ENERGY SOLUTIONS

Iroquois, Ontario

Canada

24th October 2016

Recently, Orenda Energy Solutions re-engineered their 51kW Wind Turbine, to limit it's export to 49kW.

This change was done by software changes to the control system only, and there was no physical or operational changes.

The Wind Turbine uses a patent pending hydrostatic braking system for speed control, which allows Orenda to finely balance the amount of power sent to the grid as electrical energy vs the amount of power removed from the system in the form of heat from hydraulic braking.

This system allowed the Orenda engineering team to re-set the export limit to 49kW without changing either the physical design of the system or the operational RPM.

As a consequence of this, it is anticipated that there is no change to the acoustic profile of the turbine.

[redacted]

Graeme Allan B.Eng (Hons), MSc, C.Eng, MIET

VP, Engineering & Operations

Tel: 1.613.686.1677 www.orendaenergy.com
24A Bath Road, Iroquois, Ontario, K0E 1X0 Canada

The Certification Mark for Onsite
Sustainable Energy Technologies

Microgeneration Certification Scheme: MCS 006

Product Certification Scheme Requirements:
Small Wind Turbines

Issue 2.1

This standard has been approved by the Steering Group of the Microgeneration Certification Scheme.

This document was prepared by the MCS Working Group 3 'Small Wind Systems'.

REVISION OF MICROGENERATION STANDARDS

Microgeneration Standards will be revised by issue of revised editions or amendments. Details will be posted on the website at www.microgenerationcertification.org

Technical or other changes which affect the requirements for the approval or certification of the product or service will result in a new issue. Minor or administrative changes (e.g. corrections of spelling and typographical errors, changes to address and copyright details, the addition of notes for clarification etc.) may be made as amendments.

The issue number will be given in decimal format with the integer part giving the issue number and the fractional part giving the number of amendments (e.g. Issue 3.2 indicates that the document is at Issue 3 with 2 amendments).

Users of this Standard should ensure that they possess the latest issue and all amendments.

TABLE OF CONTENTS

1. FOREWORD

The following document contains provisions, which, through reference in this text, constitute normative or informative provisions of this document MCS 006. At the time of publication, the editions indicated were valid. All documents are subject to revision, and parties applying this document MCS 006 are encouraged to investigate the possibility of applying the most recent editions of the documents referenced.

The following document MCS 006 issue 2.1 is a minor update to issue 2.0 which was a major update to MCS 006 issue 1.5. It is available for reference from the date of publication 15 January 2014. Manufacturers or importers of microgeneration systems who have certificated a microgeneration product in accordance with MCS 006 may commence working in accordance with this update from 15 January 2014. Manufacturers or importers of microgeneration systems who have certificated a microgeneration product in accordance with MCS 006 prior to 15 January 2014 must comply with this update from 15 January 2019. Manufacturers or importers of microgeneration systems who certificate a microgeneration product in accordance with MCS 006 after 15 January 2014 must comply with this update from 15 January 2017.

The exception to the above paragraph is that section 8.2 must be complied with in its entirety from 15 January 2014.

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2. INTRODUCTION

This document identifies the evaluation and assessment requirements and practices for the purposes of certification and listing of Small Wind Turbines. Certification, listing and approval of products is based on evidence acceptable to the certification body:

- that the product meets this standard;
- that the manufacturer has staff, processes and systems in place to ensure that the product delivered meets this standard.

and on:

- periodic audits of the manufacturer including testing as appropriate;
- compliance with the contract with the certification body for listing and approval including agreement to rectify faults as appropriate.

3. SCOPE

This scheme provides ongoing independent, third party assessment and approval of companies who wish to demonstrate that their small wind turbines with rated electrical power outputs up to 50 kW (measured at a wind speed of 11.0 m/s) and:

a) with a rotor swept area smaller than or equal to 200m^2 meet and continue to meet the requirements of the RenewableUK Small Wind Turbine Standard (15 January 2014)[1]; or,

b) meet and continue to meet the requirements of the most recent edition of IEC 61400-1 Wind Turbines – Design Requirements and selected requirements of the RenewableUK Small Wind Turbine Standard (15 January 2014).

For information purposes please note:

1. The RenewableUK Small Wind Turbine Standard (15 January 2014) requires conformity with almost all of the IEC 61400-2 edition 3 Small Wind Turbine Standard.

2. The IEC 61400-2 edition 3 Small Wind Turbine Standard applies to all wind turbines with a rotor swept area smaller than or equal to 200m^2, generating electricity at a voltage below 1000 V AC or 1500 V DC for both on-grid and off-grid applications.

3. The definition of a small wind turbine is fully described in IEC 61400-2, but includes all subsystems such as protection mechanisms, internal electrical systems, mechanical systems, support structures, foundations and the electrical interconnection with the load. A small wind turbine system includes the wind turbine itself including support structures, the turbine controller, the charge controller / inverter (if required), wiring and disconnects, the installation and operation manual(s) and other documentation.

4. The MCS scheme limits the scope of MCS 006 to small wind turbines with rated electrical power outputs up to 50 kW (measured at a wind speed of 11.0 m/s). To allow the MCS scheme to cater for wind turbines of more than 200m^2 swept area but less than 50kW rated electrical power the IEC 61400-1 Wind Turbines – Design Requirements standard is also available.

[1] Previously the RenewableUK Small Wind Turbine Standard was published as the BWEA Small Wind Turbine Performance and Safety Standard.

4. APPLICATIONS TO JOIN THE SCHEME

Applications should be made to an accredited certification body operating this scheme, who will provide the appropriate application form and details of the applicable fees.

5. MANAGEMENT SYSTEMS CERTIFICATION

Manufacturers shall operate a documented manufacturing quality control system, in accordance with the requirements of MCS 010 “Generic Factory Production Control Requirements”.

6. CERTIFICATION AND APPROVAL

Certification and approval is based on the following:

Evidence of compliance with:

a) the requirements of the RenewableUK Small Wind Turbine Standard (15 January 2014); or,

b) the requirements of the most recent edition of IEC 61400-1 Wind Turbines – Design Requirements and the following requirements of the RenewableUK Small Wind Turbine Standard (15 January 2014):

Foreword
Section 1: General Information, excepting 2.3 Scope
Section 2: Acoustic Noise Measurement
Section 3: Power Performance Testing
Section 4: Compliance with IEC 61400-2 is not required except for: 11 (Documentation Requirements, insofar as required by the RenewableUK Small Wind Turbine Standard); 12 (Wind Turbine Markings))
Section 5: Reporting
Section 6: Certification, except substituting IEC 61400-1 for IEC 61400-2
Section 7: Variants and Modifications
Section 8: Ongoing Obligations
Section 9: References

Evidence of compliance is accepted in accordance with MCS 011 ‘Testing acceptance criteria’.

c) Verification of the establishment and maintenance of the manufacturing company's quality management system in accordance with the Factory Production Control requirements (FPC).

Applications for a range of common products (product families) will be dealt with on a case by case basis generally in accordance with the guidance given in Section 7 of the RenewableUK Small Wind Turbine Standard (15 January 2014) on the basis that a product family can be considered to be conceptually similar to changes to a product.

A certificate is awarded following demonstration of satisfactory compliance with this standard and this scheme document, taking into account any limitations imposed by this standard and other appropriate guidelines and satisfactory verification/assessment of the manufacturer's Factory Production Control and technical documentation.

Certificates contain the name and address of the manufacturer, model and reference number of the wind turbine, this test standard, a unique certificate reference number and the issue number and date.

Certificates are valid from the date of issue and are maintained and held in force subject to satisfactory completion of the requirements for maintenance of certification (see item 7), but remain the property of the issuing certification body.

Details of the manufacturer and the certificated product(s) are listed on the website at www.microgenerationcertification.org

7. TECHNICAL DOCUMENTATION

A full set of documentation for the product as described in the RenewableUK Small Wind Turbine Standard (15 January 2014) Section 6 (or if applying para 6.b. of this MCS standard then substituting IEC 61400-1 for IEC 61400-2) must be submitted for review. This documentation shall be presented in English and shall be such that it can be assured that the products submitted for test are equivalent to those that are to be manufactured for normal production.

8. MAINTENANCE OF CERTIFICATION AND LISTING

Certificates and listing are maintained and held in force subject to satisfactory completion of the following requirements for maintenance of certification:

8.1 Factory audits

Certification is maintained through annual FPC quality system audits, which shall include a detailed check that the product being manufactured is to the same specification as the product tested.

8.2 Product audits and other ongoing obligations

Product audits will be conducted as follows:

8.2.1 review of the product technical data files including materials.

8.2.2 review of end of line tests in accordance with the manufacturer's quality plan.

8.2.3 repeat testing of elements from the product standard as appropriate to confirm that the product continues to meet the requirements for certification and listing.

8.2.4 certification is otherwise maintained as described in section 8 of the RenewableUK Small Wind Turbine Standard (15 January 2014) which includes provision for changes to the product or processes to be notified to the Certification Body in advance of implementation, unless otherwise agreed with the Certification Body.

9. CERTIFICATION MARK AND LABELLING

All approved products listed under this scheme shall be traceable to identify that they have been tested and certificated in accordance with the requirements of the test standard. See below for details.

The Supplier shall use Certification Mark(s) in accordance with the Certification Bodies' instructions

An example of the certification mark that can be used for this scheme is as follows:

APPROVED PRODUCT

MCS

Certificate Number MCS "XXX"

"Description of the Technology certificated"

Where 'XXX' is the certificate number and the logo of the certification body issuing the certification would sit in the right hand box.

Companies may only use the mark while the certification is maintained.

REVISION OF MICROGENERATION CERTIFICATION SCHEME (MCS) REQUIREMENTS

Microgeneration Certification Scheme (MCS) scheme requirements will be revised by issue of revised editions or amendments. Details will be posted on our website at www.microgenerationcertification.org

Technical or other changes which affect the requirements for the approval or certification of the product or service will result in a new issue. Minor or administrative changes (e.g. corrections of spelling and typographical errors, changes to address and copyright details, the addition of notes for clarification etc.) may be made as amendments.

The issue number will be given in decimal format with the integer part giving the issue number and the fractional part giving the number of amendments (e.g. Issue 3.2 indicates that the document is at Issue 3 with 2 amendments).

Users of this standard should ensure that they possess the latest issue and all amendments.

