SUPPORTING STATEMENT

INSTALLATION OF A 49KW WIND TURBINE AT MAINS OF PITLURG 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 – 343229 845608

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 Mains of Pitlurg Farm. The candidate turbine for this project is the Orenda Skye^{TM}. 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 Mains of Pitlurg Farm. The turbine position lies in the region of 438m south of the B9115 and 1.37km South West of the A96. There is a further unclassified road 635m to the south of the development site. Keith lies 4.6km to the north and Huntly 10.8km south east. Lying 292m south of the proposed development site lies the Den of Pitlurg (SSSI).

The proposed location for the wind turbine sits at a height above sea level of approximately 250m 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 (CO_2e). 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 gCO_2/kWh in 2010 to 289 gCO_2/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 gCO_2/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 Mains of Pitlurg 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

The Den of pitlurg (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. There are no statutory designated natural heritage sites within 5km of the proposal. 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
279272	Mains Of Davidston	Farmhouse (Period Unassigned), Farmstead (Period Unassigned)
347871	Hill Of Shenwall	Quarry (Period Unassigned)
158935	Mains Of Davidston, Cottage	Cottage (Period Unassigned)
69282	Denhead	Farmstead (Period Unassigned)
156279	Mains Of Pitlurg	Enclosure (Period Unassigned)
131146	Little Pitlurg	Farmhouse (Period Unassigned), Farmstead (Period Unassigned)
131145	Mains Of Pitlurg	Farmhouse (Period Unassigned), Farmstead (Period Unassigned)
131144	Woodhead	Farmstead (Period Unassigned)
130600	Edintore	Farmstead (Period Unassigned)
235372	Edintore House	House (Period Unassigned)
17301	Pitlurg Castle	Dovecot (Period Unassigned), Tower House (Medieval)

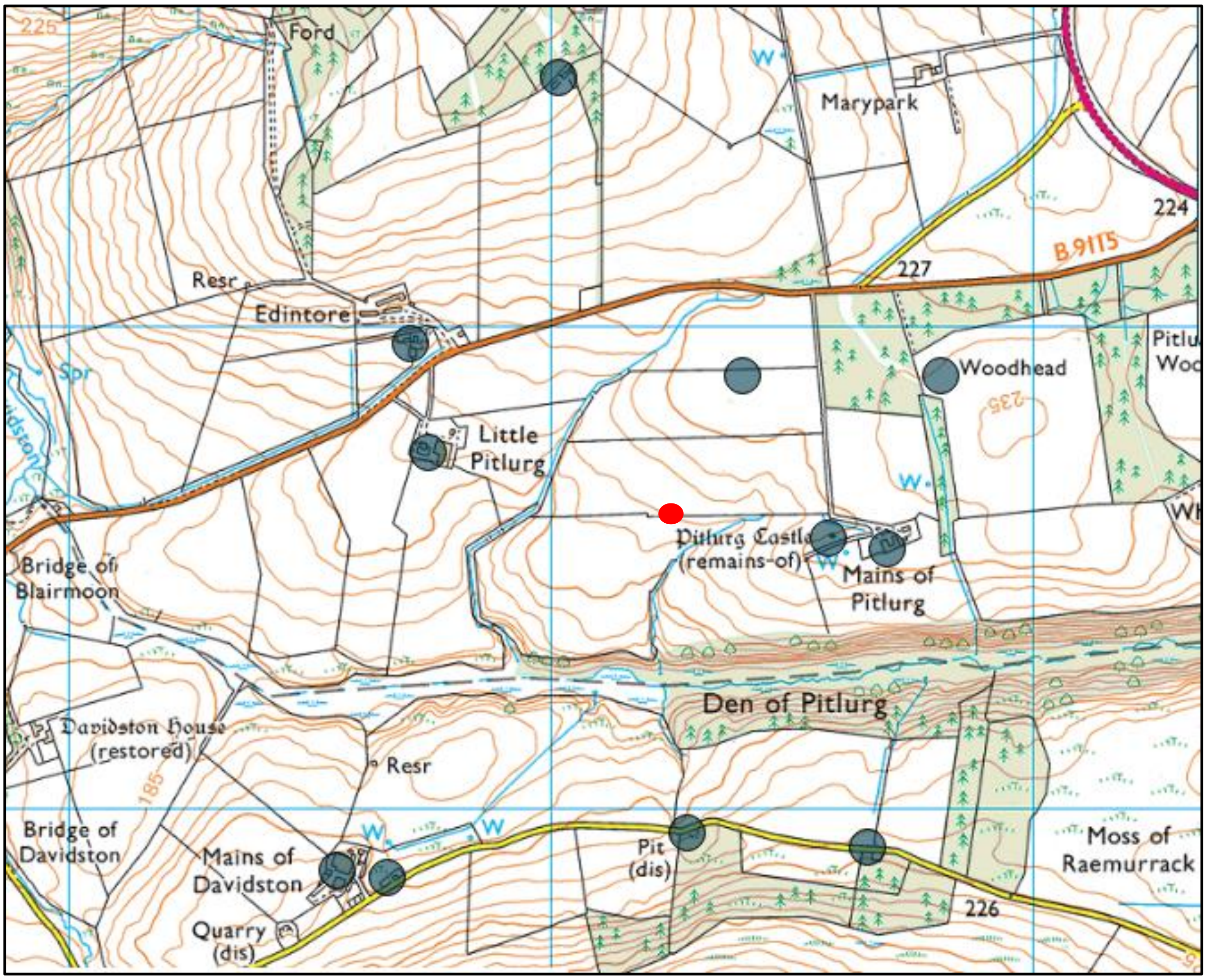
Gardens and Designed Landscapes

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 their 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 Mains of Pitlurg Farm is the small to medium scale Orenda Skye^{TM} 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

UKAS TESTING
0432

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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

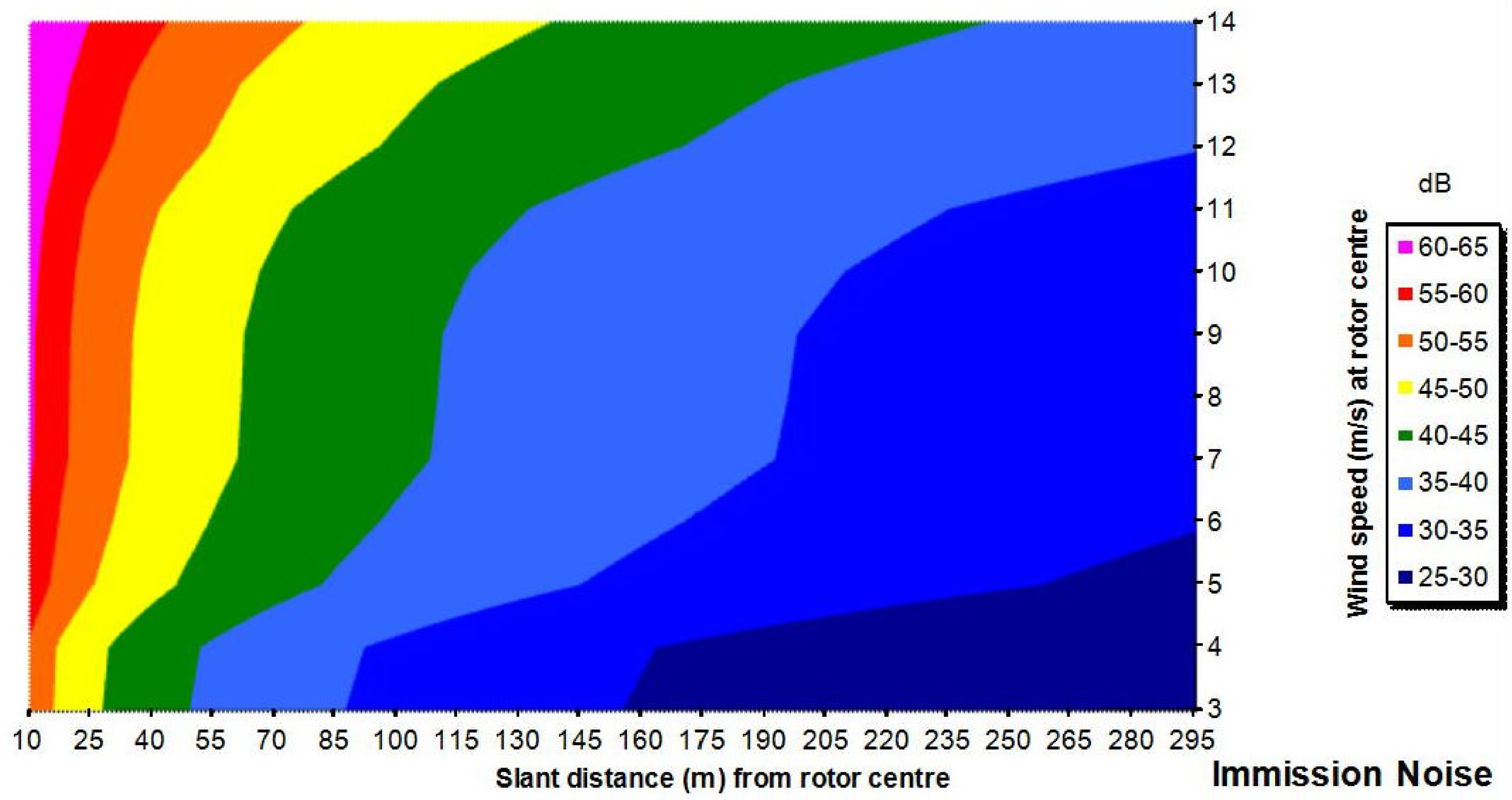
Wind Speed (m/s) at Rotor Centre Height	3	4	5	6	7	8	9	10	11	12	13	14
Apparent Sound Power Level, L_{WA}, dB(A) re 10^{-12}W	84.8	85.2	89.2	90.6	91.7	91.8	91.9	92.4	93.4	95.6	96.8	98.8
Combined Uncertainty, U_c, dB	1.06	0.84	0.64	0.64	0.62	0.63	0.62	0.62	0.63	0.66	0.68	0.77
Declared Sound Power Level, 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.



Immission Noise

ORE005 - 2016/328

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

www.tuvnel.com

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, ∆Ltn, 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
APPENDIX 3	Tonal Audibility Summaries
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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 $1/3^{rd}$ OCTAVE BAND SOUND PRESSURE LEVELS AND UNCERTAINTY VALUES FOR ROTOR CENTRE HEIGHT WIND SPEEDS

Wind Bin centre, k (m/s)	Parameter	$1/3^{rd}$ 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				

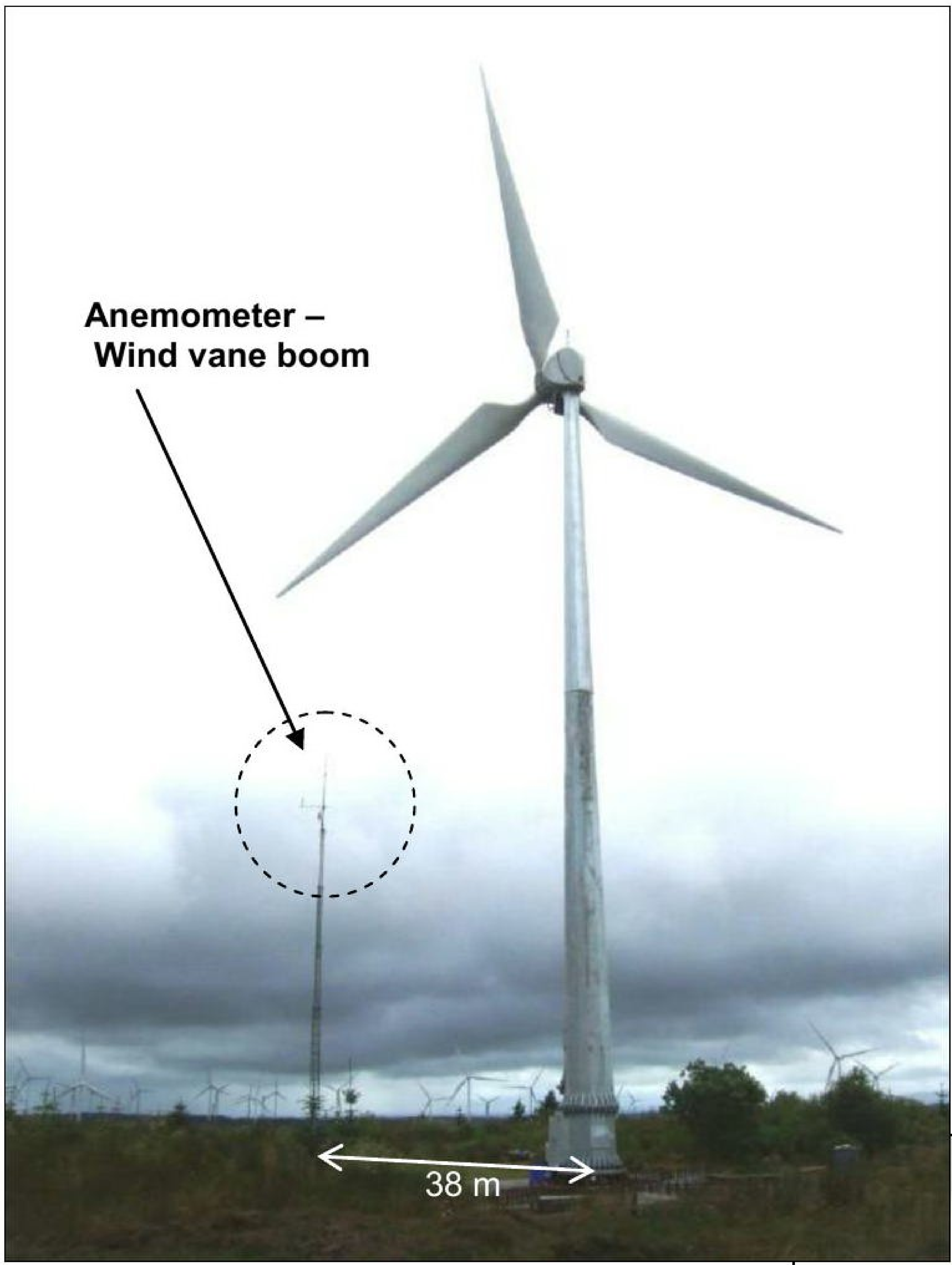
Wind Speed Bin at Rotor Centre (m/s)	Frequency (Hz)	Critical Bandwidth (Hz)	Tonality ΔL_k	Tonal Audibility $\Delta L_{a,k}$
3	6250	1227	-3.4	+1.3
4	6250	1227	-2.4	+2.3
5	No Relevant Tones			
6				
7				
8				
9				
10				
11				
12				
13				
14				

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

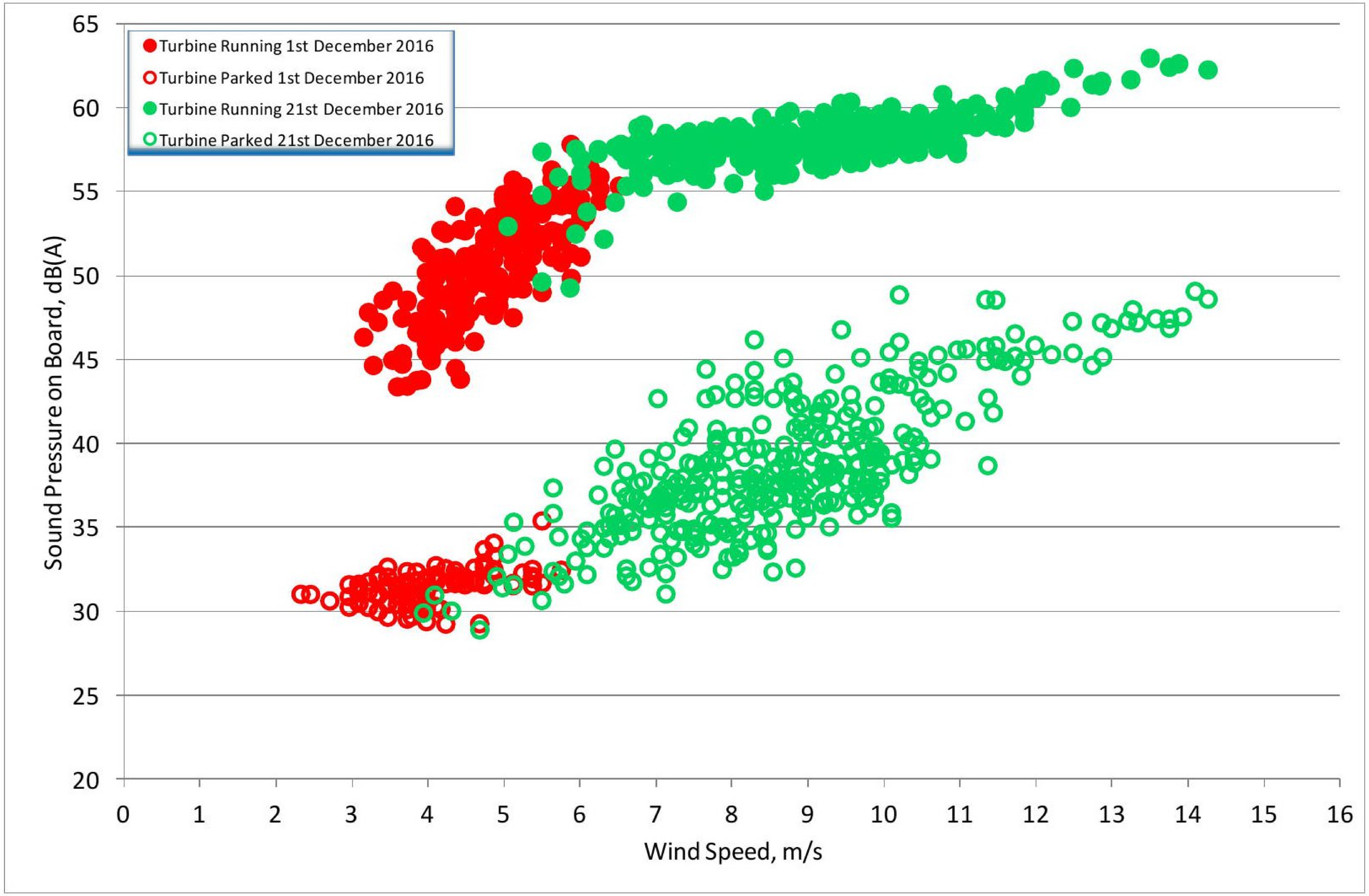


FIGURE 3 AUDIBLE NOISE (AS MEASURED AT THE GROUND BOARD) AS A FUNCTION OF WIND SPEED AT 19.5 M ABOVE GROUND LEVEL (Rotor Centre Height/ Hub Height a.g.l.)

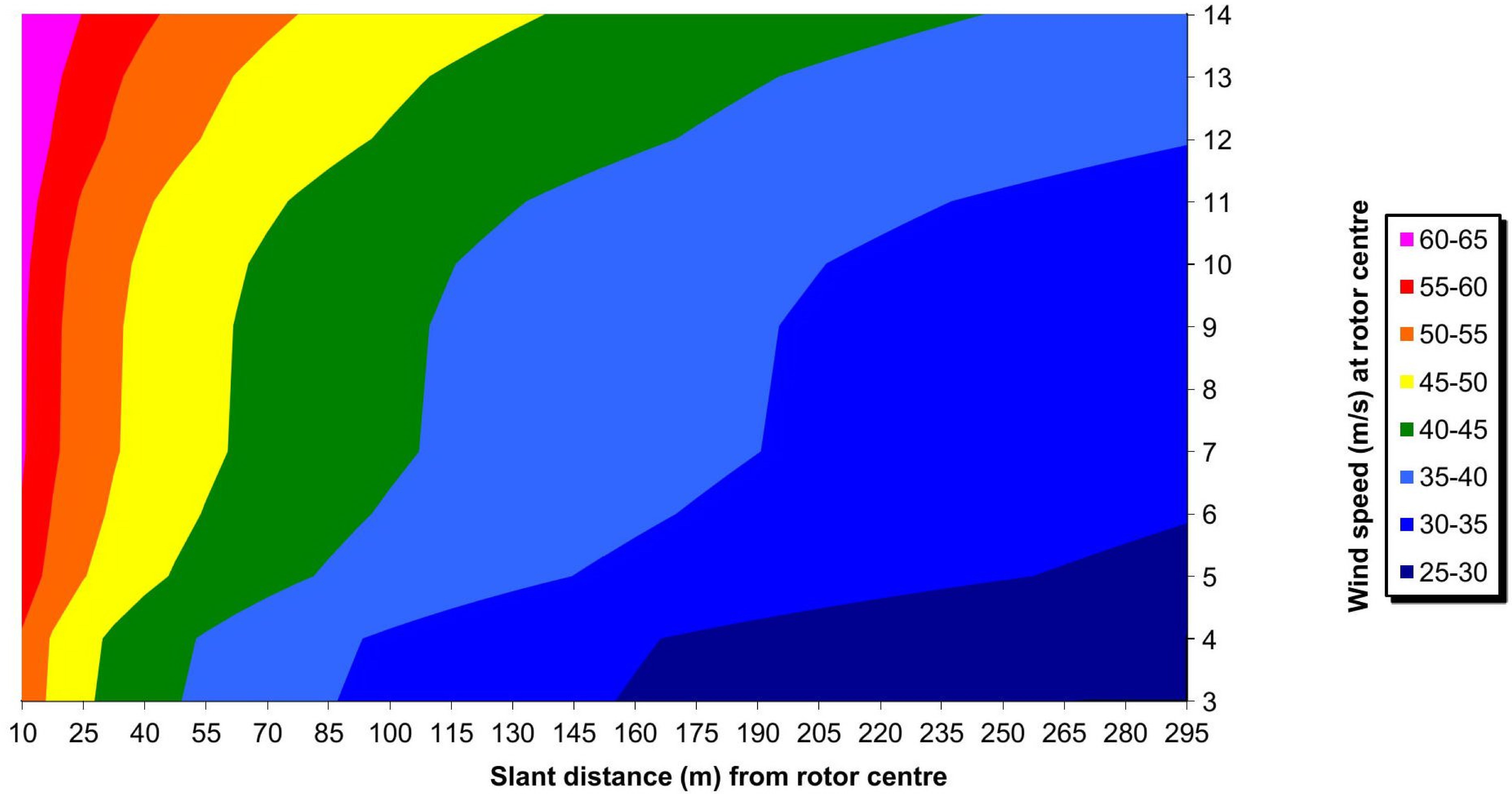


FIGURE 4 IMMISSION NOISE MAP

1/3rd Octave Band Centre Frequency																											
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	dBA Total
[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

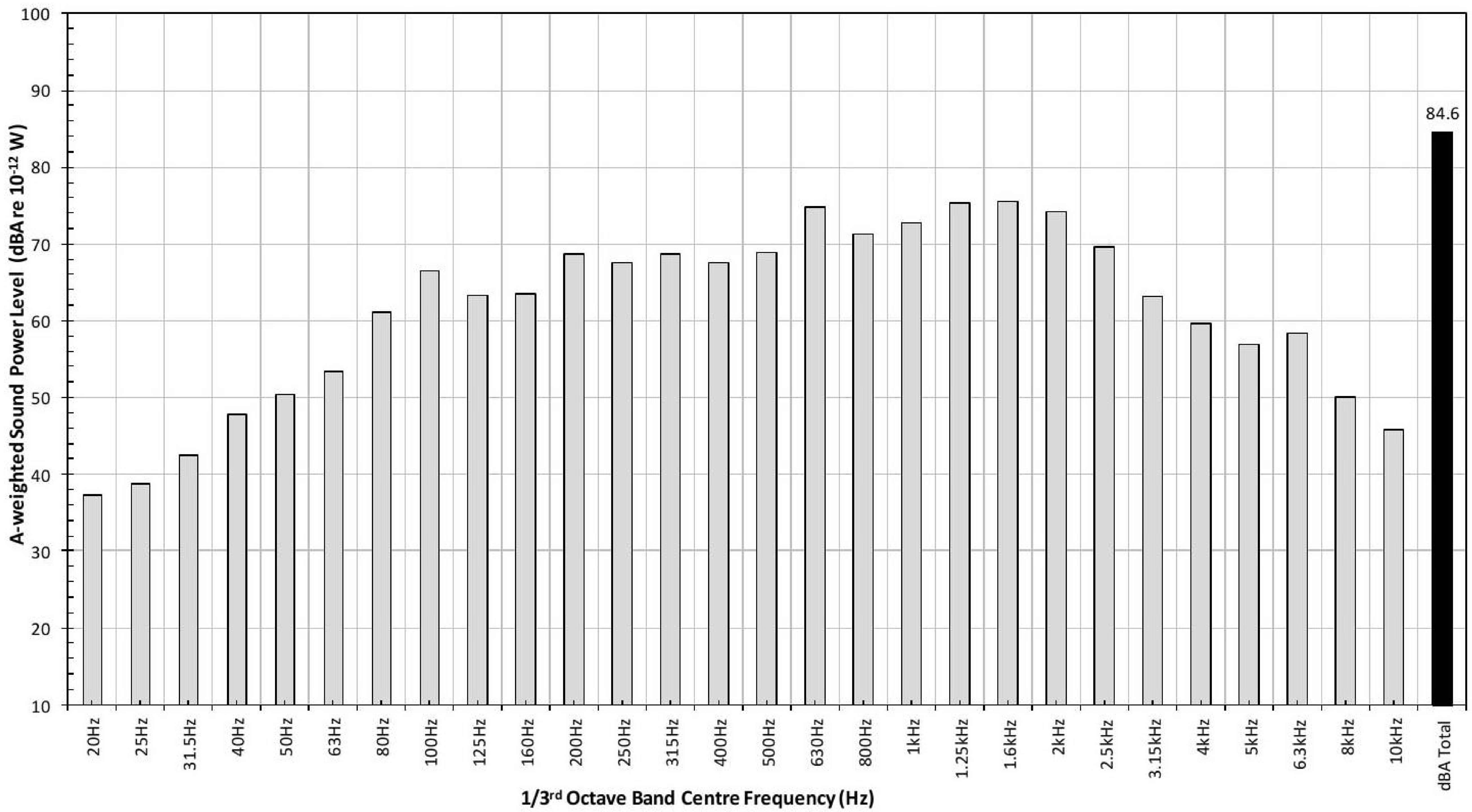


FIGURE 5 A-WEIGHTED 1/3rd OCTAVE BAND SOUND POWER LEVELS FOR 4 m/s WIND SPEED BIN AT ROTOR CENTRE HEIGHT
(3.5 m/s @ 10 m ABOVE GROUND LEVEL, WITH A ROUGHNESS LENGTH OF 0.1)

1/3rd Octave Band Centre Frequency																											
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	dBA Total
[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

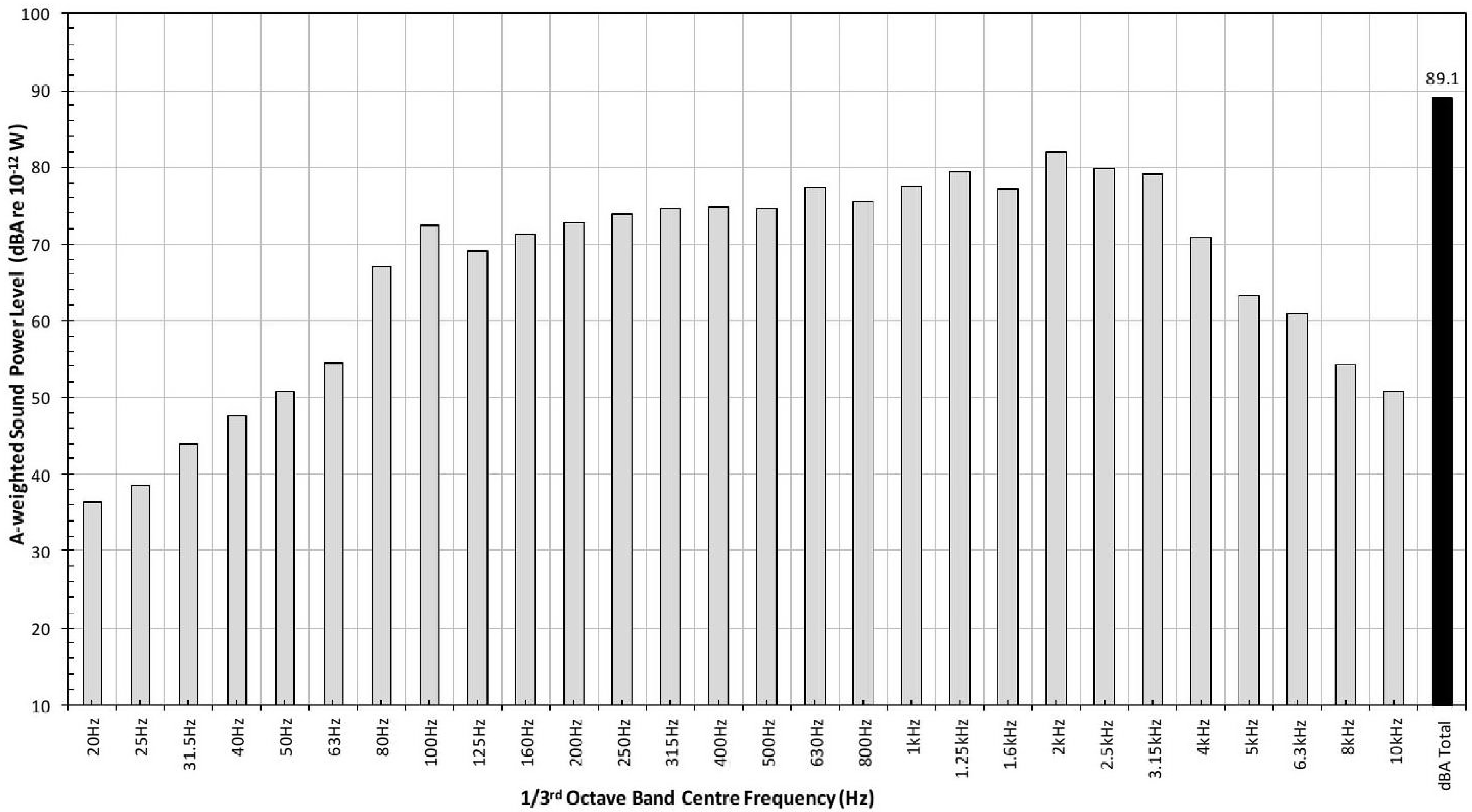


FIGURE 6 A-WEIGHTED 1/3rd OCTAVE BAND SOUND POWER LEVELS FOR 5 m/s WIND SPEED BIN AT ROTOR CENTRE HEIGHT
(4.4 m/s @ 10 m ABOVE GROUND LEVEL, WITH A ROUGHNESS LENGTH OF 0.1)

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

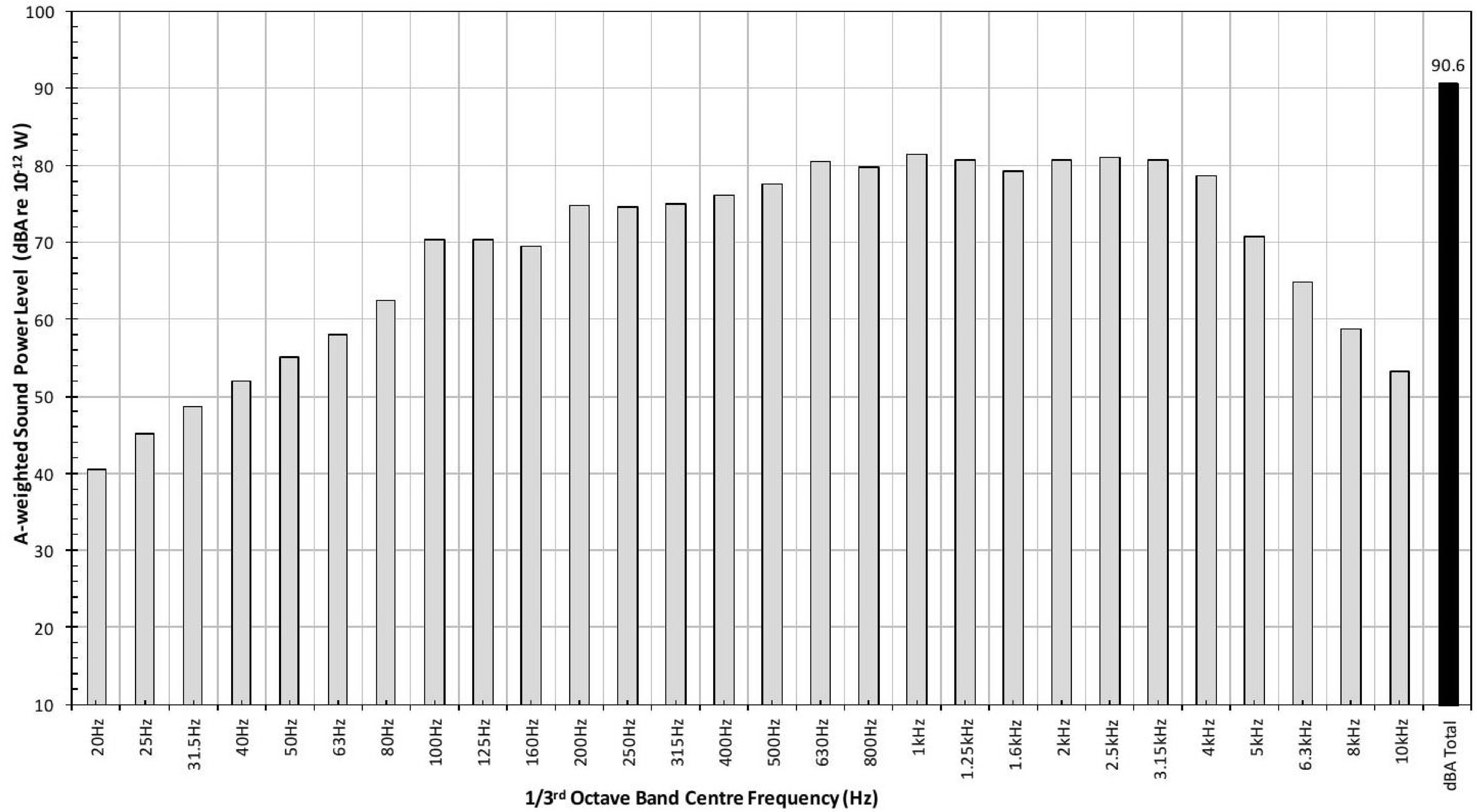


FIGURE 7 A-WEIGHTED 1/3rd OCTAVE BAND SOUND POWER LEVELS FOR 6 m/s WIND SPEED BIN AT ROTOR CENTRE HEIGHT
(5.2 m/s @ 10 m ABOVE GROUND LEVEL, WITH A ROUGHNESS LENGTH OF 0.1)