AMENDMENTS ISSUED SINCE PUBLICATION

Document Number:	Amendment Details:	Date:
1.1	‘UK’ removed from scheme name; ‘Department of Trade and Industry’ MCS mark replaced by ’BERR ‘ MCS mark	11/01/2008
1.2	Revision details added; BRE Certification Limited mark replaced by BRE Global mark	25/02/2008
1.3	Gemserv details added as Licensee. Document reformatted to reflect brand update. References to BERR updated to DECC, MCS logo updated accordingly. Website and email addresses updated to reflect new name.	01/12/2008
1.4	Quality review	10/01/2009
1.5	MCS Mark updated Update to BWEA revision 29 Feb 2008 Size limit modified to be 0 - 50kW. Repetition of underlying standards eliminated. Product family guidance given Tighter definition of compliance.	10/07/2009
2.0	Given revision number 2.0 to reflect major changes in underlying references: Revised following publication of IEC 61400-2 edition 3 (available as an FDIS pre-release of the official standard with IEC reference number 88/465/FDIS), and corresponding publication of a revision to the BWEA standard, now titled RenewableUK Small Wind Turbine Standard (01 October 2013). Name adjusted to align with international standards.	01/10/2013

	Option of using 61400-1 added with removal of 200m2 swept area constraint if used. Following initial consultation: Sunset and sunrise modified to 0-3-5 years	
2.1	Minor change following final publication of IEC 61400-2 edition 3.0 and corresponding minor changes and errata in Renewable UK Small Wind Turbine Standard.	15/01/2014

PROPOSAL TO INSTALL A 49kW ORENDA WIND TURBINE

LAND AT FIELDHEAD FARM

Turbine Location:
TURBINE 1 – 341618 853248

OCTOBER 2017

Existing view

Project:
Fieldhead

	Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Distance [m]
1 New	Yes	Orenda	-51	51	19.1	24.5	2,853
7 Exist	Yes	C & F	CF20-20	20	13.1	20.5	2,761

Recommended observation distance: 30 cm
Photo exposed: 24/09/2017 15:47:02
Lens: 50 mm Film: 36x24 mm Pixels: 2448x1633
Eye point: British TM-OSGB36/Airy (GB/IE) East: 338,866 North: 852,496
Wind direction: 0° Direction of photo: 82°
Camera: A
Photo: C:\Users\Adele\Dropbox\Adams photos\Fieldhead\338866 852496.jpg

Created by:
Adele Ellis / whichturbine@btinternet.com

Project:
Fieldhead

	Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Distance [m]
1 New	Yes	Orenda	-51	51	19.1	24.5	2,853
5 Exist	Yes	Evance	R9000-5	5	5.5	15.0	2,853
7 Exist	Yes	Evance	R9000-5	5	5.5	15.0	3,939
8 Exist	Yes	C & F	CF20-20	20	13.1	20.5	2,761

Recommended observation distance: 35 cm
Photo exposed: 24/09/2017 15:47:02
Lens: 50 mm Film: 39x19 mm Pixels: 1000x500
Eye point: British TM-OSGB36/Airy (GB/IE) East: 338,866 North: 852,496
Wind direction: 0° Direction of photo: 82°
Camera: A
Photo: C:\Users\Adele\Dropbox\Adams photos\Fieldhead\338866 852496.jpg

Created by:
Adele Ellis / whichturbine@btinternet.com

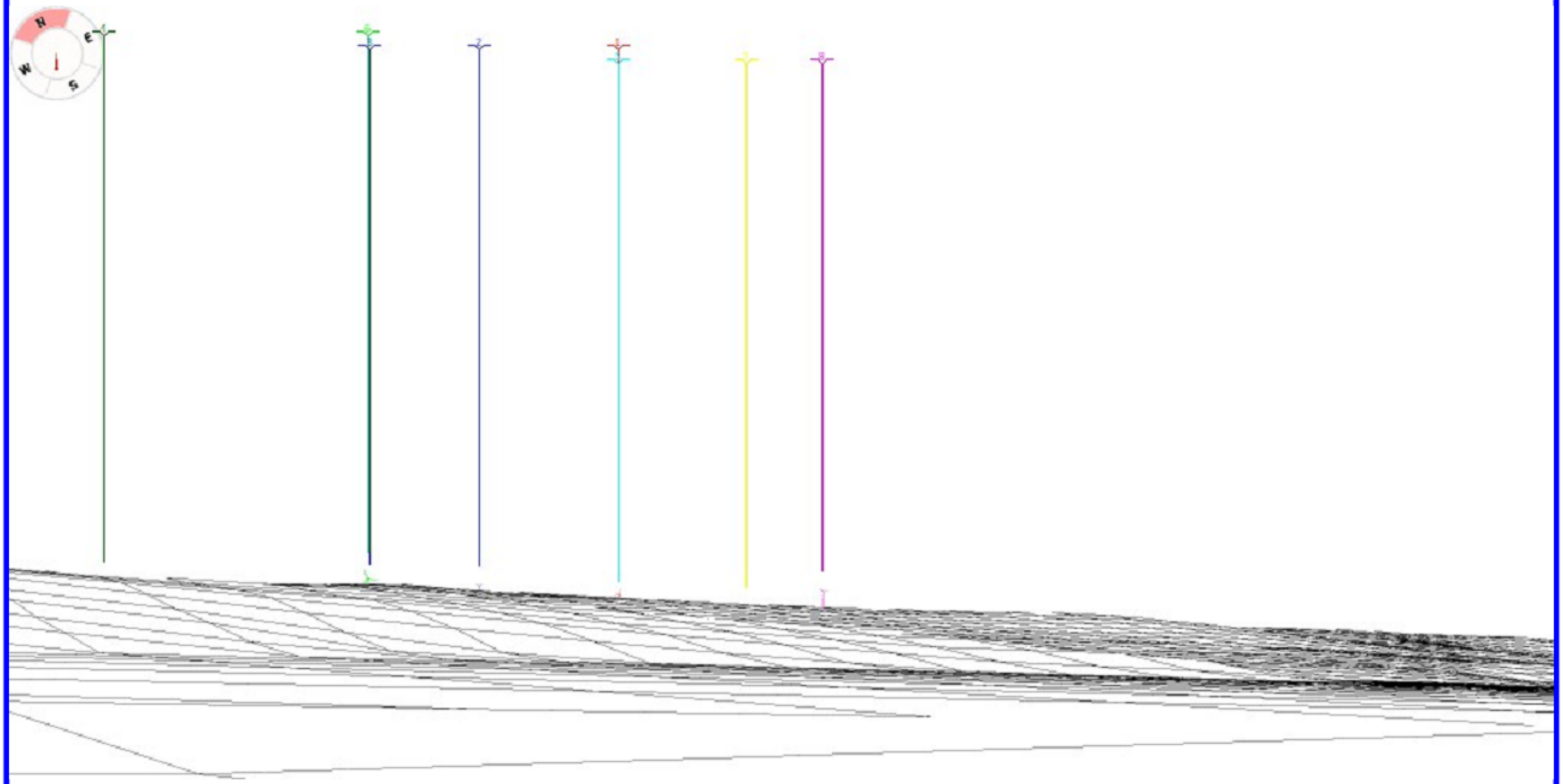
Existing view

Project:
Fieldhead

		Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Distance [m]
1	New	Yes	Orenda	-51	51	19.1	24.5	3,119
2	Exist	Yes	Orenda	-51	51	19.1	24.5	4,567
3	Exist	Yes	Orenda	-51	51	19.1	24.5	4,613
4	Exist	Yes	C & F	CF20-20	20	13.1	20.5	3,486
5	Exist	Yes	EWT	DW52-500	500	51.5	40.0	4,785
6	Exist	Yes	Evance	R9000-5	5	5.5	15.0	4,395
7	Exist	Yes	C & F	CF20-20	20	13.1	20.5	2,531

Recommended observation distance: 30 cm
Photo exposed: 24/09/2017 15:06:03
Lens: 50 mm Film: 36x24 mm Pixels: 2448x1633
Eye point: British TM-OSGB36/Airy (GB/IE) East: 340,423 North: 850,367
Wind direction: 0° Direction of photo: 26°
Camera: B
Photo: C:\Users\Adele\Dropbox\Adams photos\Fieldhead\340423 850367.jpg

Created by:
Adele Ellis / whichturbine@btinternet.com



Project:
Fieldhead

	Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Distance [m]
1 New	Yes	Orenda	-51	51	19.1	24.5	3,119
2 Exist	Yes	Orenda	-51	51	19.1	24.5	4,567
3 Exist	Yes	Orenda	-51	51	19.1	24.5	4,613
4 Exist	Yes	C & F	CF20-20	20	13.1	20.5	3,486
5 Exist	Yes	Evance	R9000-5	5	5.5	15.0	3,119
6 Exist	Yes	EWT	DW52-500	500	51.5	40.0	4,785
7 Exist	Yes	Evance	R9000-5	5	5.5	15.0	4,395
8 Exist	Yes	C & F	CF20-20	20	13.1	20.5	2,531

Recommended observation distance: 35 cm
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Wind direction: 0° Direction of photo: 26°
Camera: B
Photo: C:\Users\Adele\Dropbox\Adams photos\Fieldhead\340423 850367.jpg

Created by:
Adele Ellis / whichturbine@btinternet.com

Existing view

Project:
Fieldhead

	Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Distance [m]
1 New	Yes	Orenda	-51	51	19.1	24.5	1,969
2 Exist	Yes	Orenda	-51	51	19.1	24.5	3,435
3 Exist	Yes	Orenda	-51	51	19.1	24.5	3,532
5 Exist	Yes	EWT	DW52-500	500	51.5	40.0	3,702
6 Exist	Yes	Evance	R9000-5	5	5.5	15.0	3,152
7 Exist	Yes	C & F	CF20-20	20	13.1	20.5	1,319