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

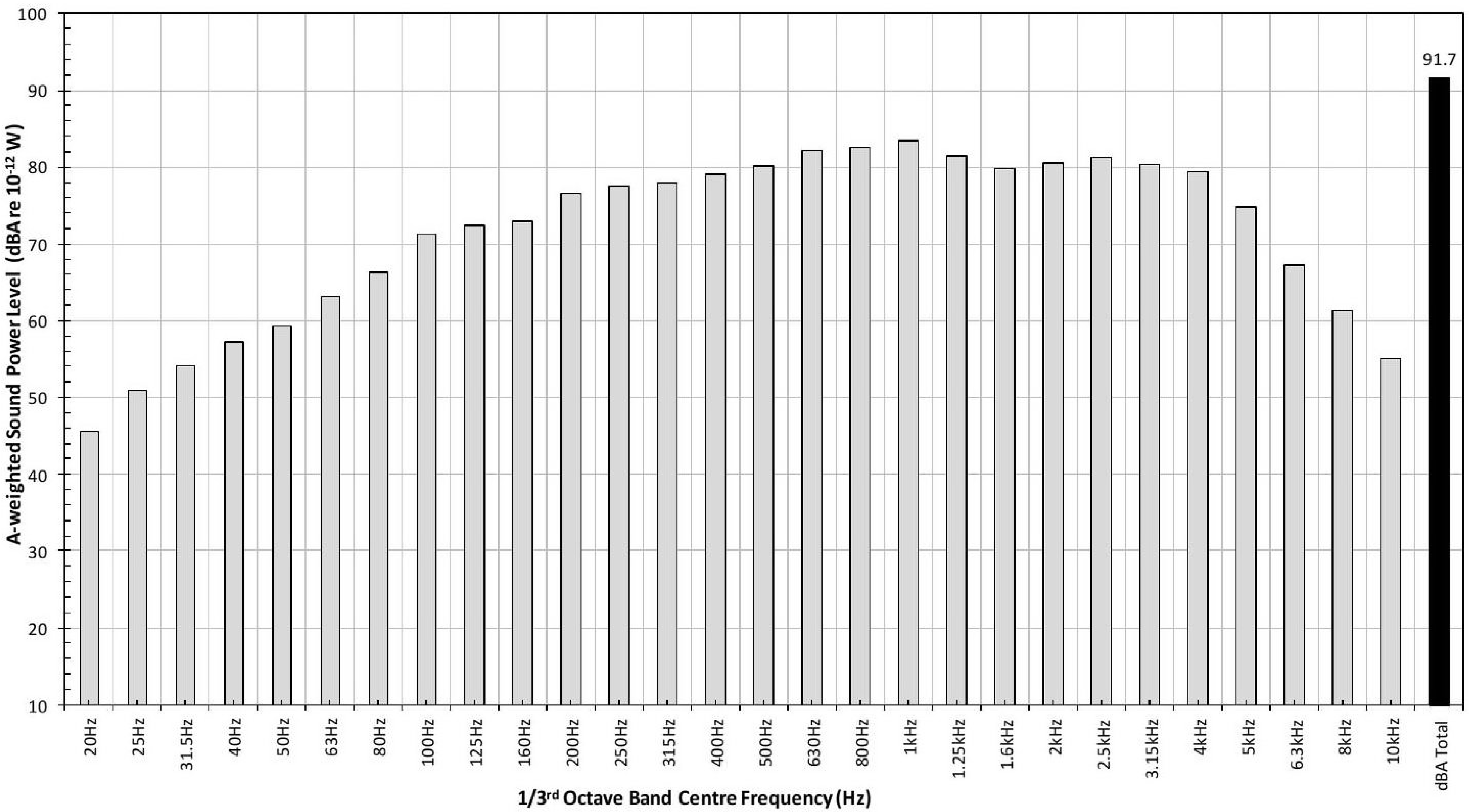


FIGURE 8 A-WEIGHTED 1/3rd OCTAVE BAND SOUND POWER LEVELS FOR 7 m/s WIND SPEED BIN AT ROTOR CENTRE HEIGHT
(6.1 m/s @ 10 m ABOVE GROUND LEVEL, WITH A ROUGHNESS LENGTH OF 0.1)

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

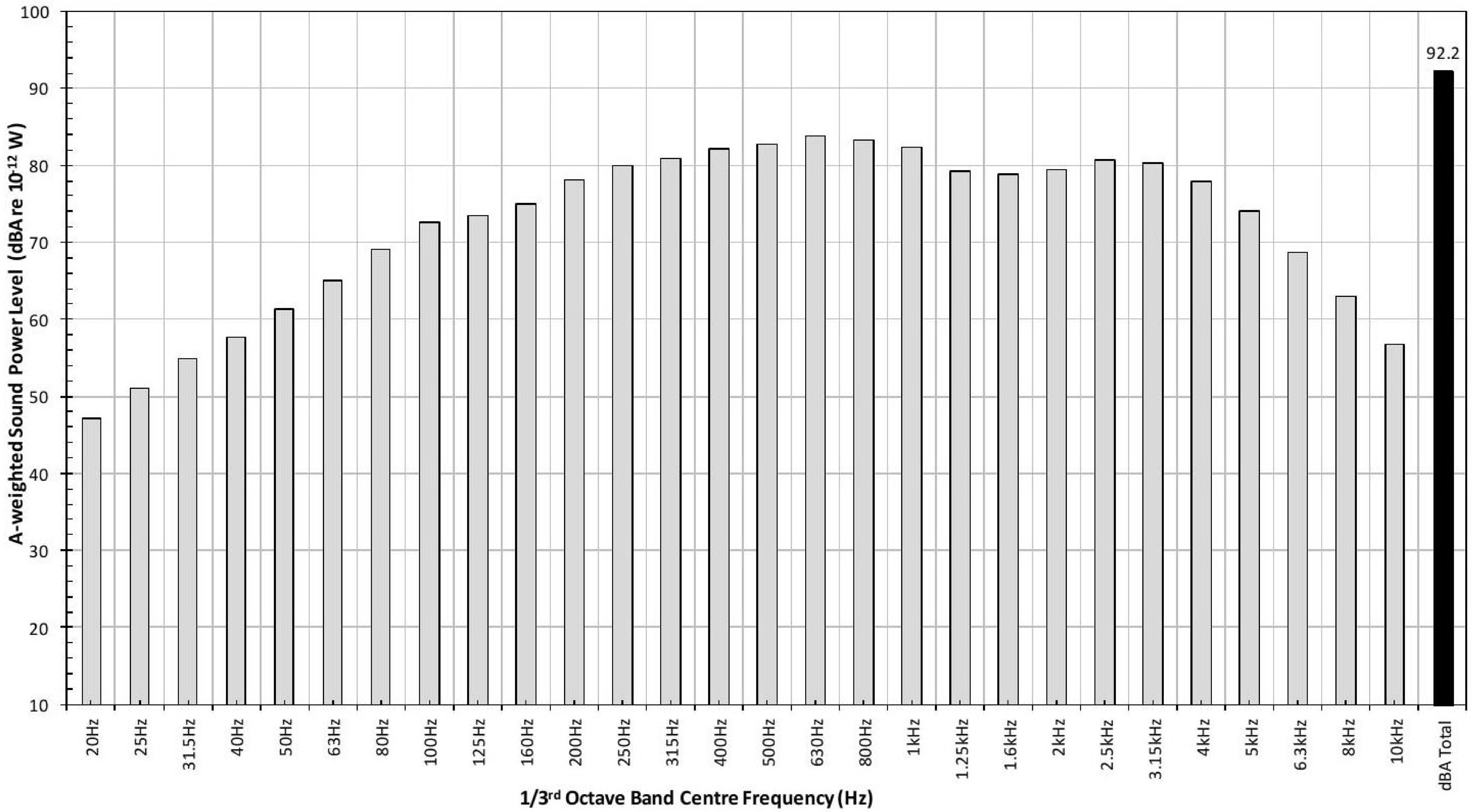


FIGURE 9 A-WEIGHTED 1/3rd OCTAVE BAND SOUND POWER LEVELS FOR 8 m/s WIND SPEED BIN AT ROTOR CENTRE HEIGHT
(7.0 m/s @ 10 m ABOVE GROUND LEVEL, WITH A ROUGHNESS LENGTH OF 0.1)

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

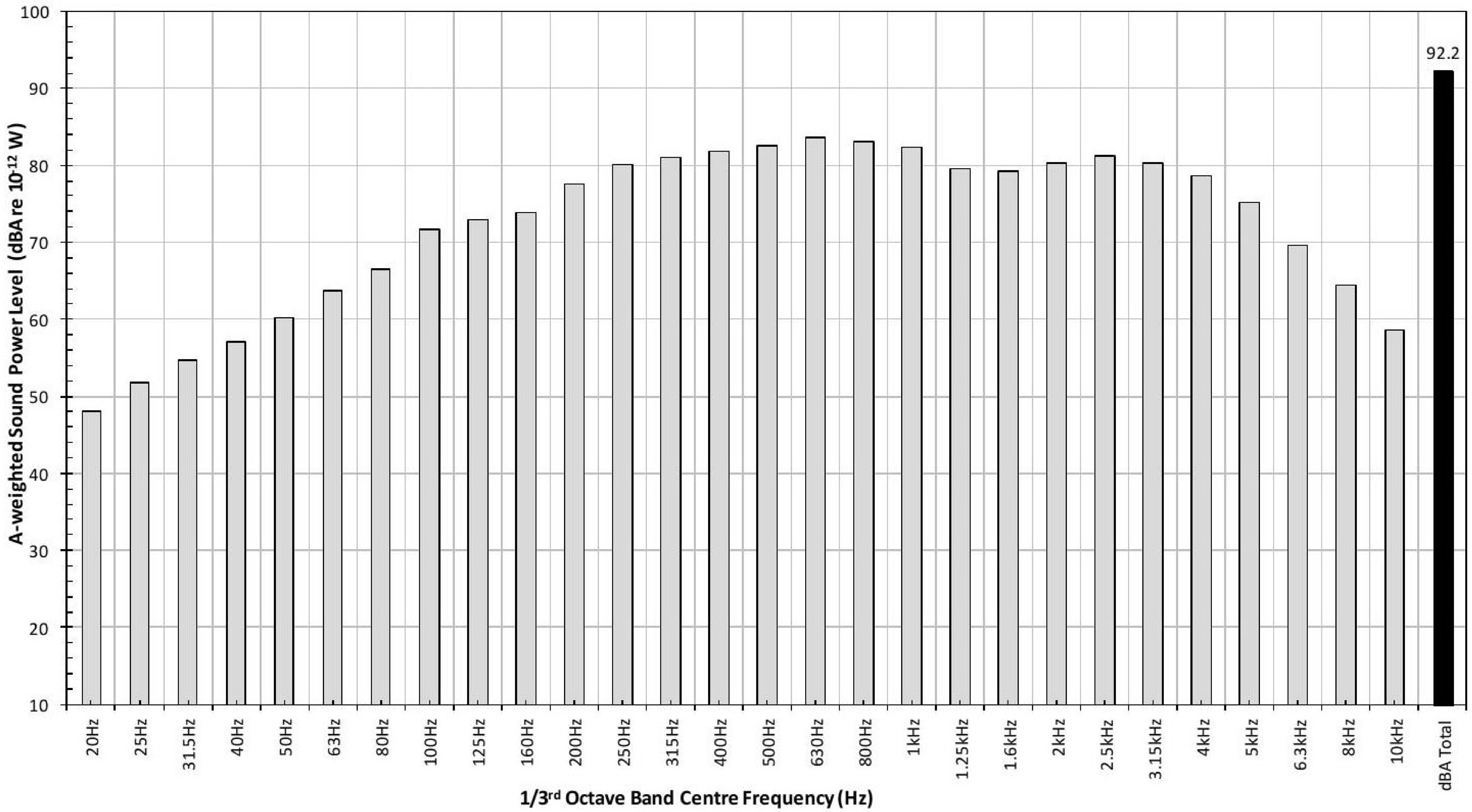


FIGURE 10 A-WEIGHTED 1/3rd OCTAVE BAND SOUND POWER LEVELS FOR 9 m/s WIND SPEED BIN AT ROTOR CENTRE HEIGHT
(7.9 m/s @ 10 m ABOVE GROUND LEVEL, WITH A ROUGHNESS LENGTH OF 0.1)

1/3rd Octave Band Centre Frequency																											
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	dBA Total
[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

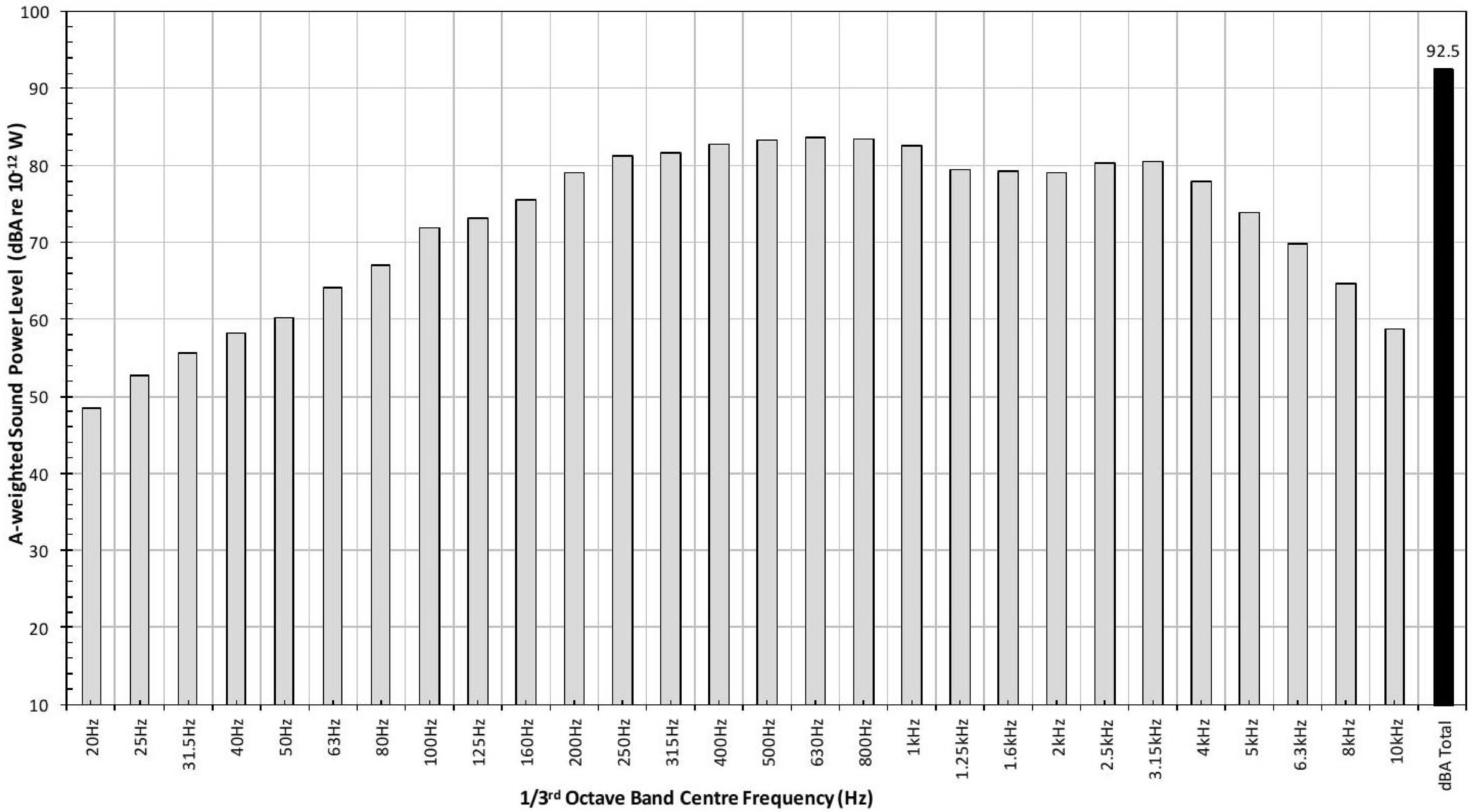


FIGURE 11 A-WEIGHTED 1/3rd OCTAVE BAND SOUND POWER LEVELS FOR 10 m/s WIND SPEED BIN AT ROTOR CENTRE HEIGHT
(8.7 m/s @ 10 m ABOVE GROUND LEVEL, WITH A ROUGHNESS LENGTH OF 0.1)