Recommended observation distance: 30 cm

Photo exposed: 24/09/2017 15:15:00

Lens: 50 mm Film: 36x24 mm Pixels: 2448x1633

Eye point: British TM-OSGB36/Airy (GB/IE) East: 341,489 North: 851,283

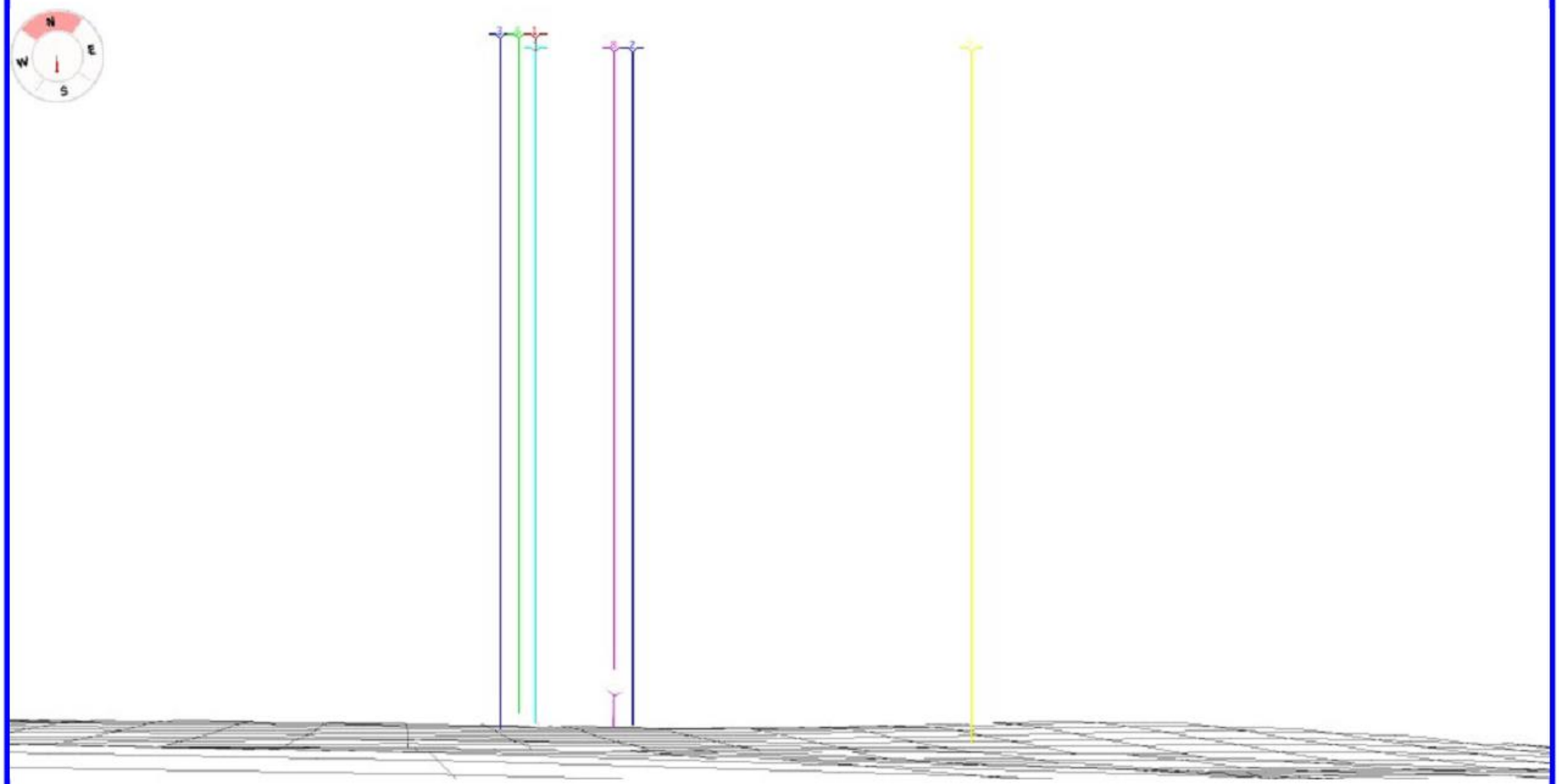
Wind direction: 0° Direction of photo: 10°

Camera: C

Photo: C:\Users\Adele\Dropbox\Adams photos\Fieldhead\341489 851283.jpg

Created by:

Adele Ellis / whichturbine@btinternet.com



Project:
Fieldhead

	Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Distance [m]
1 New	Yes	Orenda	-51	51	19.1	24.5	1,969
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5 Exist	Yes	Evance	R9000-5	5	5.5	15.0	1,969
6 Exist	Yes	EWT	DW52-500	500	51.5	40.0	3,702
7 Exist	Yes	Evance	R9000-5	5	5.5	15.0	3,152
8 Exist	Yes	C & F	CF20-20	20	13.1	20.5	1,319

Recommended observation distance: 35 cm
Photo exposed: 24/09/2017 15:15:00
Lens: 50 mm Film: 39x19 mm Pixels: 1000x500
Eye point: British TM-OSGB36/Airy (GB/IE) East: 341,489 North: 851,283
Wind direction: 0° Direction of photo: 10°
Camera: C
Photo: C:\Users\Adele\Dropbox\Adams photos\Fieldhead\341489 851283.jpg

Created by:
Adele Ellis / whichturbine@btinternet.com

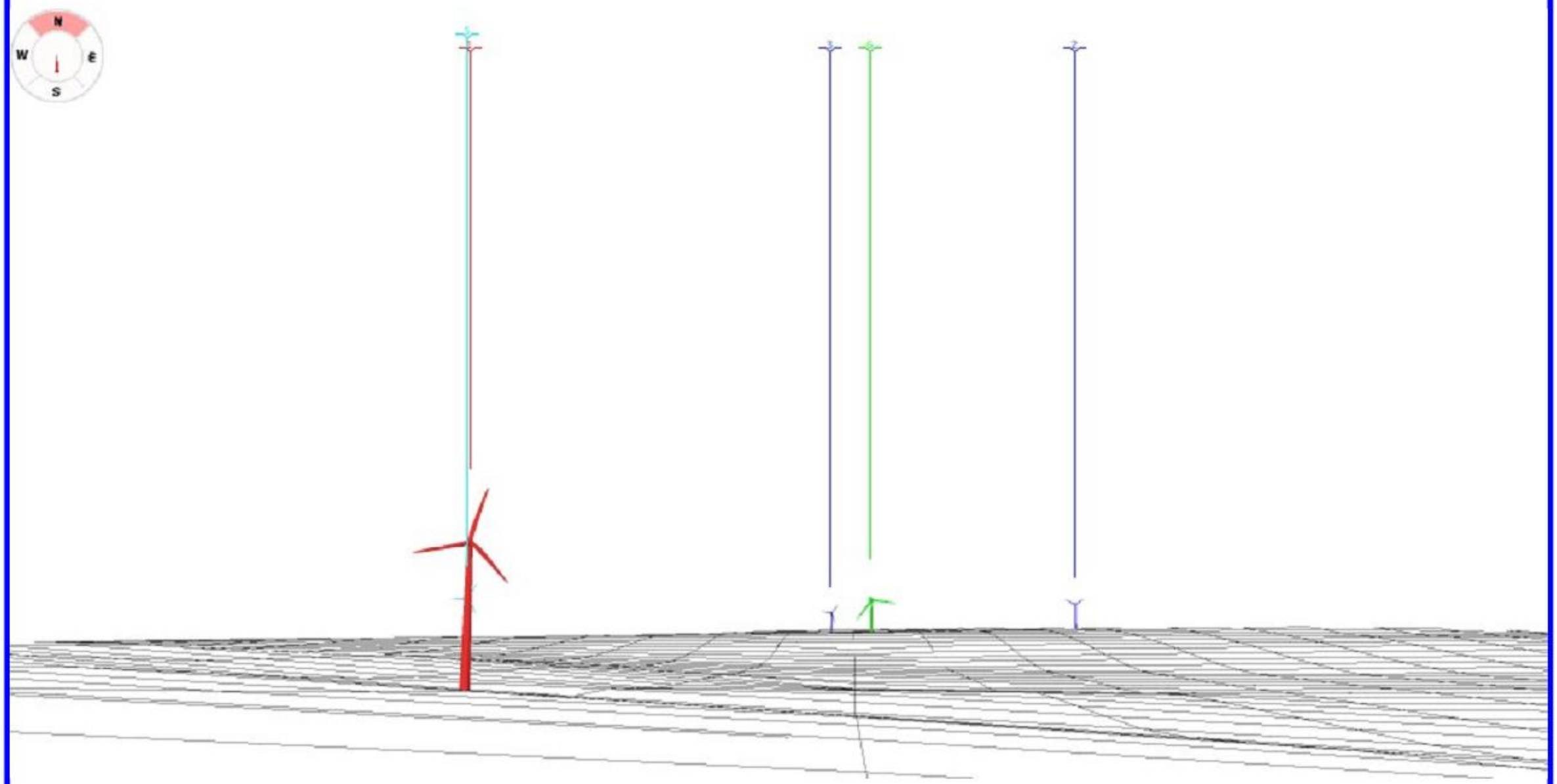
Existing view

Project:
Fieldhead

	Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Distance [m]
1 New	Yes	Orenda	-51	51	19.1	24.5	335
2 Exist	Yes	Orenda	-51	51	19.1	24.5	1,788
3 Exist	Yes	Orenda	-51	51	19.1	24.5	1,892
5 Exist	Yes	EWT	DW52-500	500	51.5	40.0	2,060

Recommended observation distance: 30 cm
Photo exposed: 24/09/2017 15:27:39
Lens: 50 mm Film: 36x24 mm Pixels: 2448x1633
Eye point: British TM-OSGB36/Airy (GB/IE) East: 341,682 North: 852,919
Wind direction: 0° Direction of photo: 357°
Camera: D
Photo: C:\Users\Adele\Dropbox\Adams photos\Fieldhead\341682 852919.jpg

Created by:
Adele Ellis / whichturbine@btinternet.com



Project:
Fieldhead

		Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Distance [m]
1	New	Yes	Orenda	-51	51	19.1	24.5	335
2	Exist	Yes	Orenda	-51	51	19.1	24.5	1,788
3	Exist	Yes	Orenda	-51	51	19.1	24.5	1,892
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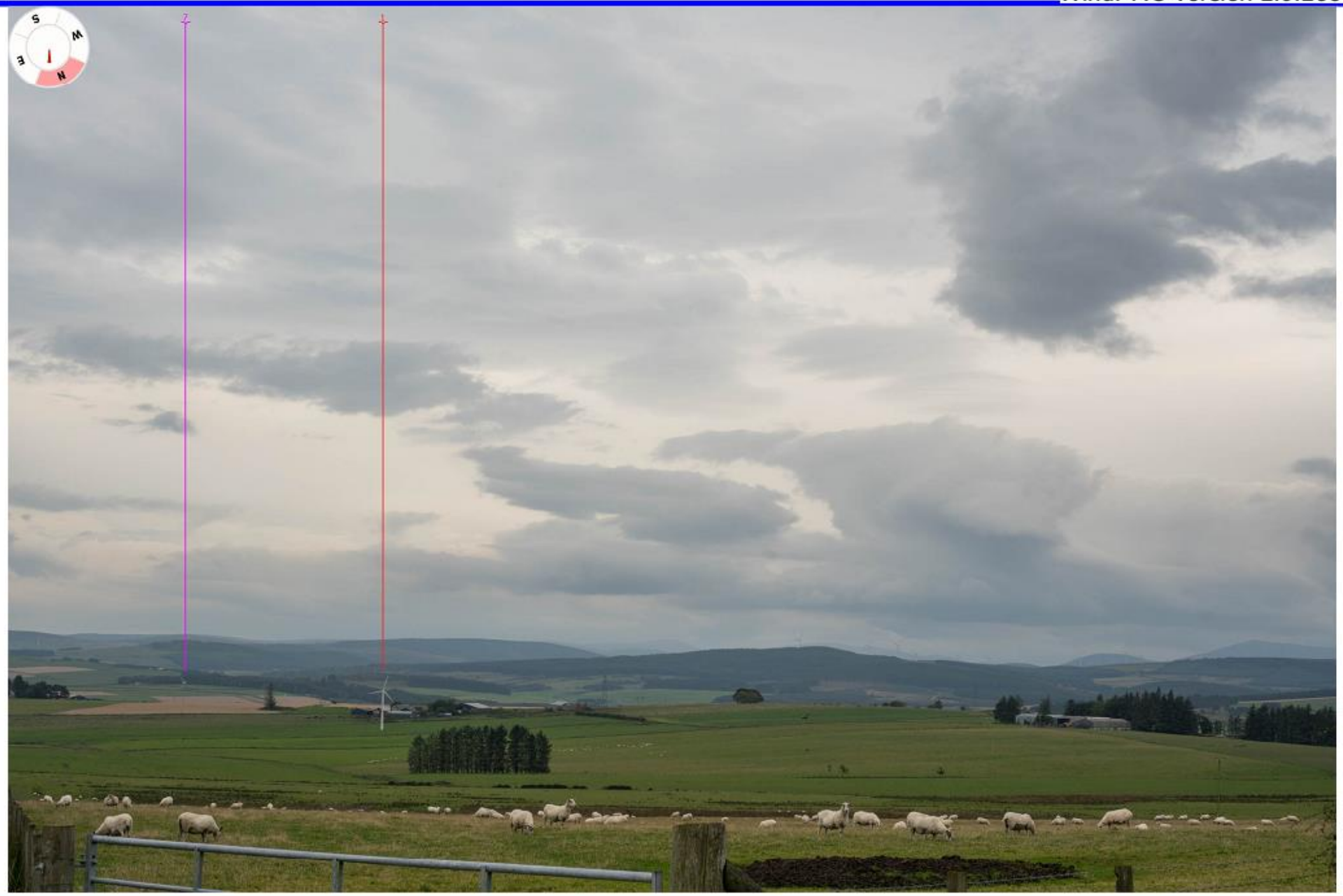
6	Exist	Yes	EWT	DW52-500	500	51.5	40.0	2,060

Recommended observation distance: 35 cm
Photo exposed: 24/09/2017 15:27:39
Lens: 50 mm Film: 39x19 mm Pixels: 1000x500
Eye point: British TM-OSGB36/Airy (GB/IE) East: 341,682 North: 852,919
Wind direction: 0° Direction of photo: 357°
Camera: D
Photo: C:\Users\Adele\Dropbox\Adams photos\Fieldhead\341682 852919.jpg

Created by:
Adele Ellis / whichturbine@btinternet.com

Existing view

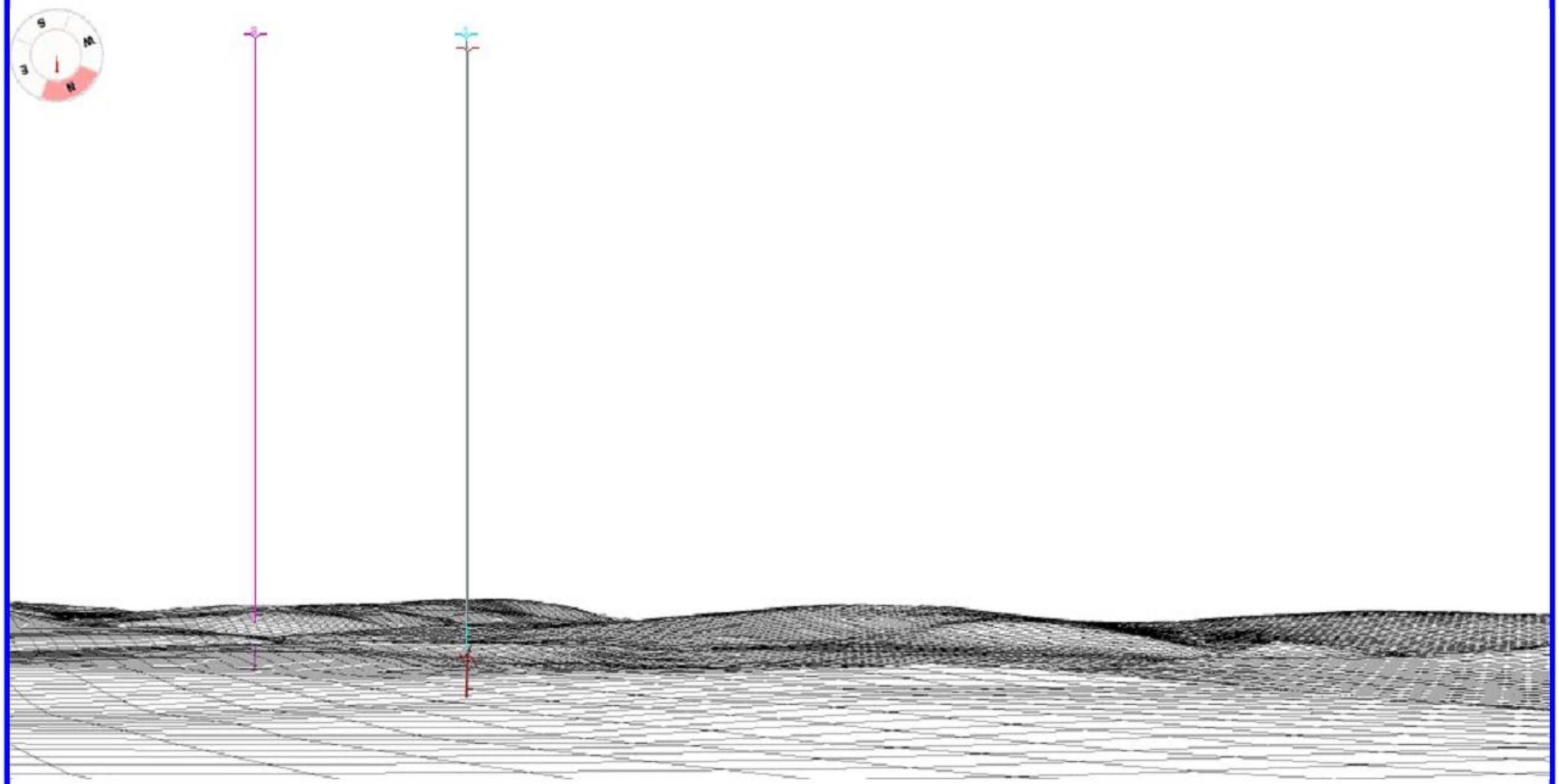


Project:
Fieldhead

	Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Distance [m]
1 New	Yes	Orenda	-51	51	19.1	24.5	1,167
7 Exist	Yes	C & F	CF20-20	20	13.1	20.5	1,803

Recommended observation distance: 30 cm
Photo exposed: 24/09/2017 15:32:14
Lens: 50 mm Film: 36x24 mm Pixels: 2448x1633
Eye point: British TM-OSGB36/Airy (GB/IE) East: 341,933 North: 854,372
Wind direction: 0° Direction of photo: 203°
Camera: E
Photo: C:\Users\Adele\Dropbox\Adams photos\Fieldhead\341933 854372.jpg

Created by:
Adele Ellis / whichturbine@btinternet.com



Project:
Fieldhead

	Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Distance [m]
1 New	Yes	Orenda	-51	51	19.1	24.5	1,167
5 Exist	Yes	Evance	R9000-5	5	5.5	15.0	1,167
8 Exist	Yes	C & F	CF20-20	20	13.1	20.5	1,803

Recommended observation distance: 35 cm
Photo exposed: 24/09/2017 15:32:14
Lens: 50 mm Film: 39x19 mm Pixels: 1000x500
Eye point: British TM-OSGB36/Airy (GB/IE) East: 341,933 North: 854,372
Wind direction: 0° Direction of photo: 203°
Camera: E
Photo: C:\Users\Adele\Dropbox\Adams photos\Fieldhead\341933 854372.jpg