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

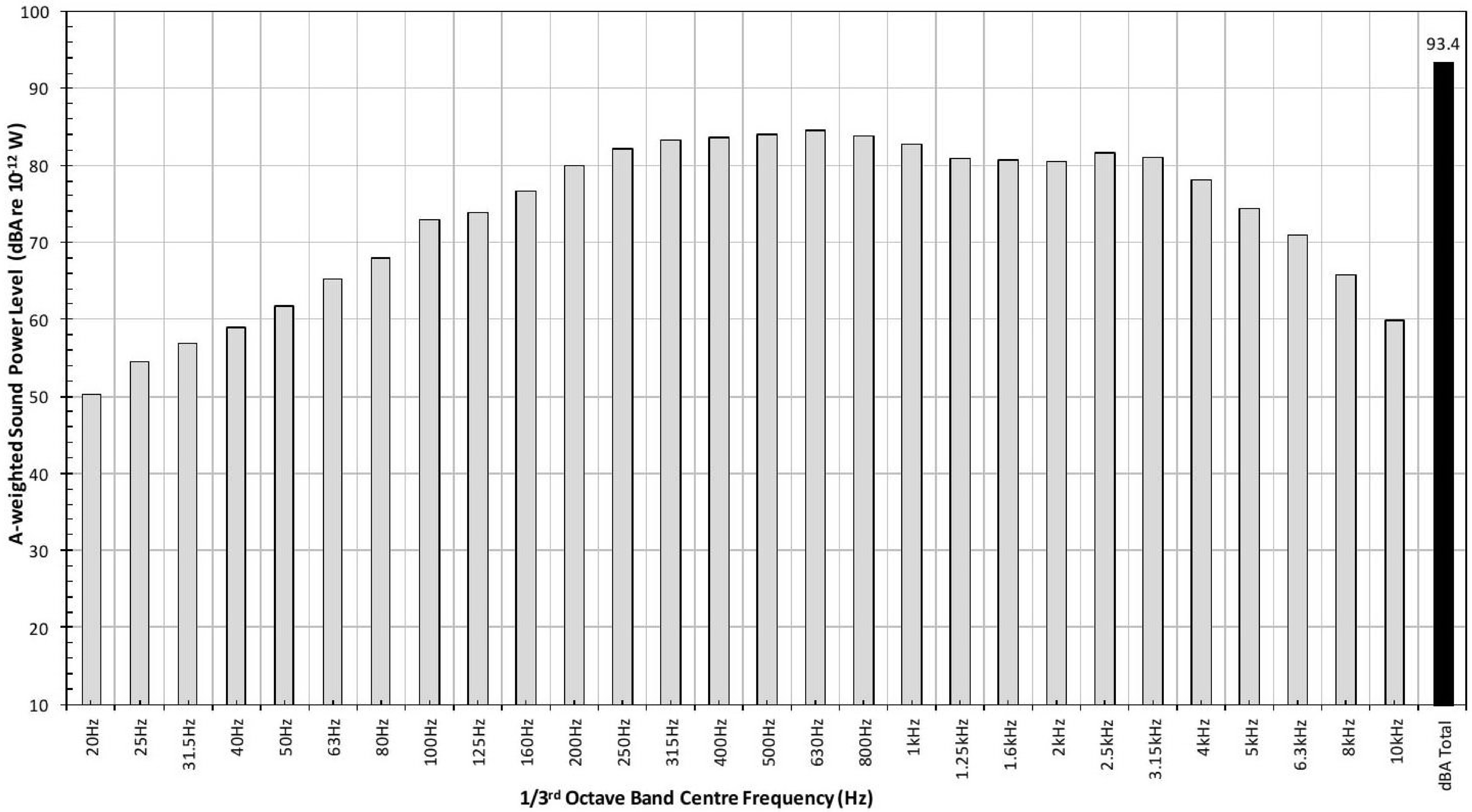


FIGURE 12 A-WEIGHTED 1/3rd OCTAVE BAND SOUND POWER LEVELS FOR 11 m/s WIND SPEED BIN AT ROTOR CENTRE HEIGHT
(9.6 m/s @ 10 m ABOVE GROUND LEVEL, WITH A ROUGHNESS LENGTH OF 0.1)

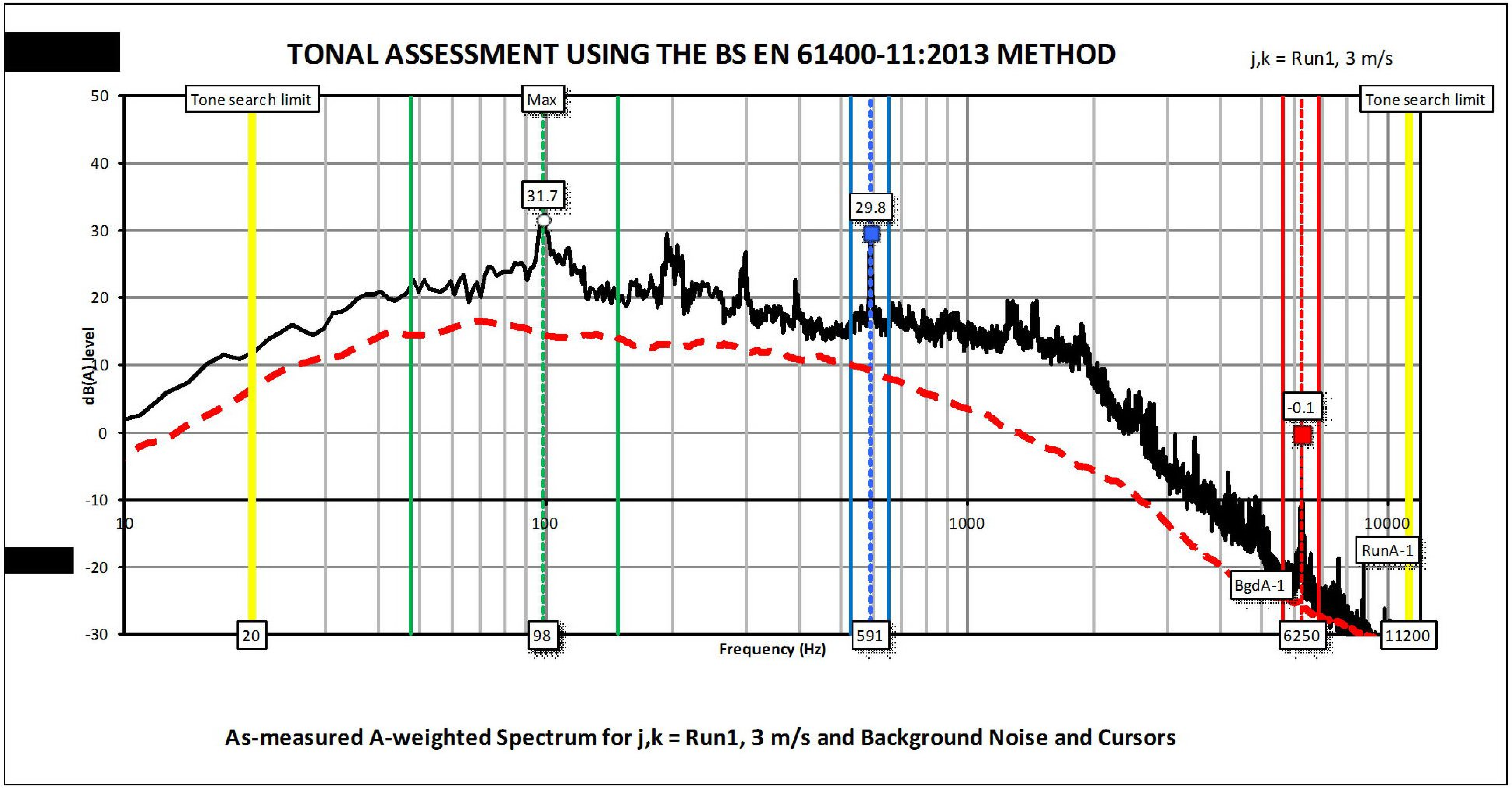


FIGURE 13a TONAL ASSESSMENT USING THE IEC 61400-11:2012 METHOD FOR THE 3 m/s HUB-HEIGHT WIND SPEED BIN

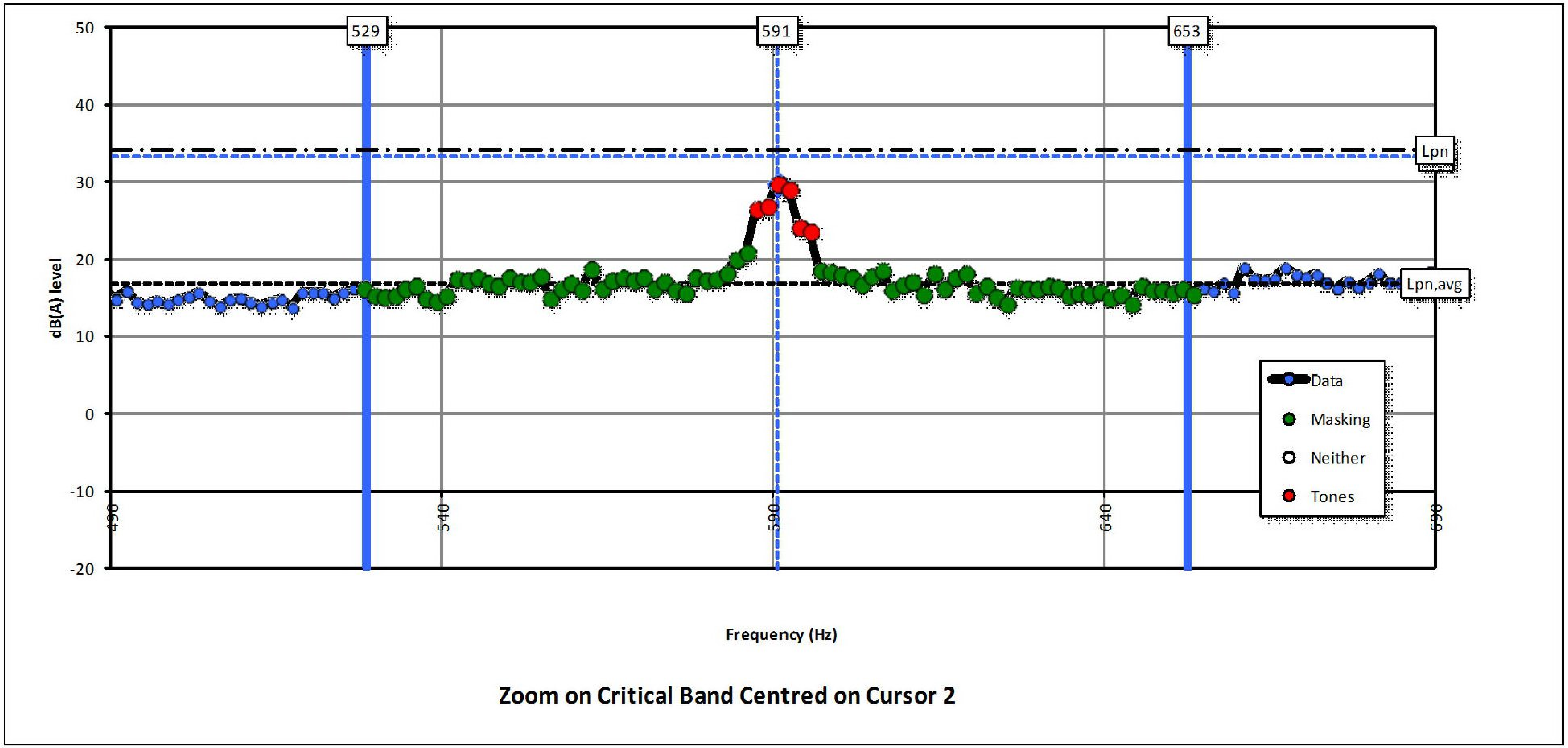


FIGURE 13b CRITICAL BAND WITH HIGHEST TONALITY SHOWING TONES AND MASKING NOISE FOR 3 m/s WIND SPEED BIN. (Tonality +1.6 dB)

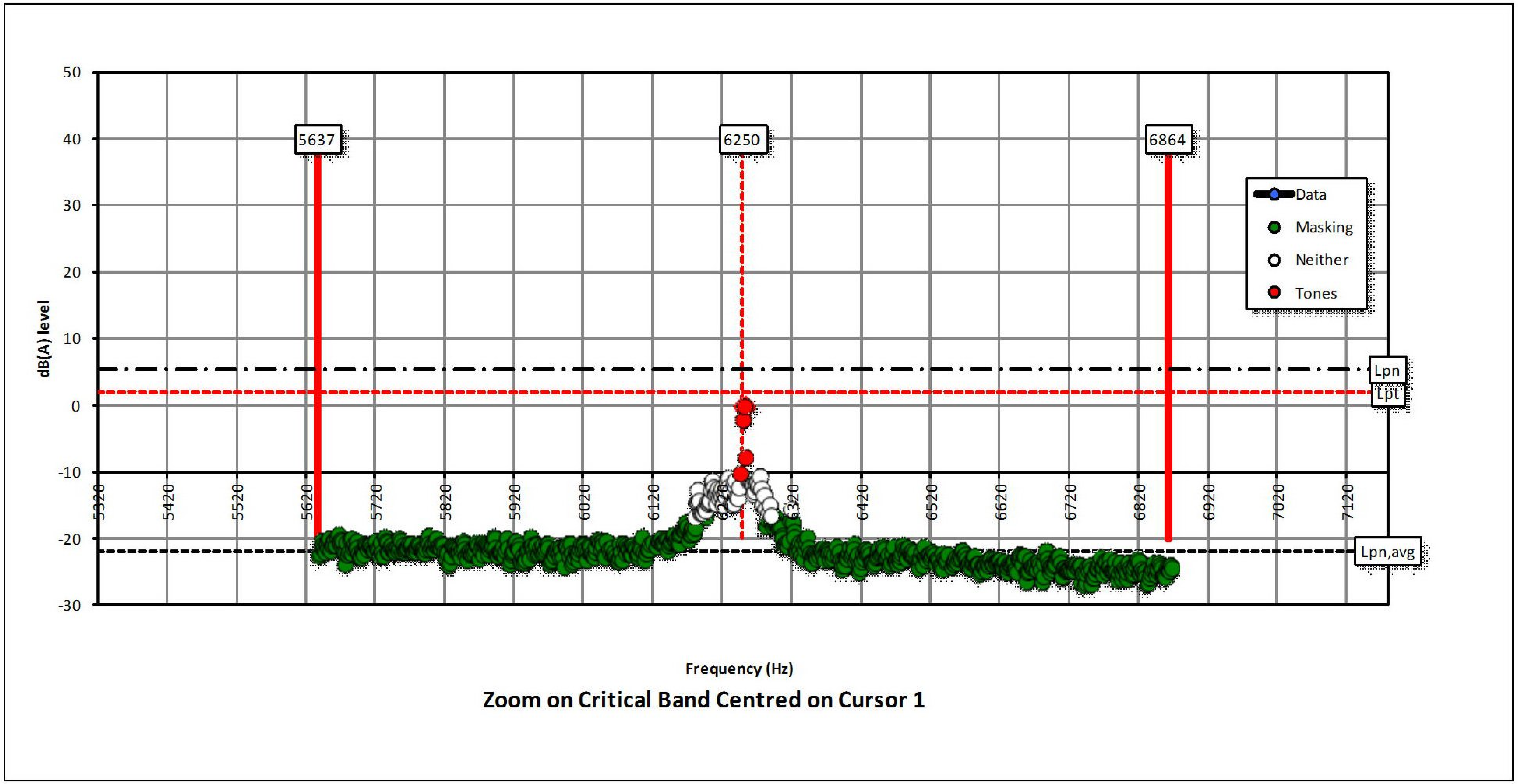


FIGURE 13c CRITICAL BAND WITH 2nd HIGHEST TONALITY SHOWING TONES AND MASKING NOISE FOR 3 m/s WIND SPEED BIN. (Tonality +1.3 dB)