Created by:
Adele Ellis / whichturbine@btinternet.com

Project:
Fieldhead

Description:
Installation of an orenda wind turbine

Printed/Page
04/10/2017 17:12 / 1

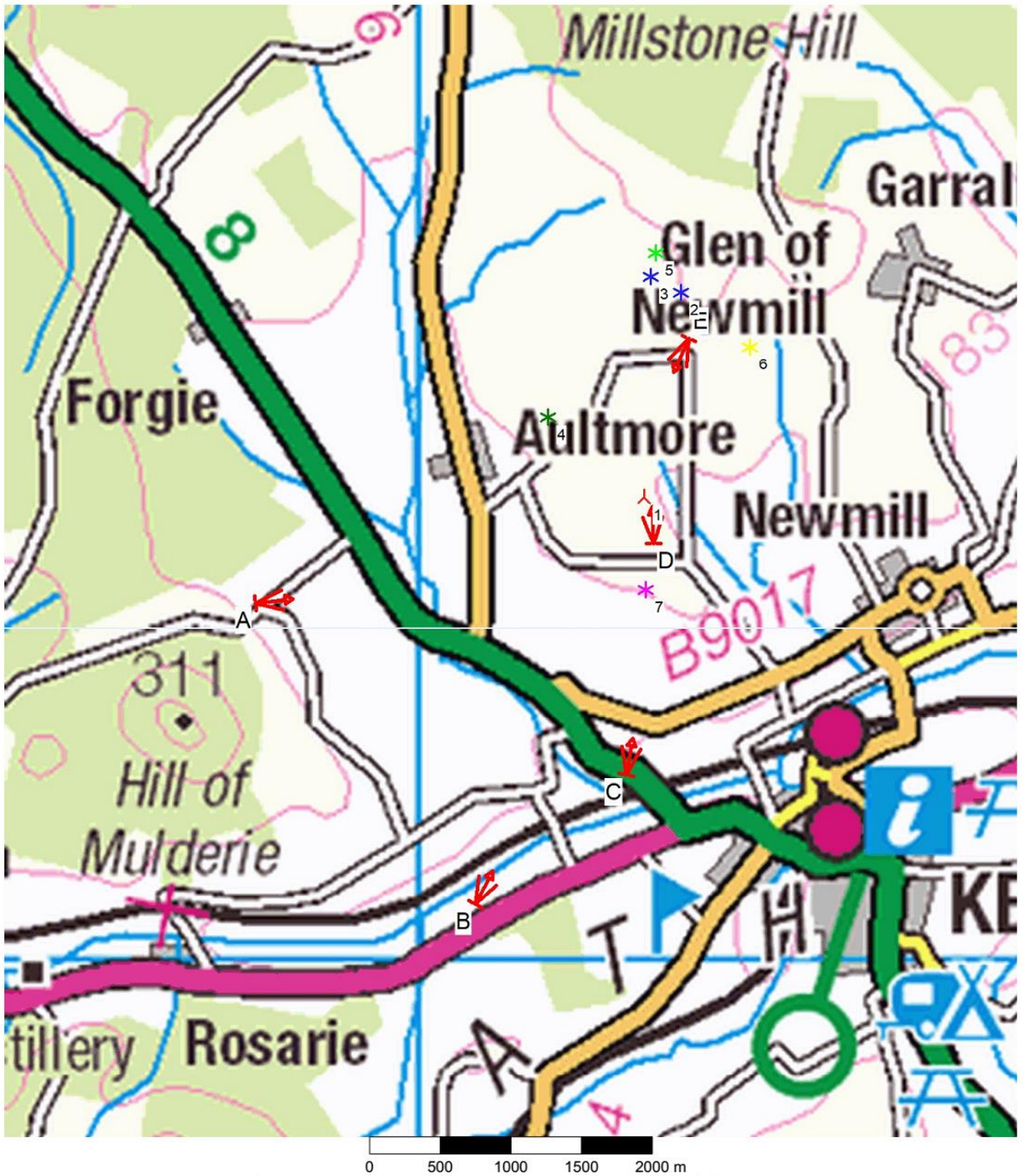
Licensed user:

Adele Ellis / whichturbine@btinternet.com

Calculated:
04/10/2017 17:02/2.9.285

VISUAL - Map

Calculation: VISUAL MONTAGE



Map: Bitmap map: NJ.tif , Print scale 1:40,000, Map center British TM-OSGB36/Airy (GB/IE) East: 340,614 North: 852,673

New WTG Existing WTG Camera

The Ecological Appraisal on the following pages has been partially redacted in terms of Scottish Government Guidance “Publishing Planning Applications online August 2013” which at para 11 includes “sensitive (or confidential) information or data from Environmental Impact Assessments (EIAs) or similar documents submitted in support of the application, for example information relating to sites or locations of protected bird and mammal species, etc.”.

ECOLOGICAL APPRAISAL

PROPOSAL TO INSTALL A 49kW ORENDA WIND TURBINE

LAND AT FIELDHEAD FARM

Turbine Location:
TURBINE 1 – 341618 853248

OCTOBER 2017

INTRODUCTION

The following report pertains to the potential ecological constraints and assessment of potential impacts on Protected Species and Habitats within the vicinity of the proposed 49kw Orenda Wind turbine on land at Fieldhead Farm.

The purpose of the assessment is to assess

- The potential constraints to a development of this nature taking place on site.
- Assess the ecological value of the site
- Ascertain the level of ecological impact
- Highlight and recommend any further specialist assessment requirements.

It has been established that in line with The Town & Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2011 that the proposed development does not require an Environmental Impact Assessment to be submitted in support of the application and therefore a full, in-depth ecological and ornithological study is not required.
It has however been requested that further information regarding of the potential ecological impact and protected species in the area of the proposed development be submitted in order to provide more information to the relevant interested parties.

LEGISLATIVE CONTEXT

In line with current legislation it is acknowledged that the following legislation and guidance requires to be taken into consideration:

- Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Flora and Fauna (the Habitats Directive 1992)
- The Wildlife and Countryside Act 1981 (as Amended)
  Birds
  Schedule 5 Animals
- The Natural Conservation (Scotland) Act 2004; Protection of Badgers Act 1992
- Conservation (Natural Habitat &c.) Regulations 1994 (as Amended)
- Natura 2000 Sites (European Sites)
- Bird Species of Conservation Concern
- Amphibians & Reptiles
- Scottish Biodiversity List
- UK and Local Biodiversity Action Plan (BAP)
- Statutory Designated Sites

Protected Species include:

- Badgers
- Bats
- Water Vole
- Otters
- Red Squirrels
- Great Crested Newts
- Amphibians & Reptiles
- Birds

Protected Sites and Habitats include:

- Sites of Special Scientific Interest (SSSI)
- Special protection Area (SPA)
- Special Area of Conservation (SAC)

AREA OF ECOLOGICAL CONSIDERATION

The area of sensitivity for ecological features vary dependent on the nature, behaviour and/or habitat of the species and how sensitive it/they are to the proposed development.
In order to assess the impact to species, individual habitats and sensitive areas [redacted] has been considered [redacted].

METHODOLOGY
In order to compile an informed report we have consulted SNH directly concerning potential for impact, especially concerning bird activity, Magic Maps, NBN Gateway and NBN Atlas Scotland. The landowners were also asked to provide any information they could about the current interaction of wildlife within the area.

SITE DESCRIPTION
The site lies within an area of land associated with Fieldhead Farm. The Farm is situated within an area known as Aultmore which has a serios of unclassified public roads. The turbine position lies in the region of 313m North, 212m West, 1.08km south and 670m South West of the aforementioned unclassified roadways. The B9017 lies in the region of 1.5km to the South, the B9016 lies 1.29km to the West and the A96 1.85km to the West. Keith lies 2.2km to the south and Newmill 1.7km to the south east. Lying 4.5km south East of the proposed development site lies Mill Wood (SSSI), the only designated site within 5km of the proposed turbine.
The proposed location for the wind turbine sits at a height above sea level of approximately 190m AOD.

We have undertaken desk top analysis of available information in order to ascertain whether there is likely to be impact and if so whether further site specific specialist surveys require to be undertaken.

Based on the information available it has been identified that there is very little bird activity [redacted] and that SNH did not have any comment , we do not anticipate that site specific specialist reporting is required in this instance.

SPECIES REVIEW
Utilising the data provided by Nesbrec and NBN Atlas Scotland for the area we can identify the recorded sightings of species [redacted] is as noted below:

Wood Mouse
Roe Deer

Brown Hare
Otter
Weasel
American Mink
Rabbit
45 Khz Pipistrelle
Pipistrelle
Brown Rat
Mole

BATS
Given that there is recorded bat activity in the area even although it is very low it is considered prudent to adhere to given guidelines regarding the sighting of turbines in relation to potential impact to bats.
It is noted that the turbine position is [redacted] from any building noted for bat activity, that the turbines are not sited along any hedgerow and that they are [redacted] separation between the turbine blade tips and any linear feature that bats may follow.

RED SQUIRREL
There are no recorded sightings of Red squirrel [redacted] and the land on which the turbine is to be sited does not offer suitable habitat for Red squirrels. More suitable and available habitats are available in the wider locale. No tree will be removed or affected by the proposed development.

PINE MARTIN
There are no ecorded sighting of Pine Martin [redacted]. The area in and around the turbine development does not offer suitable habitats or play suitable host to pine martin activity.

WATER VOLE
There are no recorded sighting of water Vole [redacted]. The area in and around the turbine development does not offer suitable habitats or play suitable host to water vole activity.

OTTER
Evidence of Otter has been shown [redacted] Due to their tendency to utilise burns and dense gorse for their habitats it is thought that otter activity it will be centralised in those areas. The area around the turbines does not offer prime habitat which is readily available in other areas. In order to ensure that no impact to any undiscovered habitats that the turbines or an part of the infrastructure including cable runs would not be within 30m of a Burn in order to ensure that any habitat, feeding or commuting route is not disturbed.

BADGERS
There are no identified sites of badgers [redacted]. It is noted however that badgers have been noted to wander widely and therefore it is prudent to mitigate against any potential impact or inadvertent destruction of habitat by the following methods:

- All contractors will be made aware of badgers and their legal protection.
- All contractors will be made aware that there is the potential for badgers to be near the site and that they are at risk from vehicles, exposed trenching and pipes. In order to reduce the risk of badgers being hit by vehicles a speed restriction will be implemented for all vehicles during construction, maintenance and visitations to the site. All trenchwork, pipes and any other potential for open entrapment will be covered safely at the end of each working day to ensure that no badgers or any other wildlife becomes trapped.
- Ramps will be located within trenches or pits that cannot be covered at the end of each day in order to provide an exit for any animal that may inadvertently wander into a pit or trench.

SUMMARY

It can be concluded from the information provided and that readily available online information that [redacted] around the proposed turbine development shows little terrestrial mammals and/or ornithological activity that would be of concern. The land does not offer suitable habitat in respect of ornithological concerns. There has been no evidence of any protected species or habitat on site and with preferred habitats within the areas away from the turbines it is considered that there is minimal risk of impact to species or habitats by the installation of the 49kw Orenda wind turbine. It is noted that there have been sightings of protected species [redacted] and so in order to protect any potential disruption or impact all contractors will be instructed on how to maintain a safe environment and reduce the risk of harm to habitats and species [redacted].