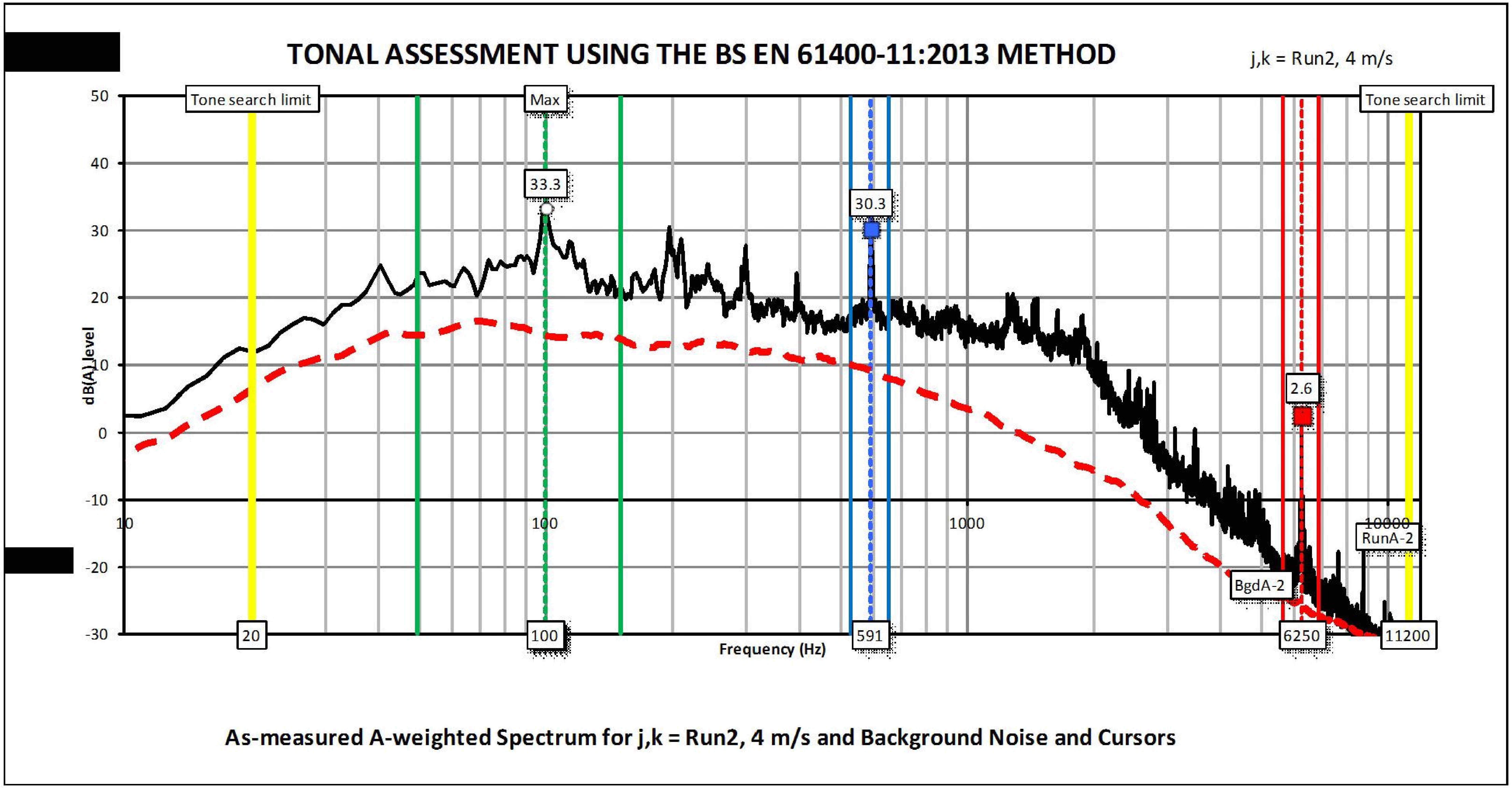


FIGURE 14a TONAL ASSESSMENT USING THE IEC 61400-11:2012 METHOD FOR THE 4 m/s HUB-HEIGHT WIND SPEED BIN

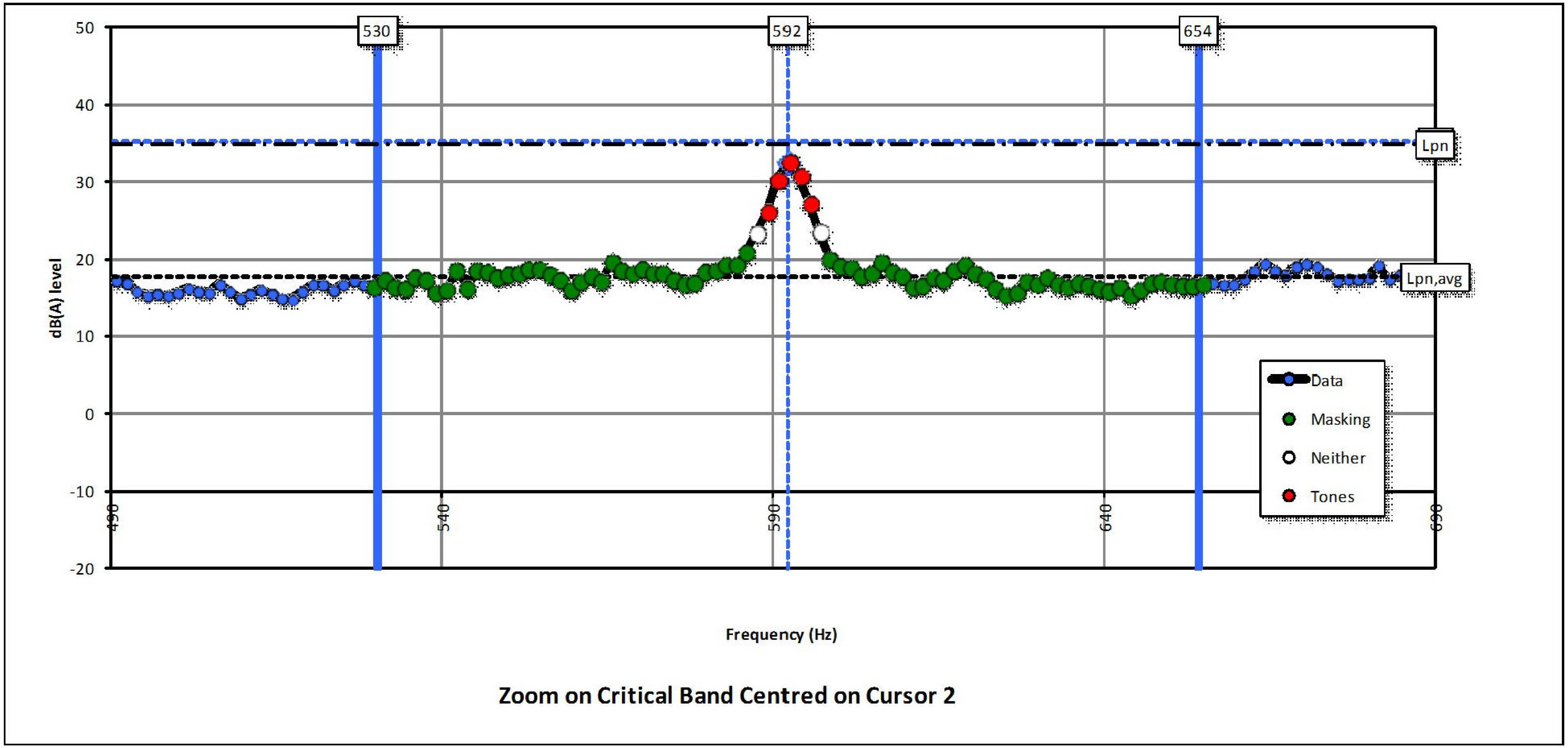


FIGURE 14b CRITICAL BAND WITH HIGHEST TONALITY SHOWING TONES AND MASKING NOISE FOR 4 m/s WIND SPEED BIN. (Tonality +2.7 dB)

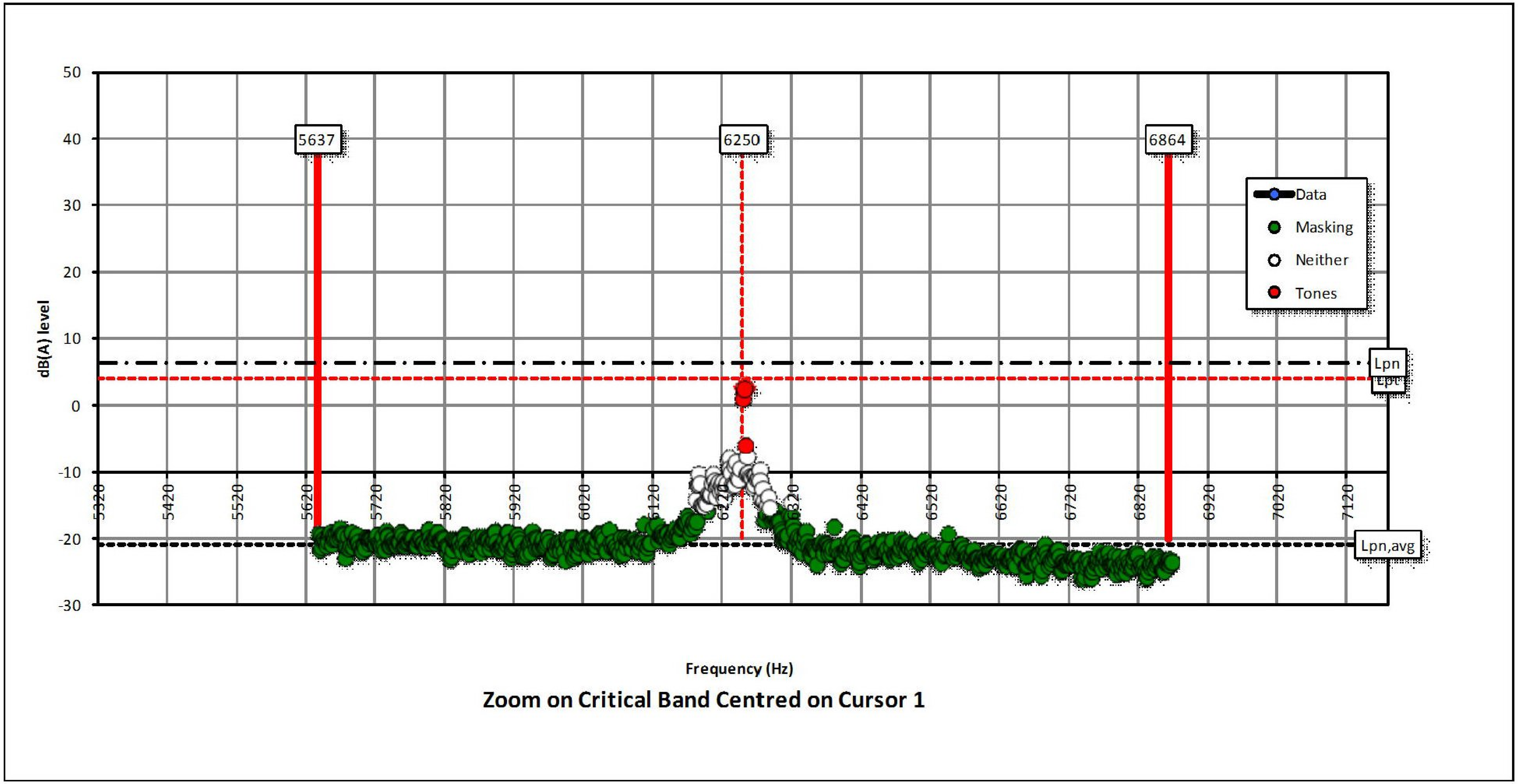


FIGURE 14c CRITICAL BAND WITH 2nd HIGHEST TONALITY SHOWING TONES AND MASKING NOISE FOR 4 m/s WIND SPEED BIN. (Tonality +2.3 dB)

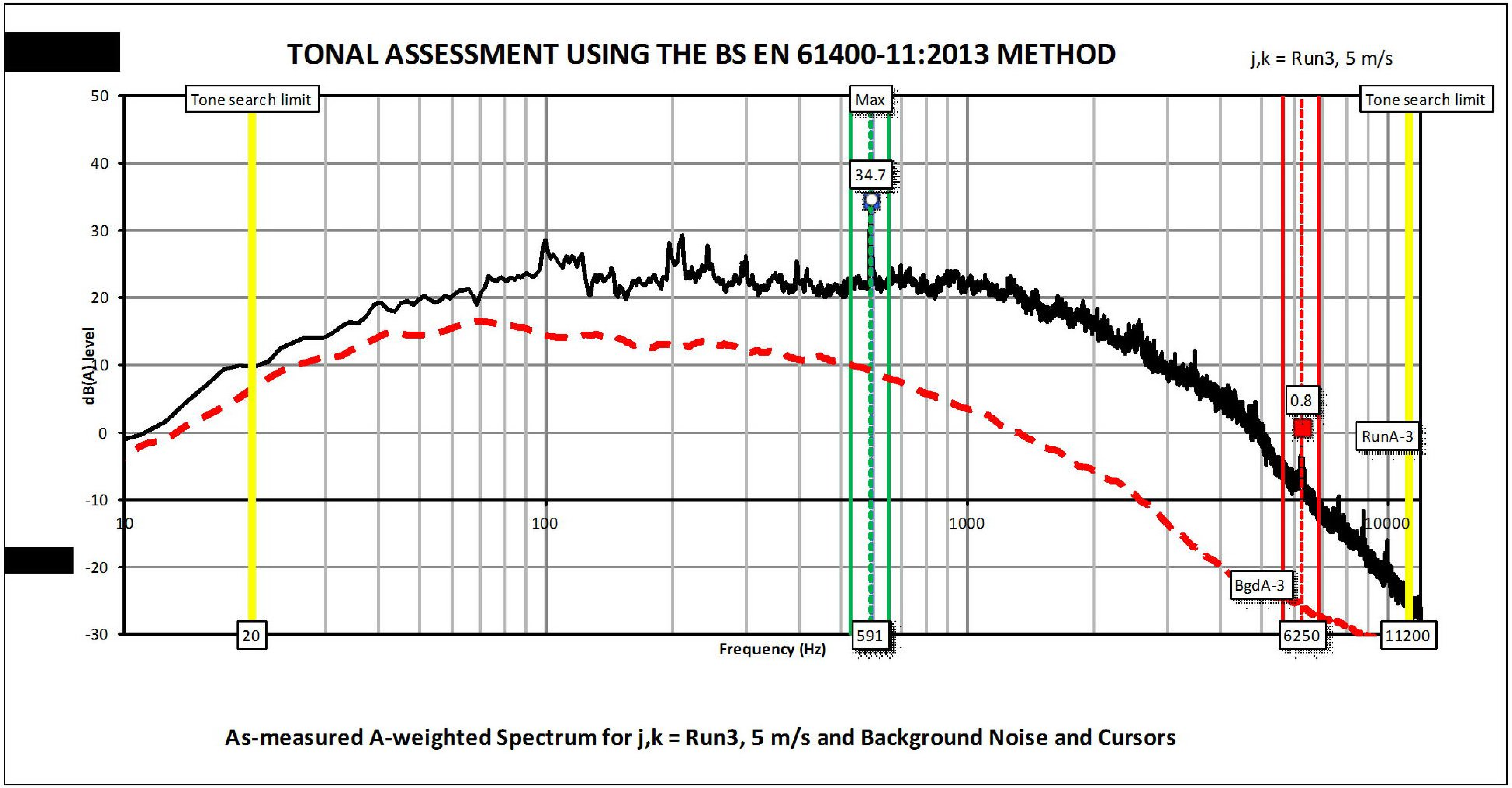


FIGURE 15a TONAL ASSESSMENT USING THE IEC 61400-11:2012 METHOD FOR THE 5 m/s HUB-HEIGHT WIND SPEED BIN

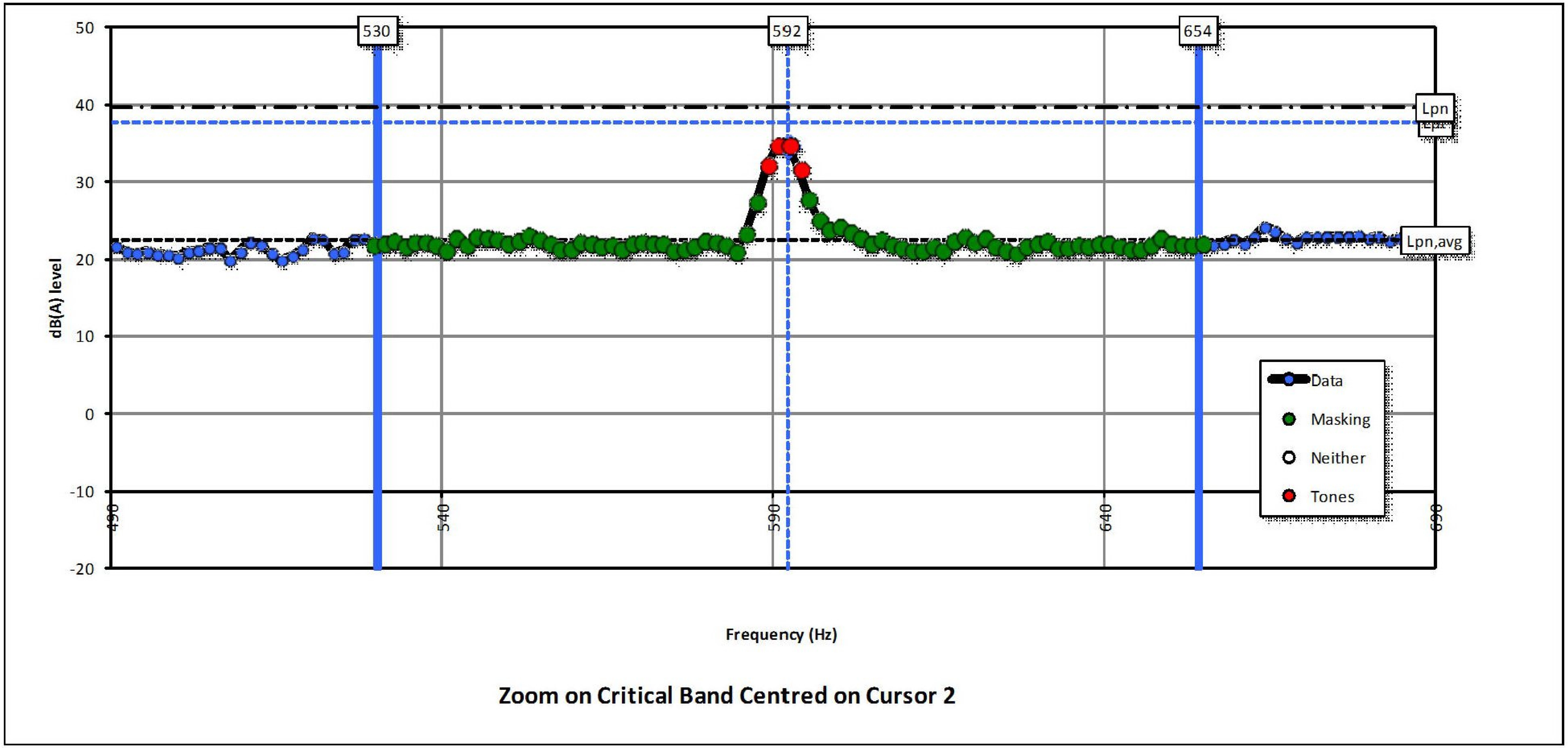


FIGURE 15b CRITICAL BAND WITH HIGHEST TONALITY SHOWING TONES AND MASKING NOISE FOR 5 m/s WIND SPEED BIN. The Spectrum Maximum and Highest Tonality are equivalent in this case (Tonality +0.5 dB)

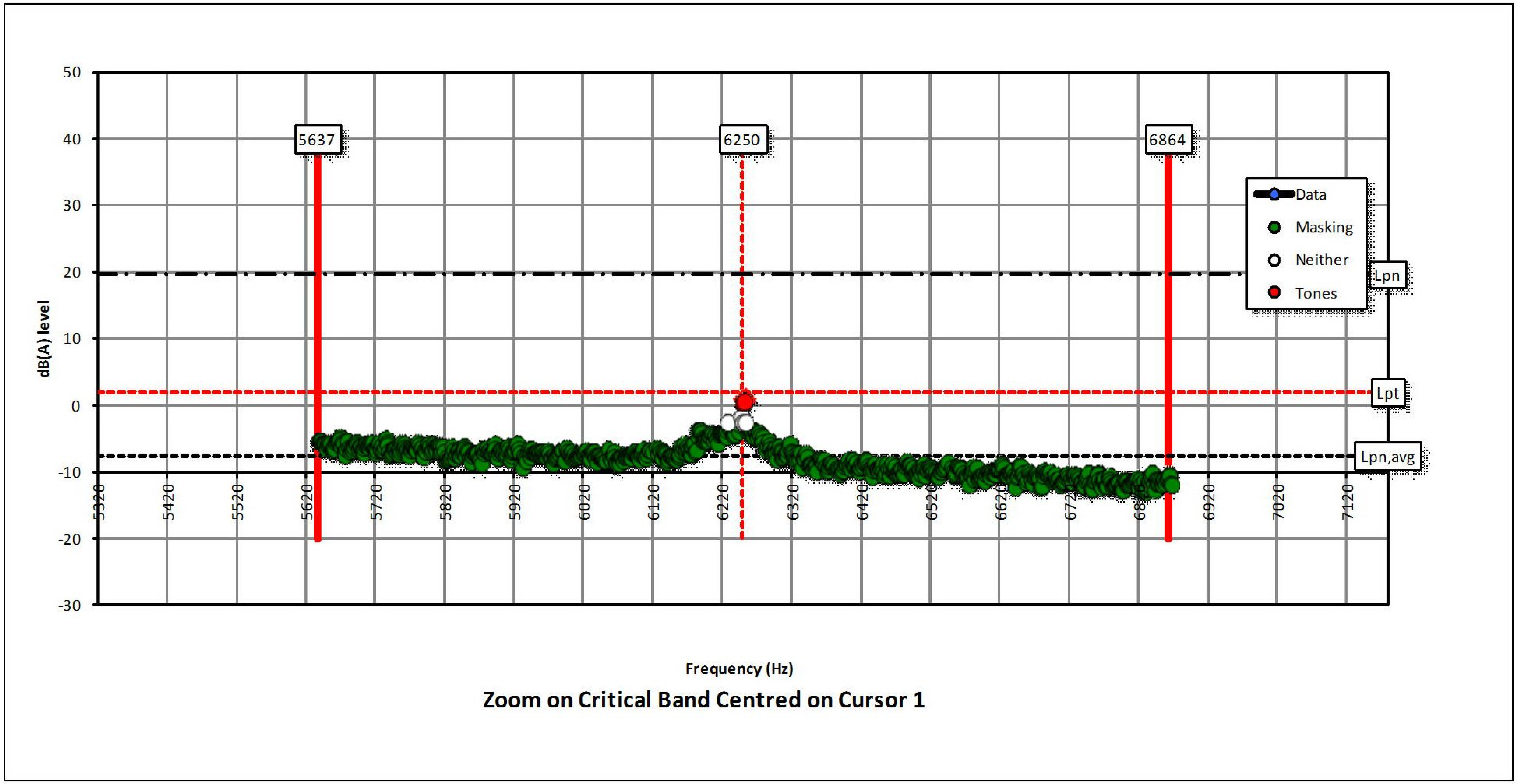


FIGURE 15c CRITICAL BAND WITH 2nd HIGHEST TONALITY SHOWING TONES AND MASKING NOISE FOR 5 m/s WIND SPEED BIN. (Tonality -13 dB)

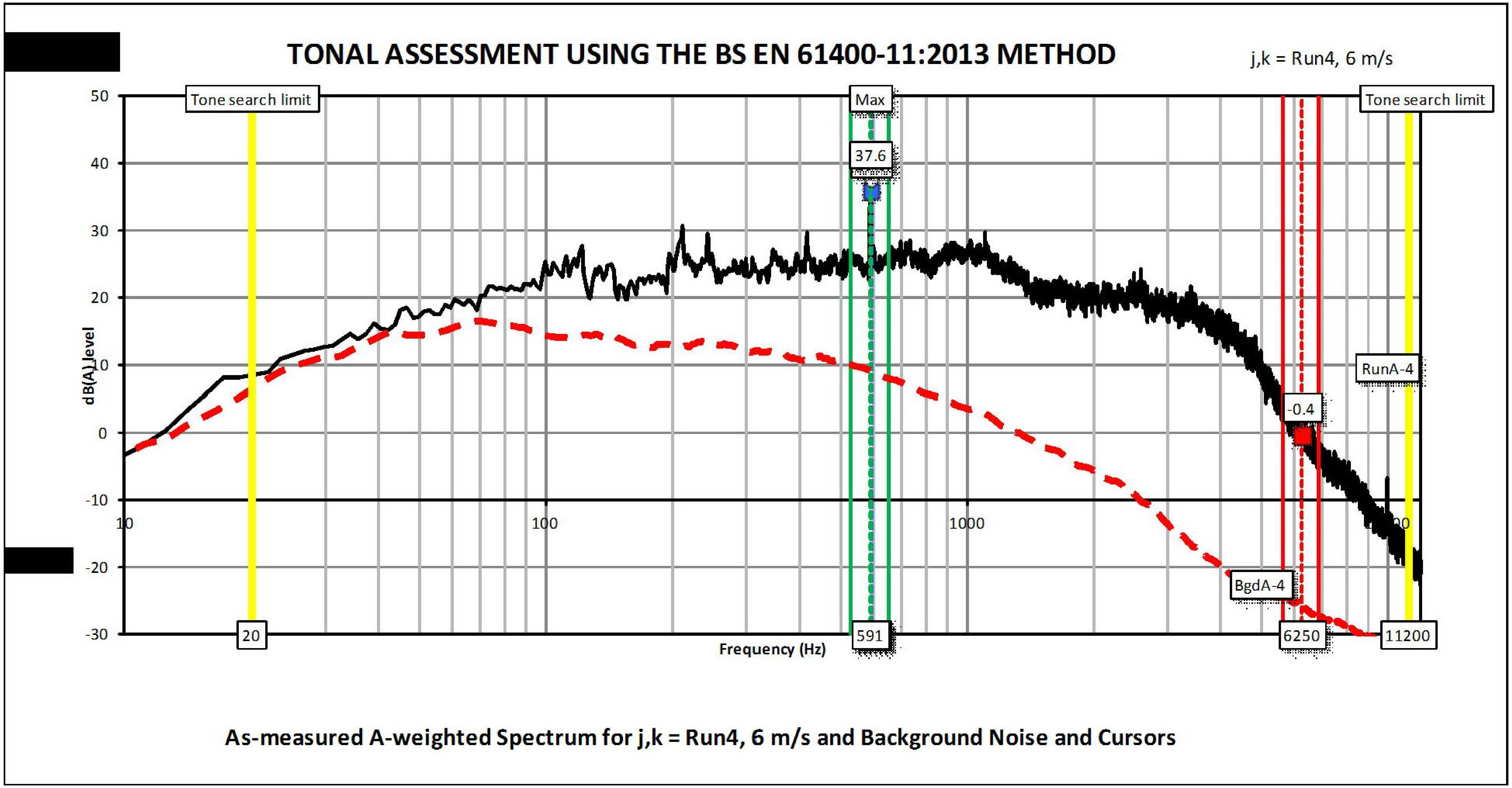


FIGURE 16a TONAL ASSESSMENT USING THE IEC 61400-11:2012 METHOD FOR THE 6 m/s HUB-HEIGHT WIND SPEED BIN

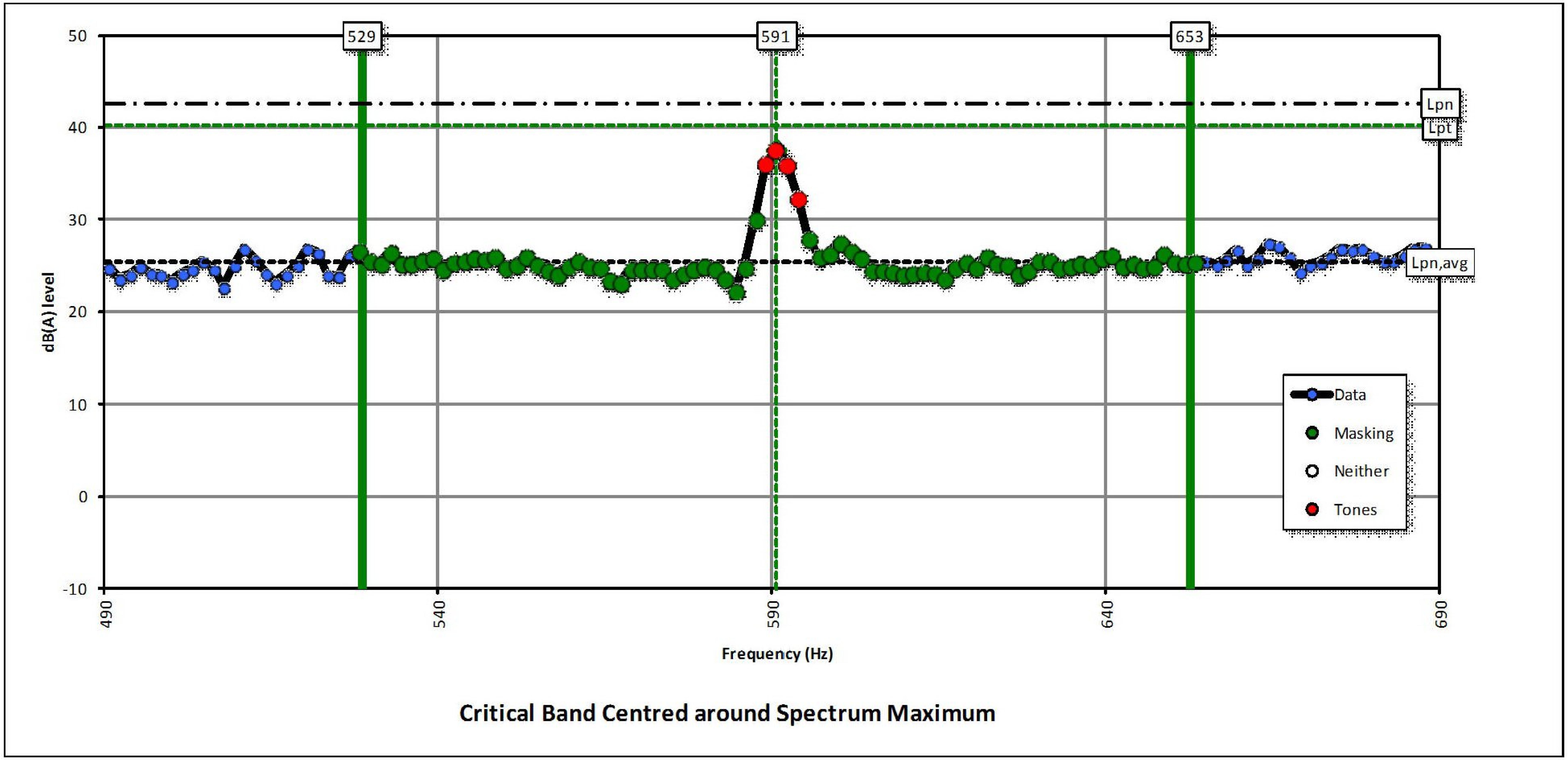


FIGURE 16b CRITICAL BAND WITH HIGHEST TONALITY SHOWING TONES AND MASKING NOISE FOR 6 m/s WIND SPEED BIN. The Highest Tonality and Spectrum Maximum Coincide (Tonality -0.1 dB)

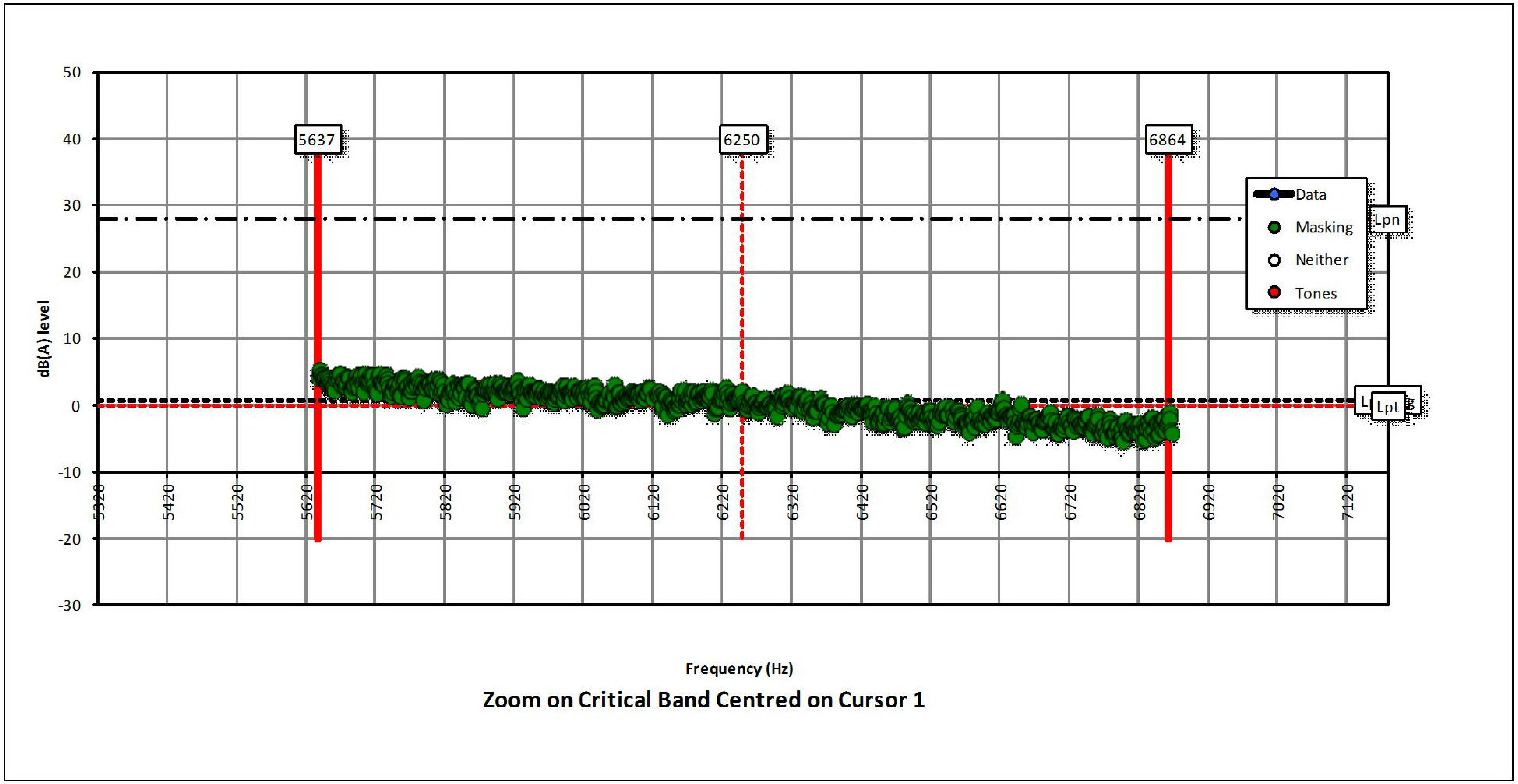


FIGURE 16c CRITICAL BAND WITH 2nd HIGHEST TONALITY SHOWING TONES AND MASKING NOISE FOR 6 m/s WIND SPEED BIN. (Tonality -22 dB)