It is considered that no further survey work will be required in order for the turbine development to proceed.

THE MORAY COUNCIL
TOWN AND COUNTRY PLANNING (SCOTLAND) ACT 1997,
as amended

REFUSAL OF PLANNING PERMISSION

[Keith And Cullen]
Application for Planning Permission

TO Orenda Energy Solutions
c/o AE Associates
Cameron House
26 Cupar Road
Auchtermuchty
Fife
KY14 7DD

With reference to your application for planning permission under the above mentioned Act, the Council in exercise of their powers under the said Act, have decided to **REFUSE** your application for the following development:-

Install an Orenda 49kw wind turbine (rotor diameter 18.9M) on Land At Fieldhead Newmill Keith Moray

and for the reason(s) set out in the attached schedule.

Date of Notice: **8 January 2018**

[redacted]

HEAD OF DEVELOPMENT SERVICES
Environmental Services Department
The Moray Council
Council Office
High Street
ELGIN
Moray IV30 1BX

IMPORTANT
YOUR ATTENTION IS DRAWN TO THE REASONS and NOTES BELOW

SCHEDULE OF REASON(S) FOR REFUSAL

By this Notice, the Moray Council has REFUSED this proposal. The Council's reason(s) for this decision are as follows: -

The proposal is contrary to policies PP1, ER1 and IMP1 of the Moray Local Development Plan 2015 and the Council's Moray Onshore Wind Energy Guidance (MOWE) 2017 and Moray Wind Energy Landscape Capacity Study (MWELCS) 2017 for the following reasons:

1. The proposed wind turbine, by reason of its height and exposed open position within the central area of a field, with no adjacent landform or features to mitigate its scale and impact would appear as an unduly prominent feature in the landscape. As such the proposal would fail to integrate sensitively with the landscape and would cause unacceptable adverse visual and landscape character impacts to the detriment of the landscape.

2. The MWELCS outlines a number of constraints which affect this particular Landscape Character Type when assessing wind turbine proposals; these include amongst others cumulative effects with larger turbines and the potential cumulative landscape and visual effects associated with multiple developments that could exacerbate visual clutter around Keith. The MWELCS (at Appendix D) provides further guidance, highlighting the visual clutter effects that occur when different types of wind turbine are erected across the landscape with differing styles, sizes of structures and speeds of blade movement. The introduction of the proposed turbine at this location close to the A96 corridor where, in addition to existing power lines and pylons, there are already a number of consented wind farms and turbines within the vicinity of the site of varying type and size would lead to unacceptable cumulative visual impacts and clutter which would be detrimental to the character of the landscape and surrounding area, contrary to policy PP1, ER1, IMP1, MOWE and MWELCS guidance.

LIST OF PLANS AND DRAWINGS SHOWING THE DEVELOPMENT

The following plans and drawings form part of the decision:-

Reference	Version	Title
EN-4004-A	A	Elevations
		Block plan
		Location plan
		Site location

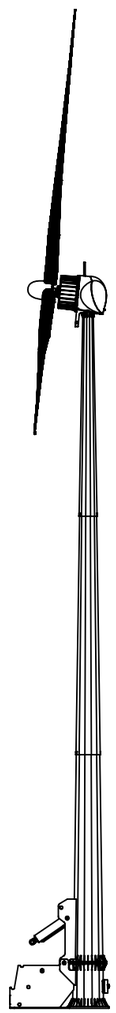
DETAILS OF ANY VARIATION MADE TO ORIGINAL PROPOSAL, AS AGREED WITH APPLICANT (S.32A of 1997 ACT)

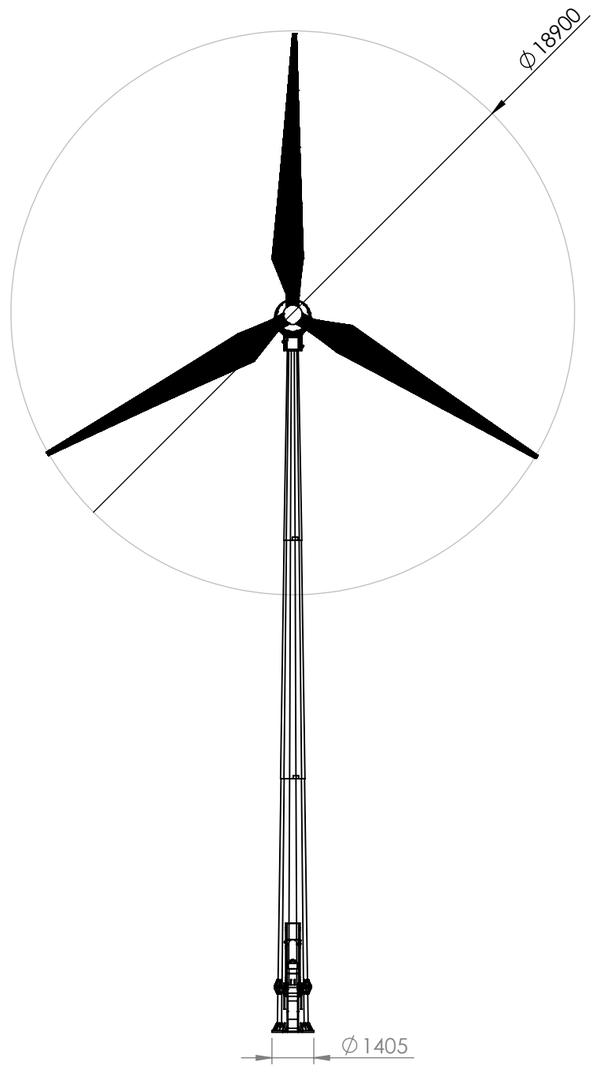
N/A

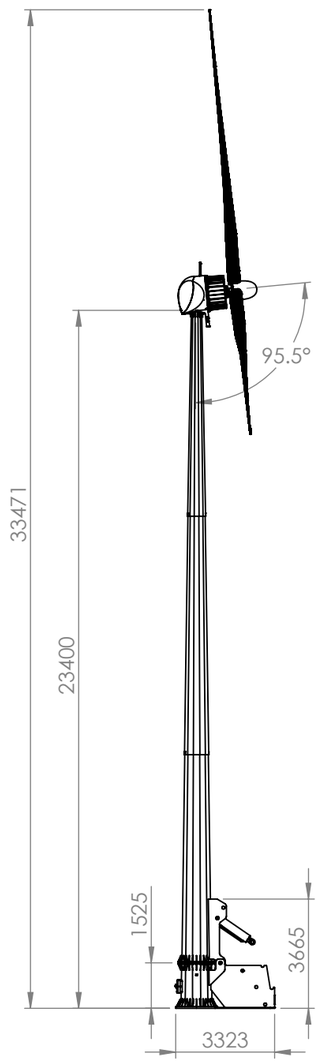
NOTICE OF APPEAL
TOWN AND COUNTRY PLANNING (SCOTLAND) ACT 1997

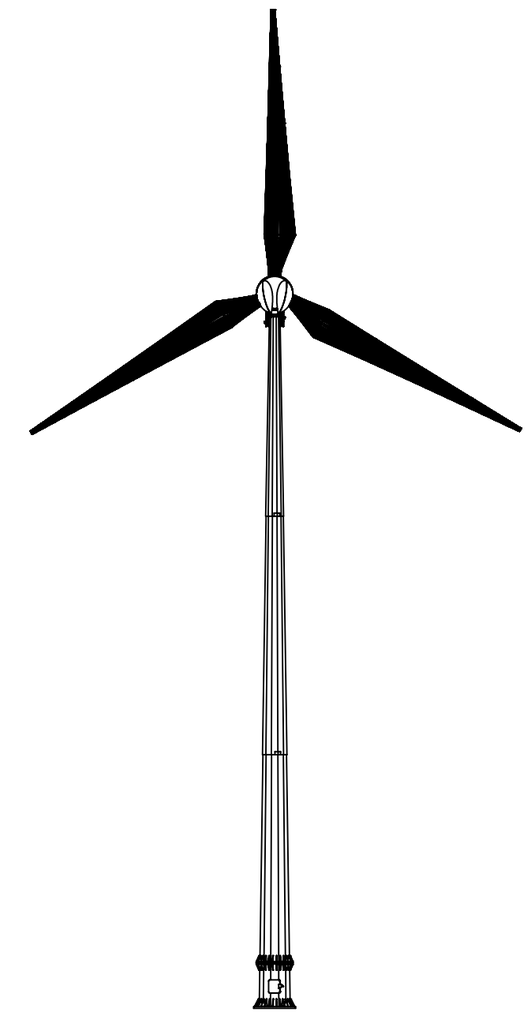
If the applicant is aggrieved by the decision to refuse permission for or approval required by a condition in respect of the proposed development, or to grant permission or approval subject to conditions, the applicant may require the planning authority to review the case under section 43A of the Town and Country Planning (Scotland) Act 1997 within three months from the date of this notice. The notice of review should be addressed to The Clerk, The Moray Council Local Review Body, Legal and Committee Services, Council Offices, High Street, Elgin IV30 1BX. This form is also available and can be submitted online or downloaded from www.eplanning.scotland.gov.uk

If permission to develop land is refused or granted subject to conditions and the owner of the land claims that the land has become incapable of reasonably beneficial use in its existing state and cannot be rendered capable of reasonably beneficial use by the carrying out of any development which has been or would be permitted, the owner of the land may serve on the planning authority a purchase notice requiring the purchase of the owner of the land's interest in the land in accordance with Part 5 of the Town and Country Planning (Scotland) Act 1997.