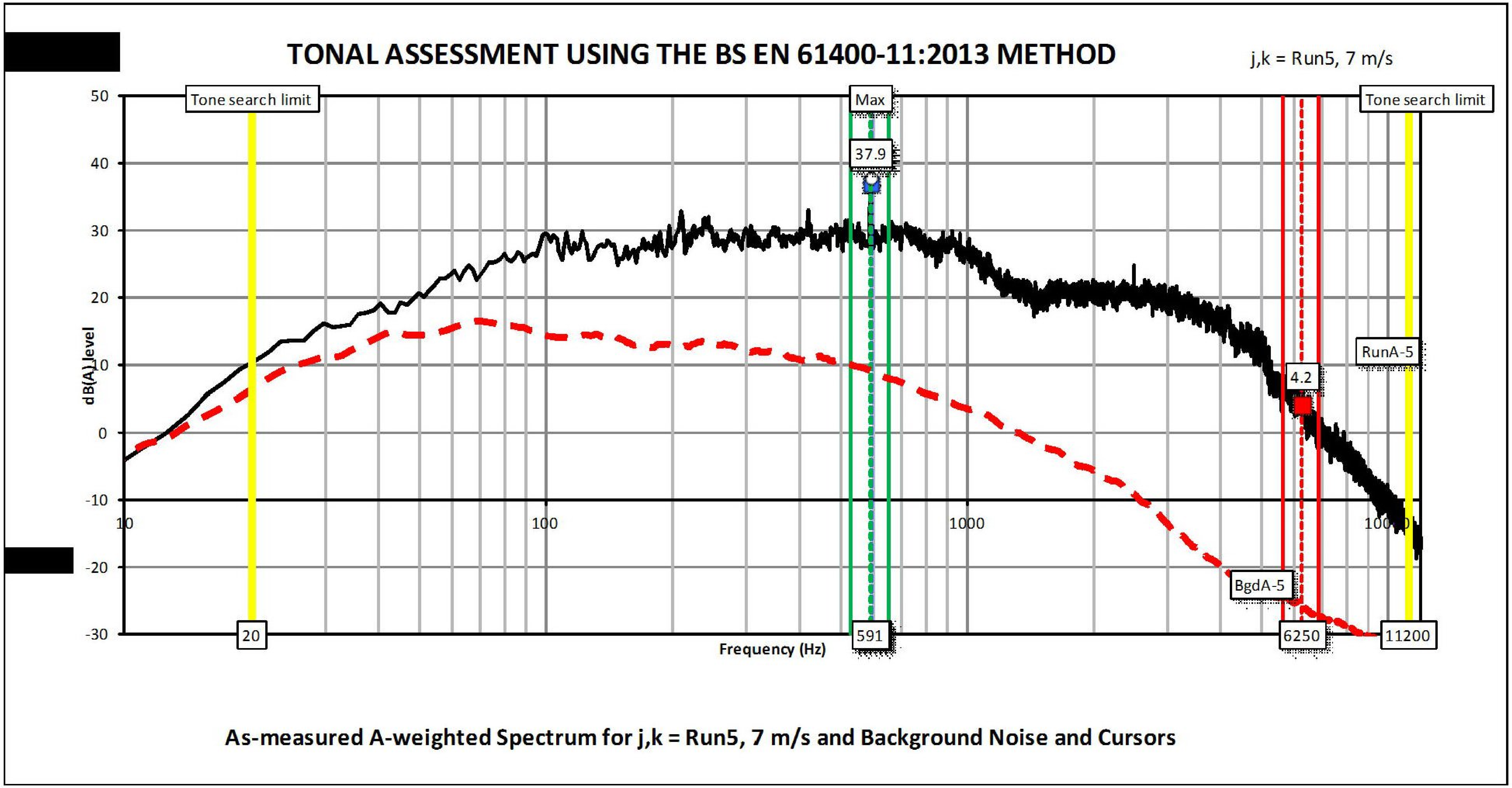


FIGURE 17a TONAL ASSESSMENT USING THE IEC 61400-11:2012 METHOD FOR THE 7 m/s HUB-HEIGHT WIND SPEED BIN

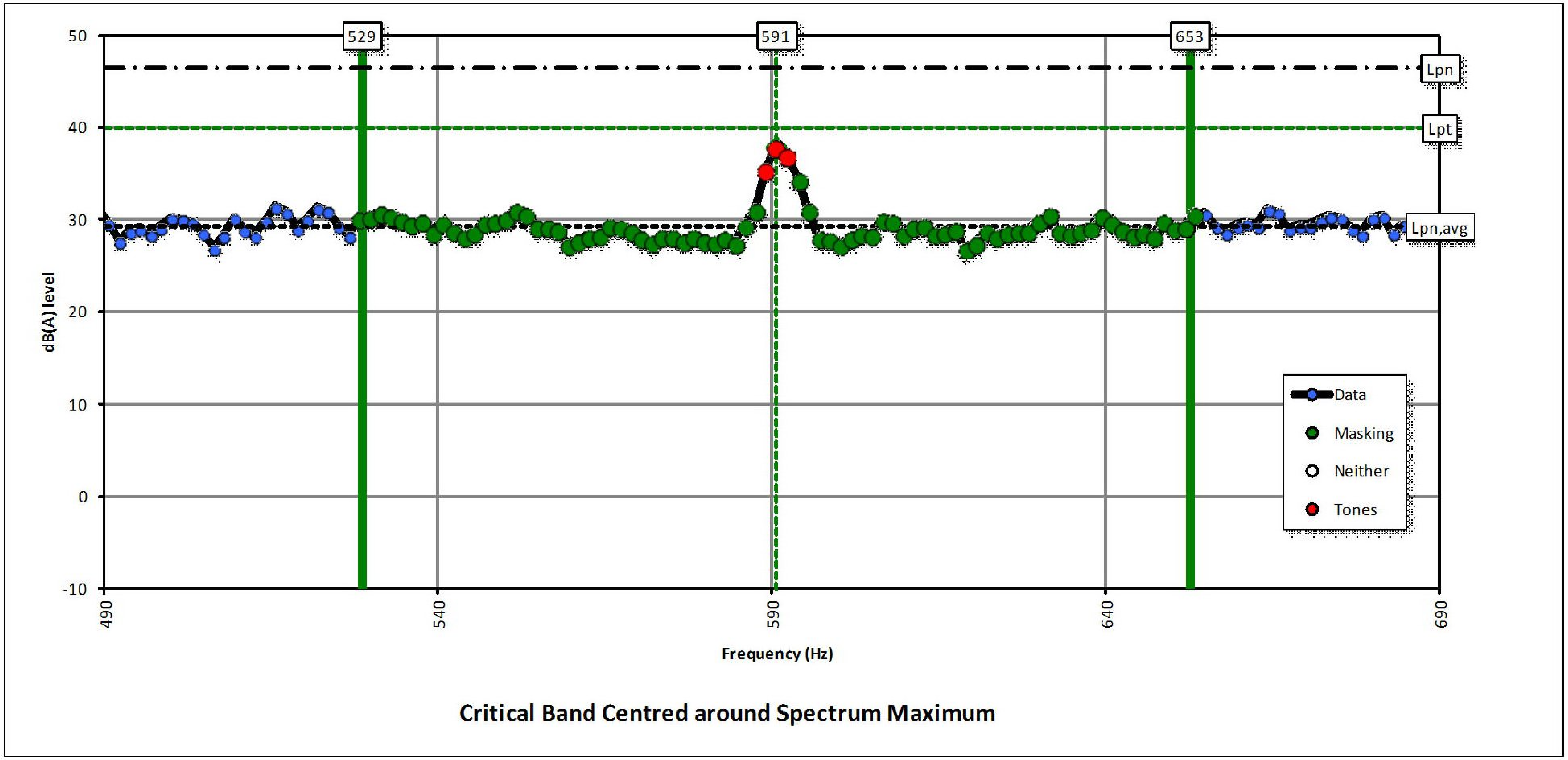


FIGURE 17b CRITICAL BAND WITH SPECTRUM MAXIMUM SHOWING TONES AND MASKING NOISE FOR 7 m/s WIND SPEED BIN. (Tonality -4.1 dB)

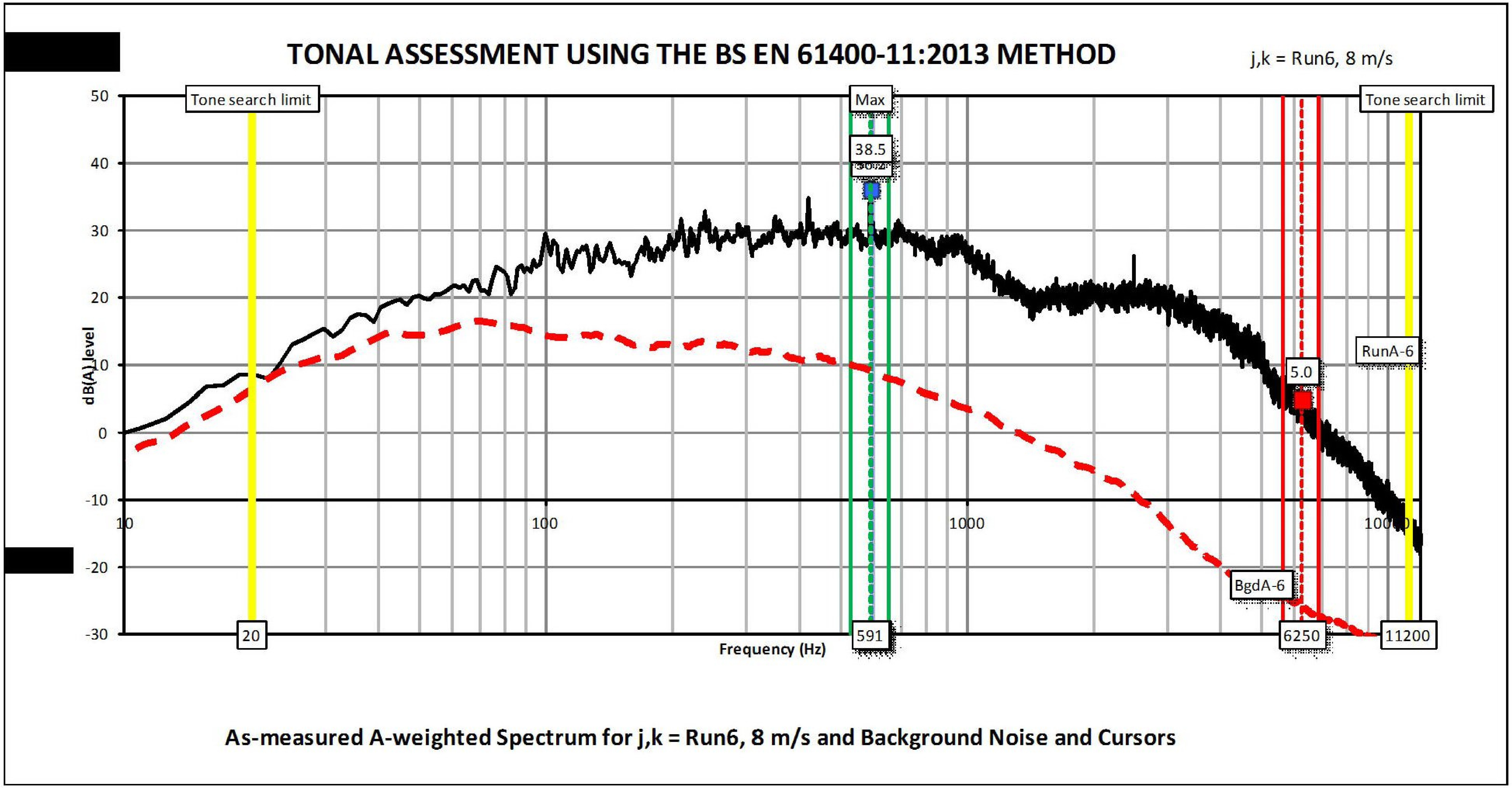


FIGURE 18a TONAL ASSESSMENT USING THE IEC 61400-11:2012 METHOD FOR THE 8 m/s HUB-HEIGHT WIND SPEED BIN

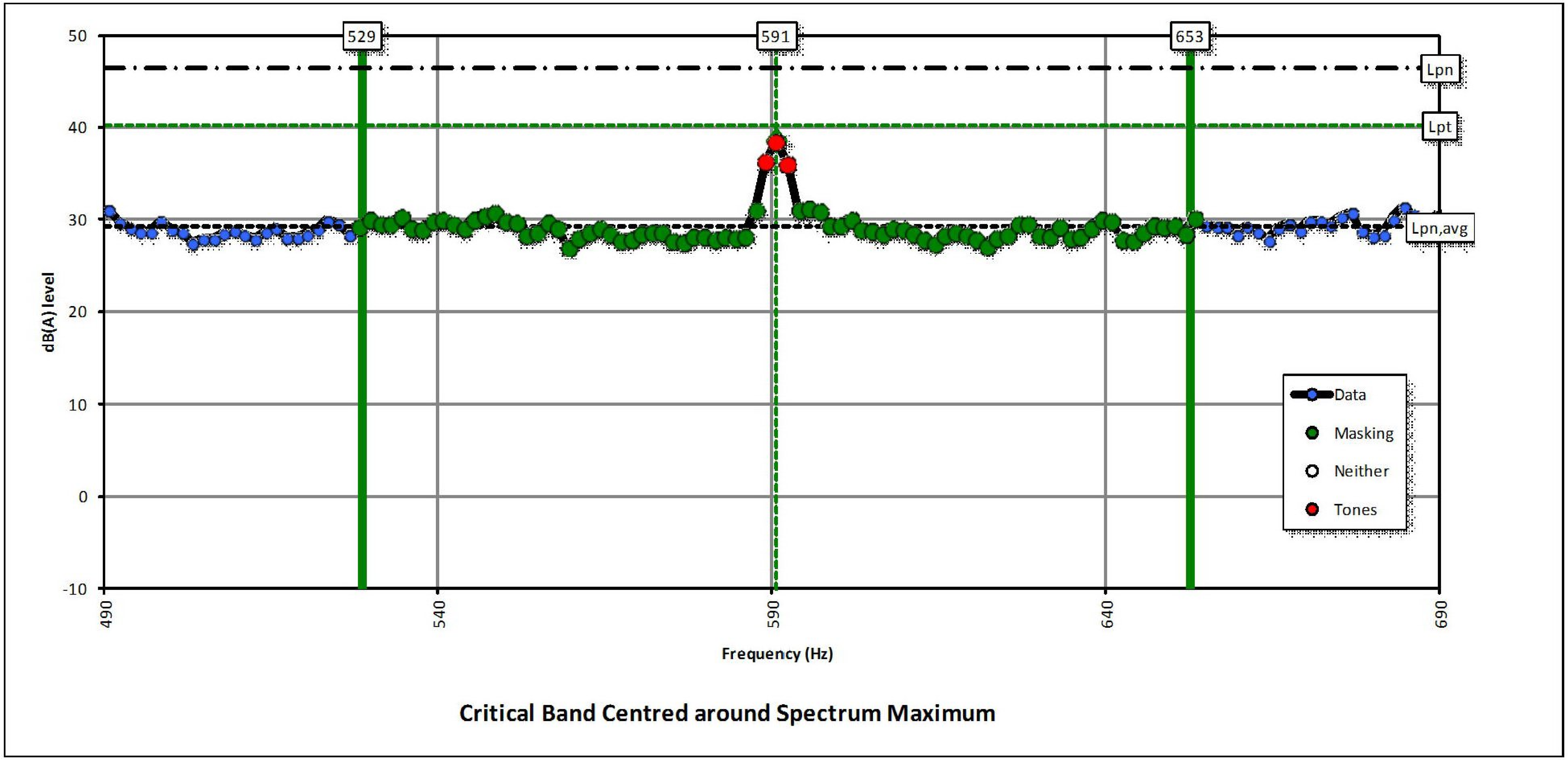


FIGURE 18b CRITICAL BAND WITH SPECTRUM MAXIMUM SHOWING TONES AND MASKING NOISE FOR 8 m/s WIND SPEED BIN. (Tonality -6.2 dB)