0 10m

scale 1:200 @ A3

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN MM
TOLERANCES:
ANGULAR: MACH ±0.5°
ONE PLACE DECIMAL ±0.25
TWO PLACE DECIMAL ±0.1

INTERPRET GEOMETRIC TOLERANCING PER:

MATERIAL

FINISH

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	CW	13/12/12
CHECKED	PD	13/12/13
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:

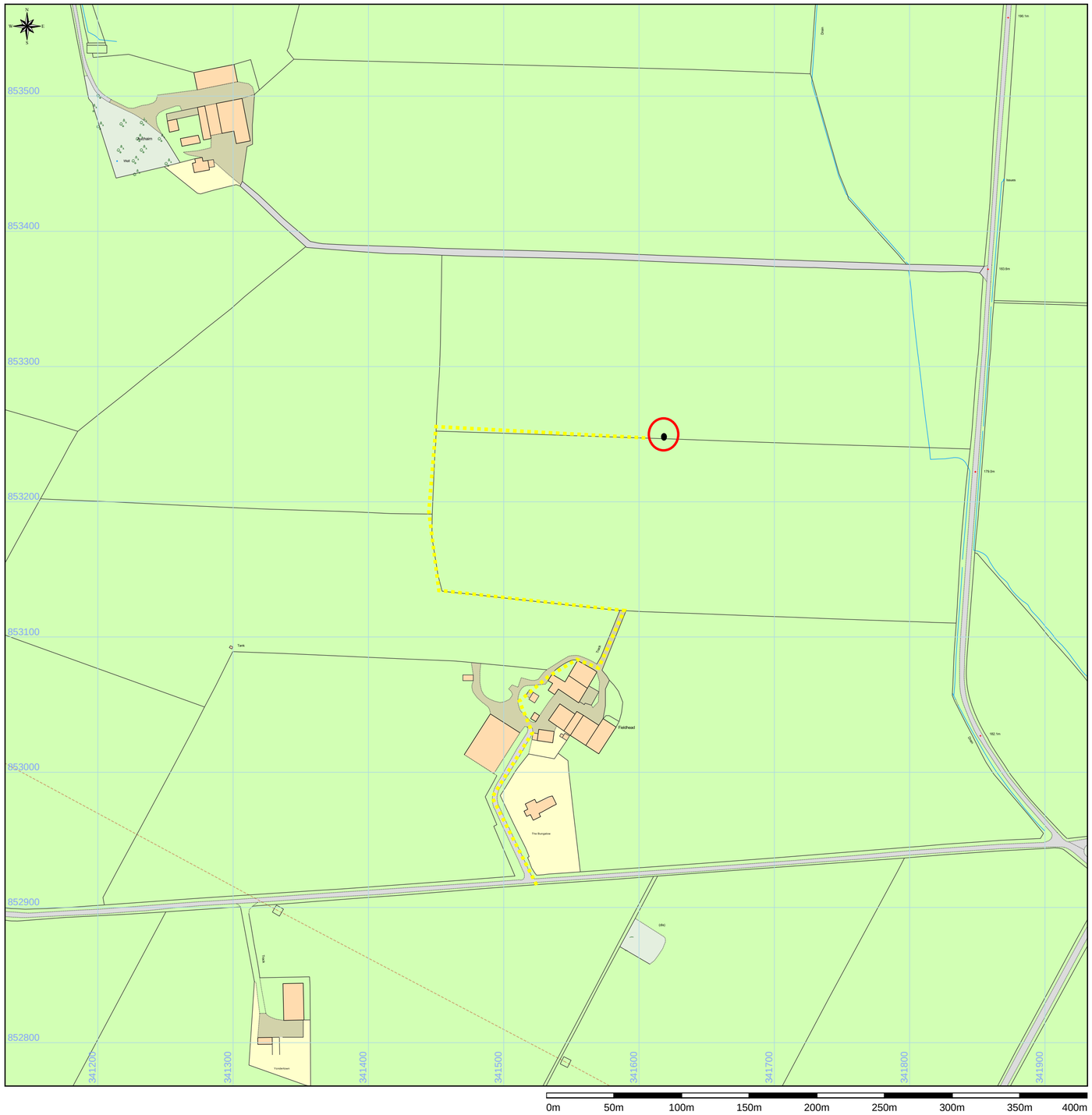
Orenda Energy Solutions

TITLE: SKYE 23.4m TOWER INSTALLATION PLANNING DRAWING

SIZE	DWG. NO.	REV
B	EN-4004-A	A

SCALE: 1:200 WEIGHT: SHEET 1 OF 1

LAND AT FIELDHEAD FARM



Access route

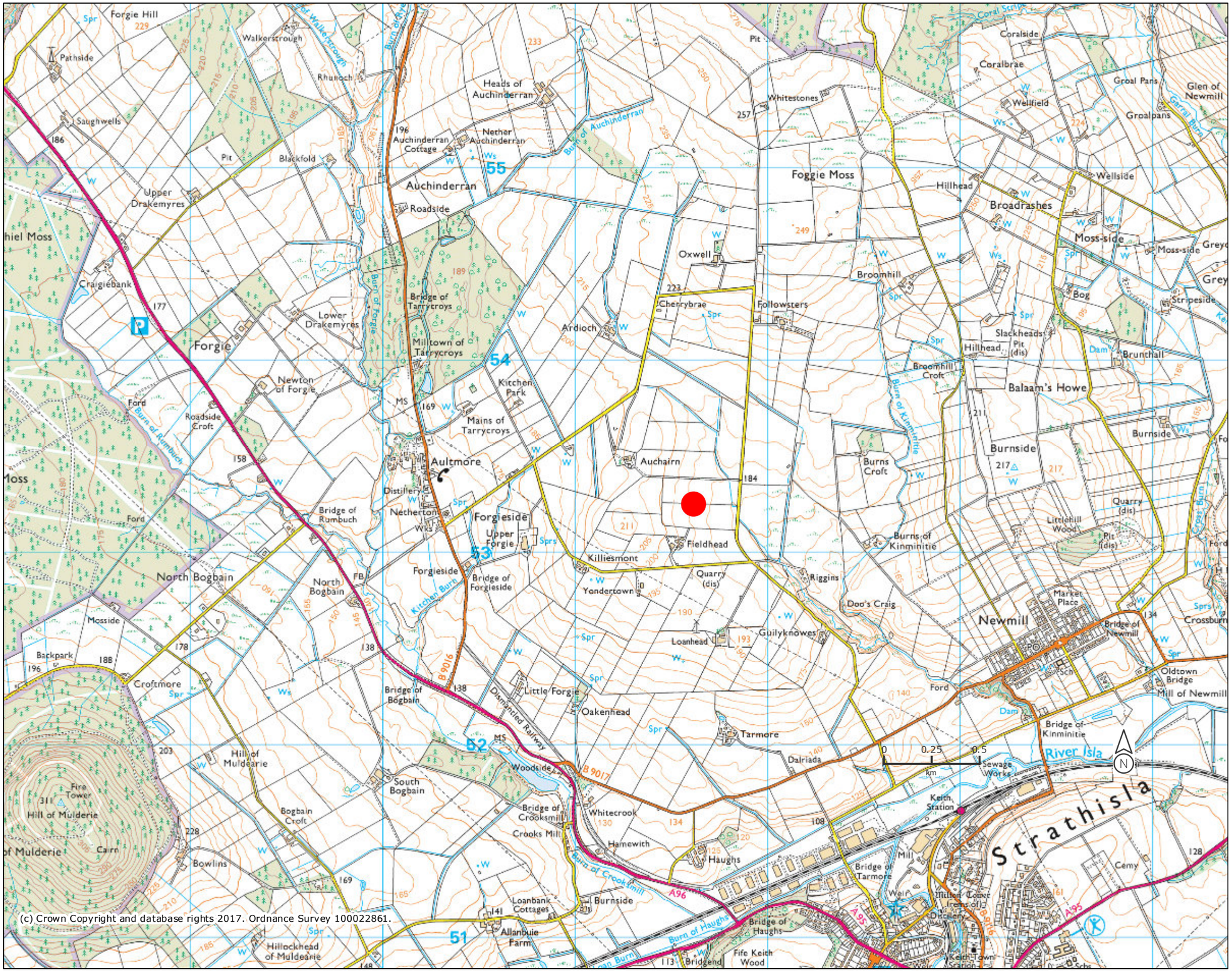
Turbine location - 341618, 853248

Scale: 1:2500, paper size: A2

plans ahead by emapsite™

Prepared by: Craig Allan, 04-07-2017

SITE LOCATION



Legend

- National Nature Reserves (Scotland)
- Ramsar Sites (Scotland)
- Sites of Special Scientific Interest (Scotland)
- Special Areas of Conservation (Scotland)
- Special Protection Areas (Scotland)
- Biosphere Reserves (Scotland)

TURINE POSITION: 341618 853248

0 — 1km

SCALE 1:20,000 @ A3

Project:
Fieldhead

Description:
Installation of an orenda wind turbine

Printed/Page
20/09/2017 13:01 / 1

Licensed user:

Adele Ellis / whichturbine@btinternet.com

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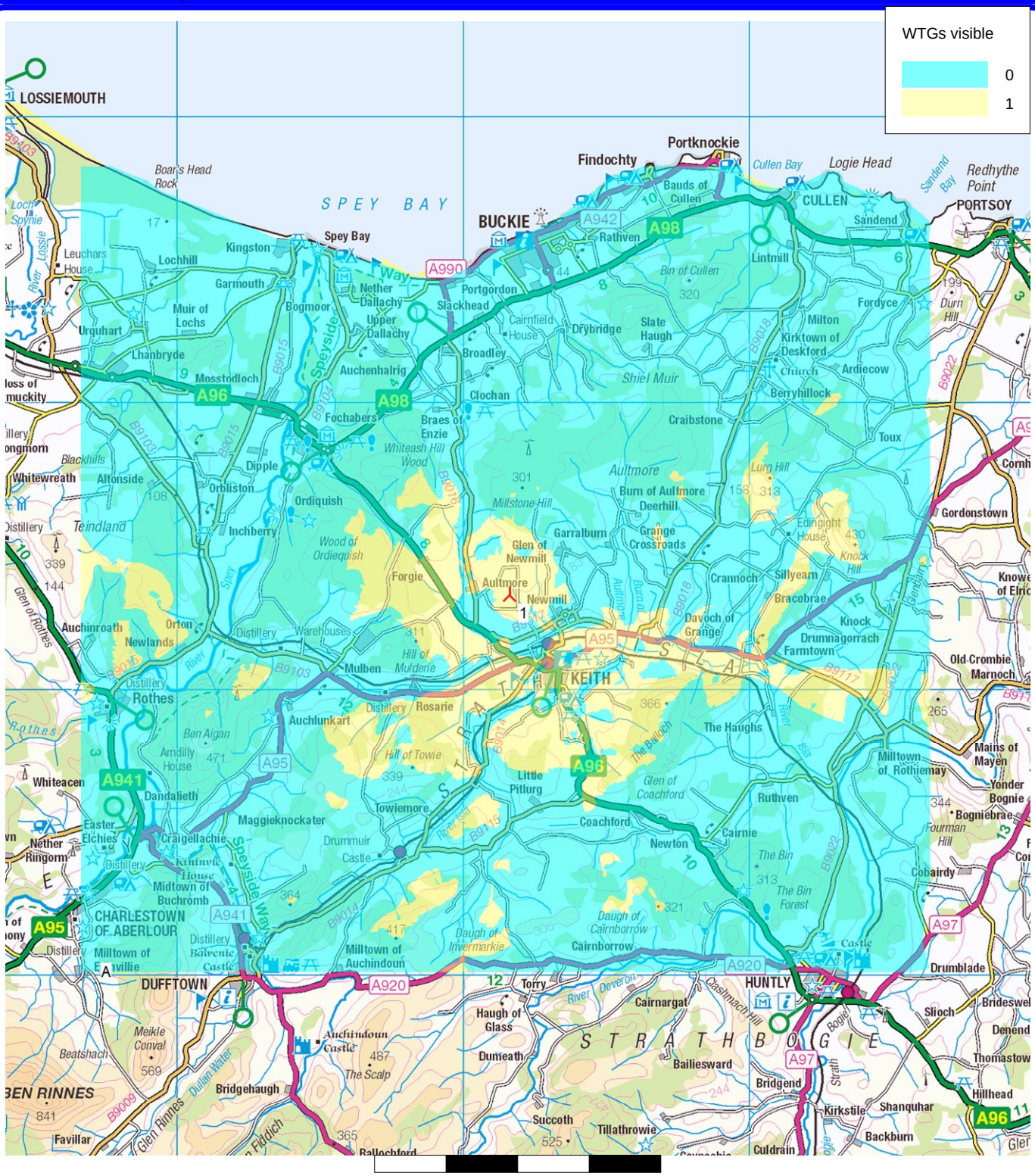
20/09/2017 13:01/2.9.285

ZVI - Map

Calculation: ZTV to tip

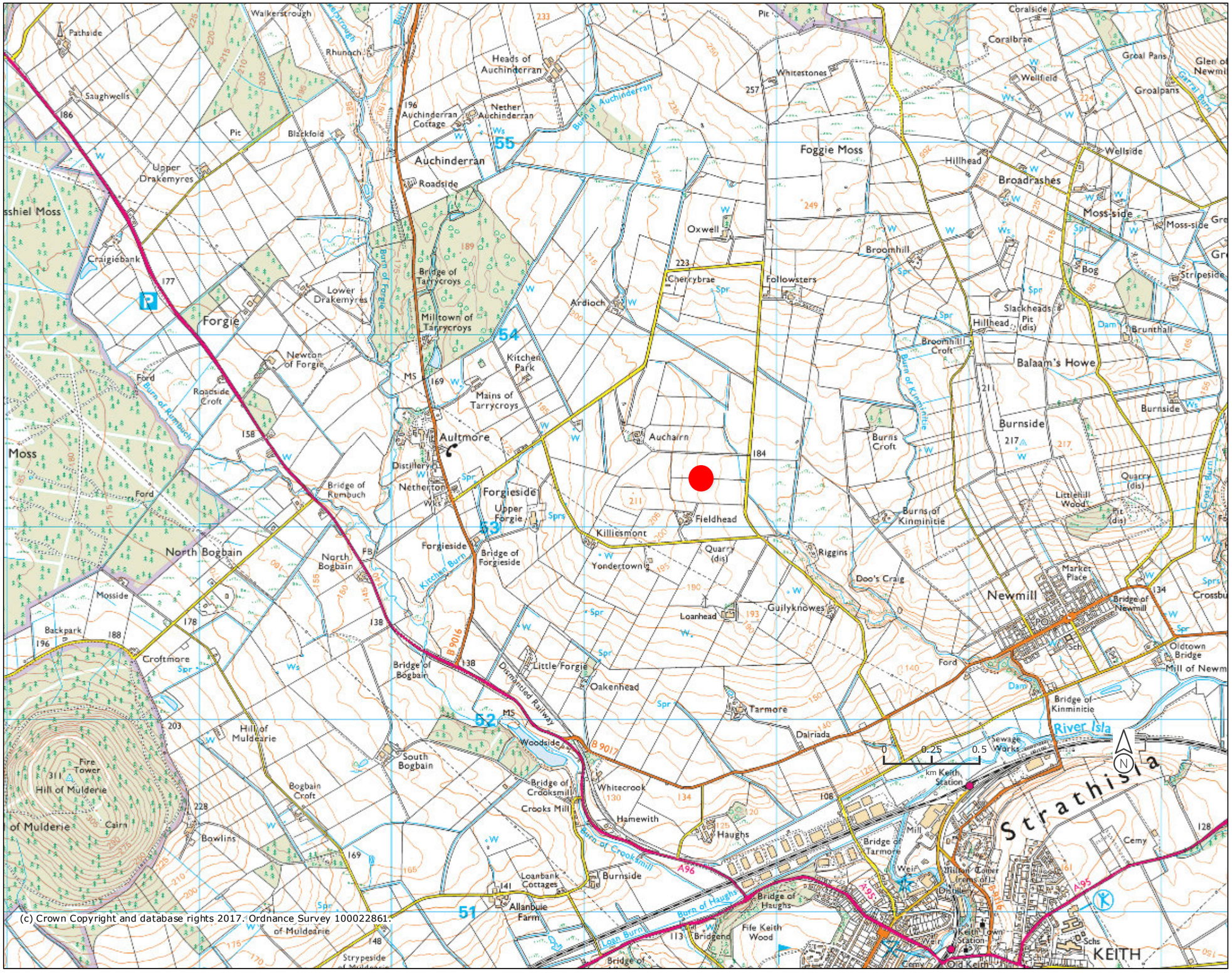


0 2.5 5 7.5 10km

Map: Bitmap map: NJ.tif , Print scale 1:200,000, Map center British TM-OSGB36/Airy (GB/IE) East: 341,618 North: 853,248

New WTG Obstacle

SITE LOCATION



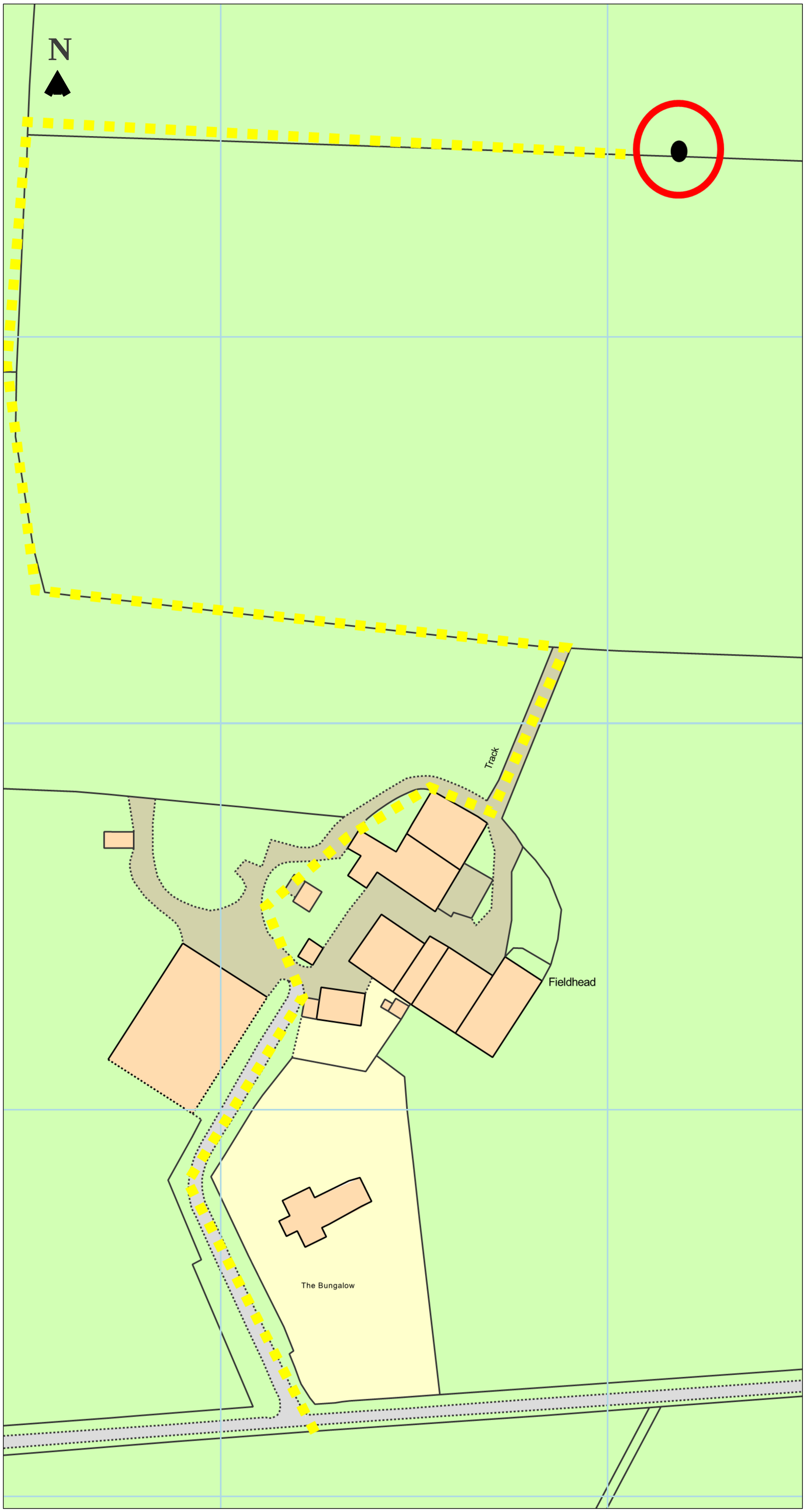
TURBINE POSITION:
341618 853248

0 — 1km

SCALE 1:20,000 @ A3

BLOCK PLAN

LAND AT FIELDHEAD FARM



TURBINE POSITION:
341618, 853248

ACCESS ROUTE

0 100m

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