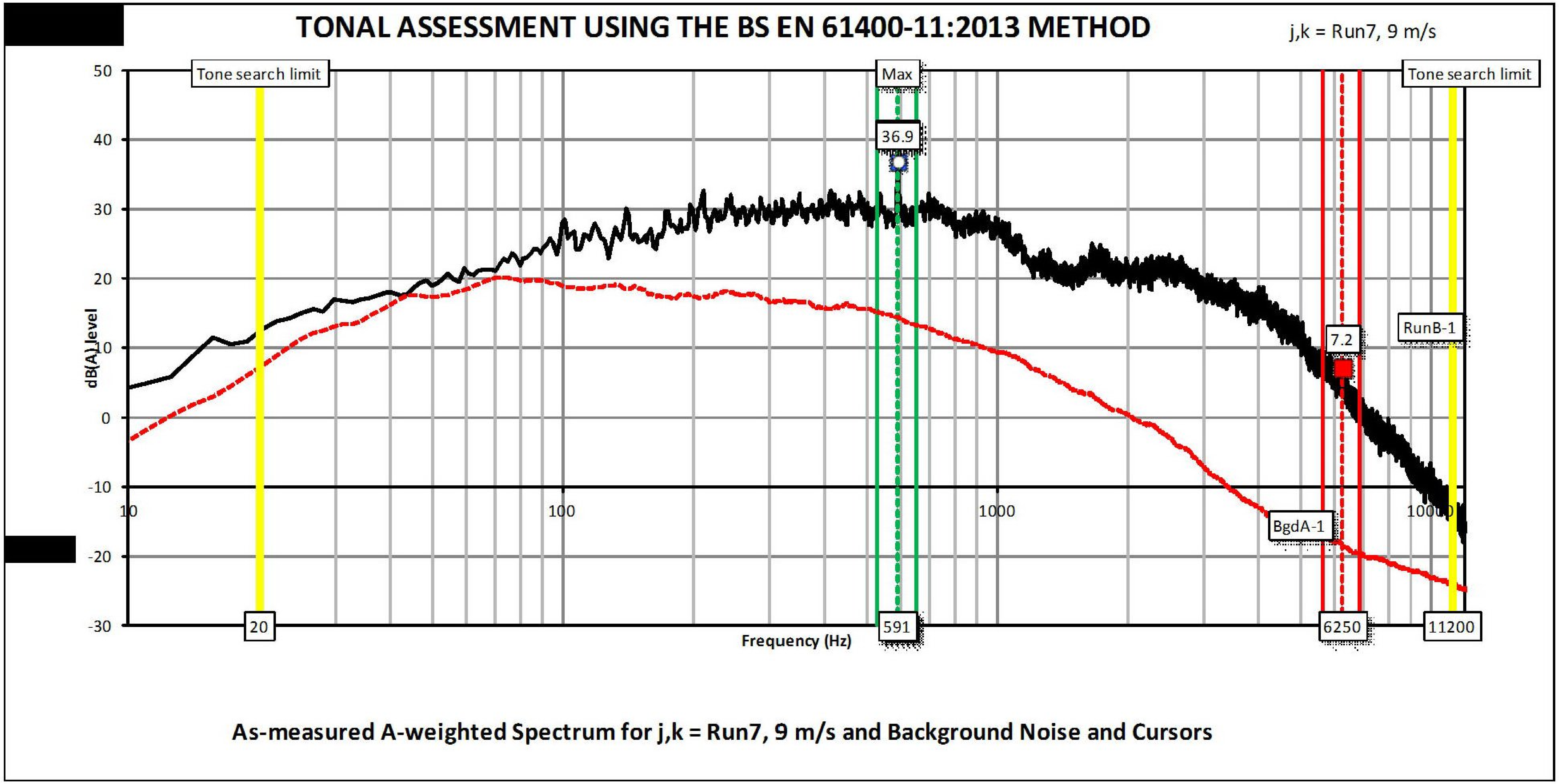


FIGURE 19a TONAL ASSESSMENT USING THE IEC 61400-11:2012 METHOD FOR THE 9 m/s HUB-HEIGHT WIND SPEED BIN

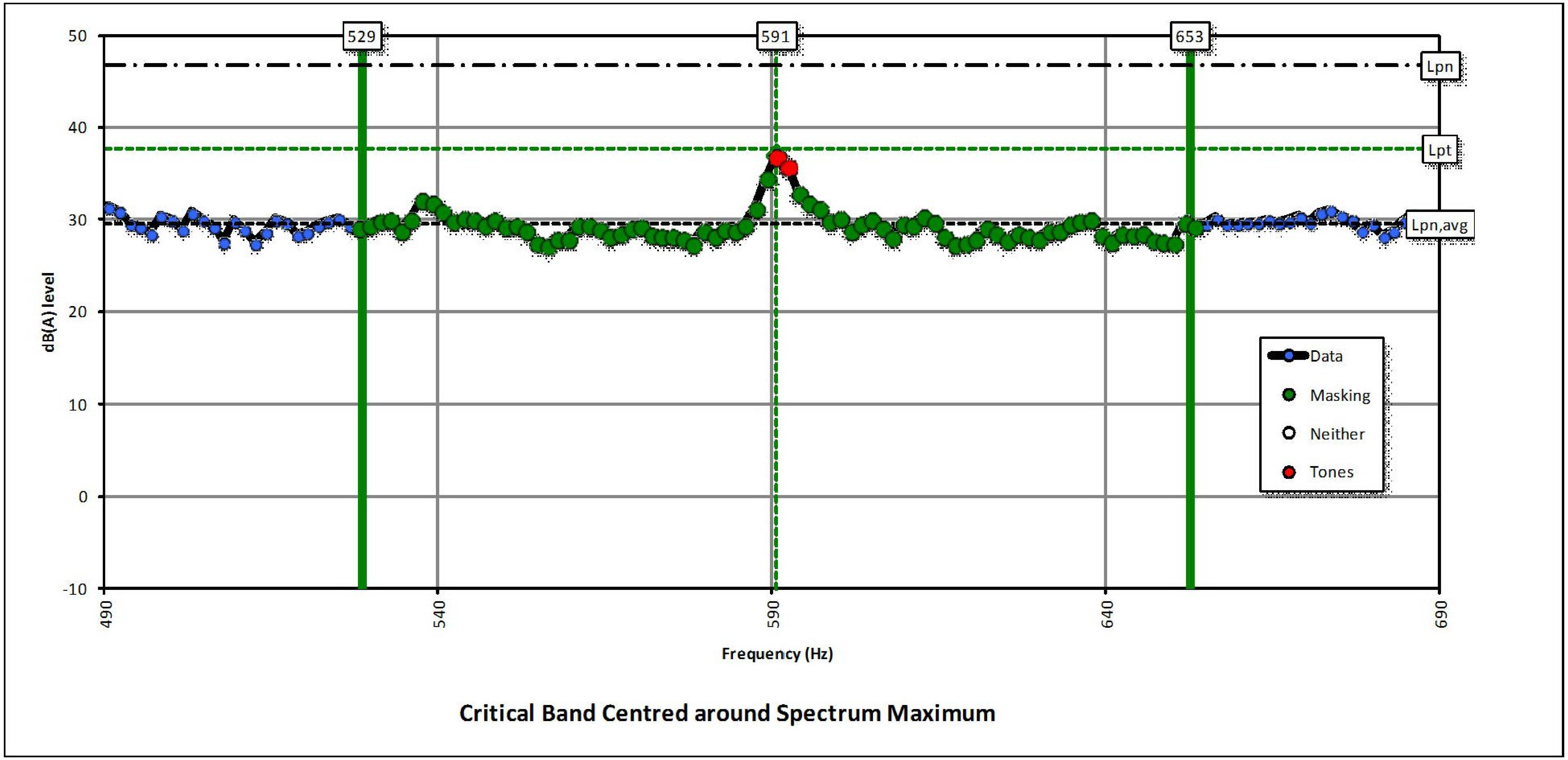


FIGURE 19b CRITICAL BAND WITH SPECTRUM MAXIMUM SHOWING TONES AND MASKING NOISE FOR 9 m/s WIND SPEED BIN. (Tonality -6.7 dB)

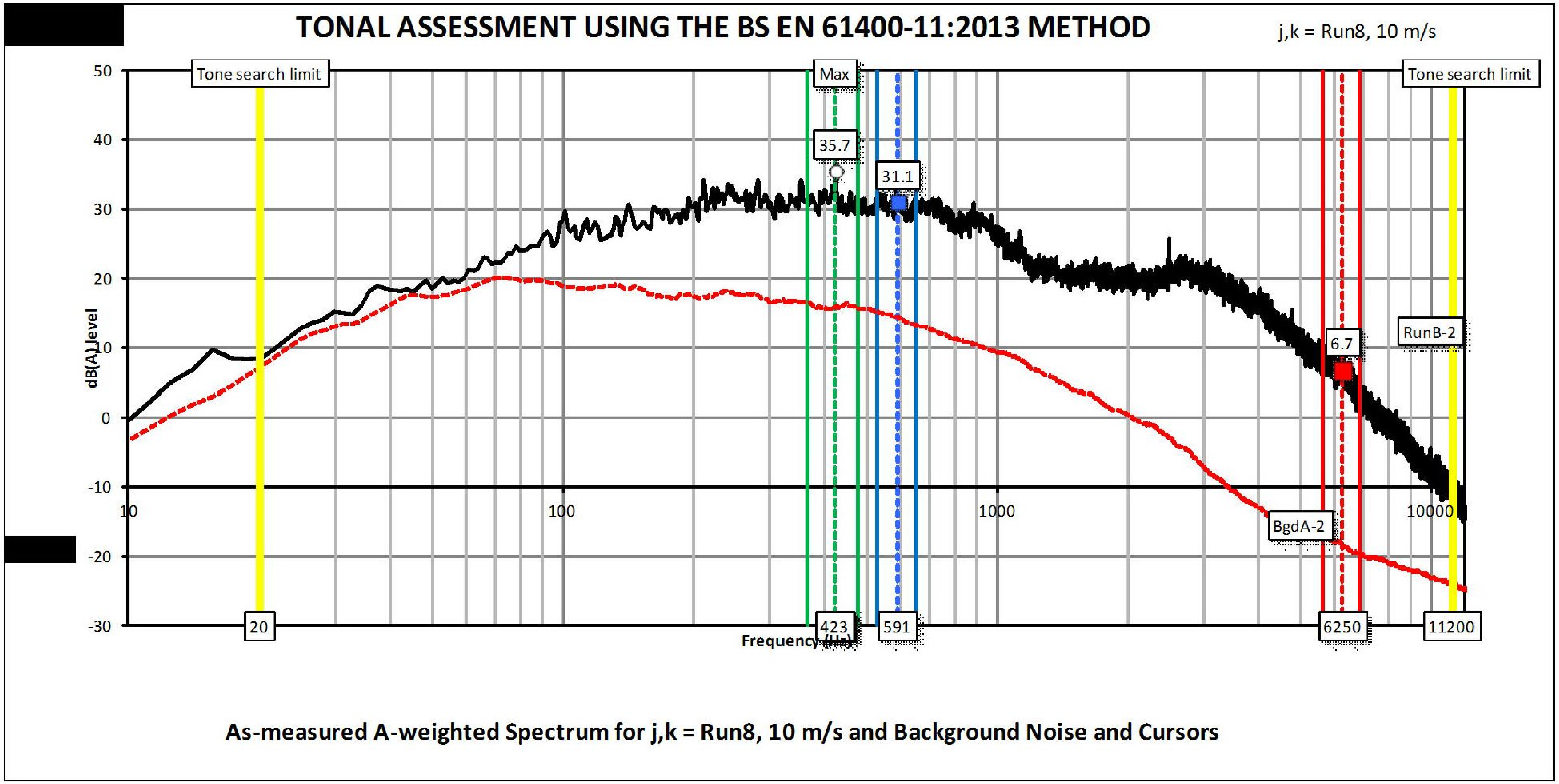


FIGURE 20a TONAL ASSESSMENT USING THE IEC 61400-11:2012 METHOD FOR THE 10 m/s HUB-HEIGHT WIND SPEED BIN

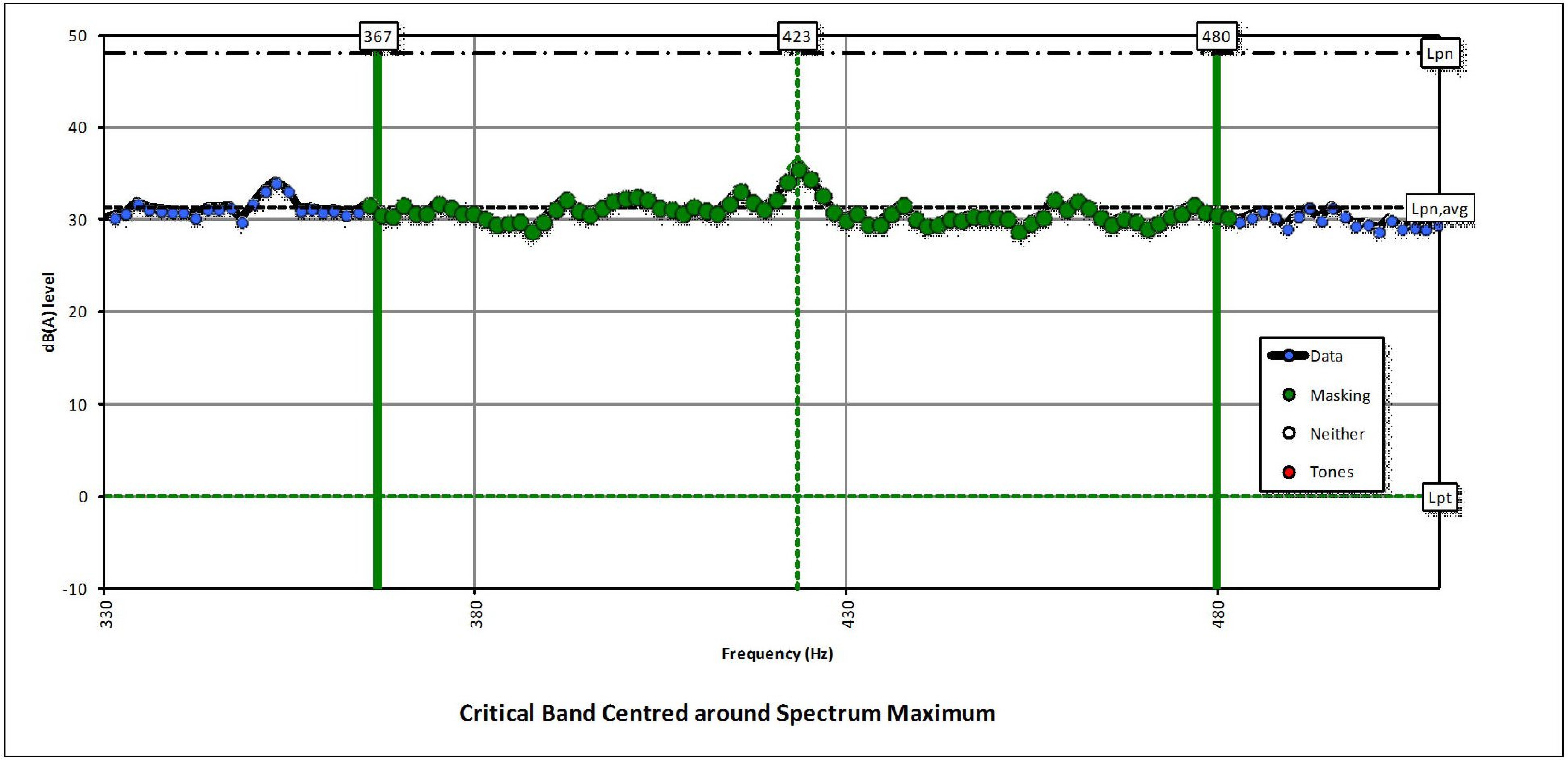


FIGURE 20b CRITICAL BAND WITH SPECTRUM MAXIMUM SHOWING TONES AND MASKING NOISE FOR 10 m/s WIND SPEED BIN. (Tonality -15 dB)

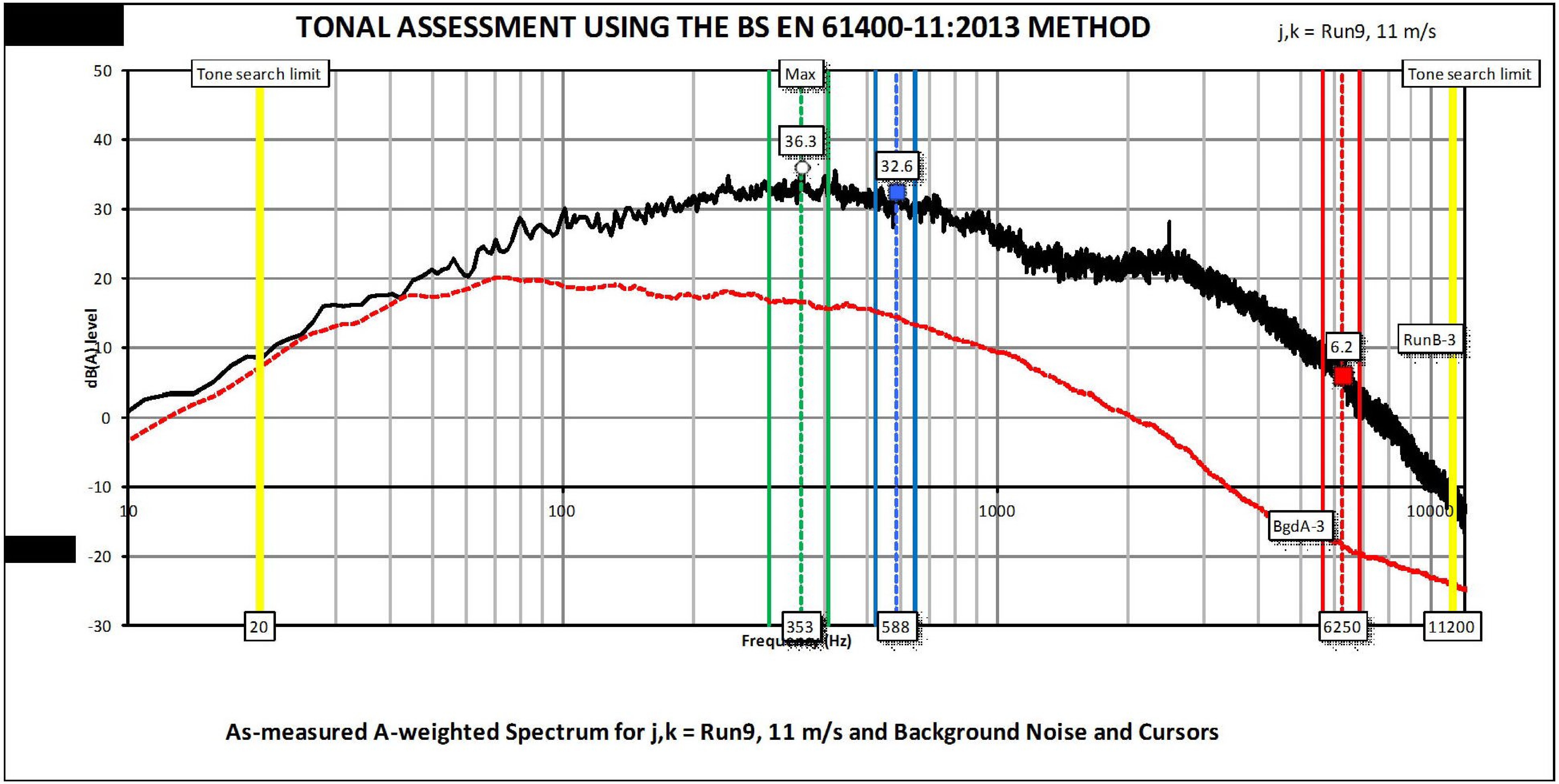


FIGURE 21a TONAL ASSESSMENT USING THE IEC 61400-11:2012 METHOD FOR THE 11 m/s HUB-HEIGHT WIND SPEED BIN

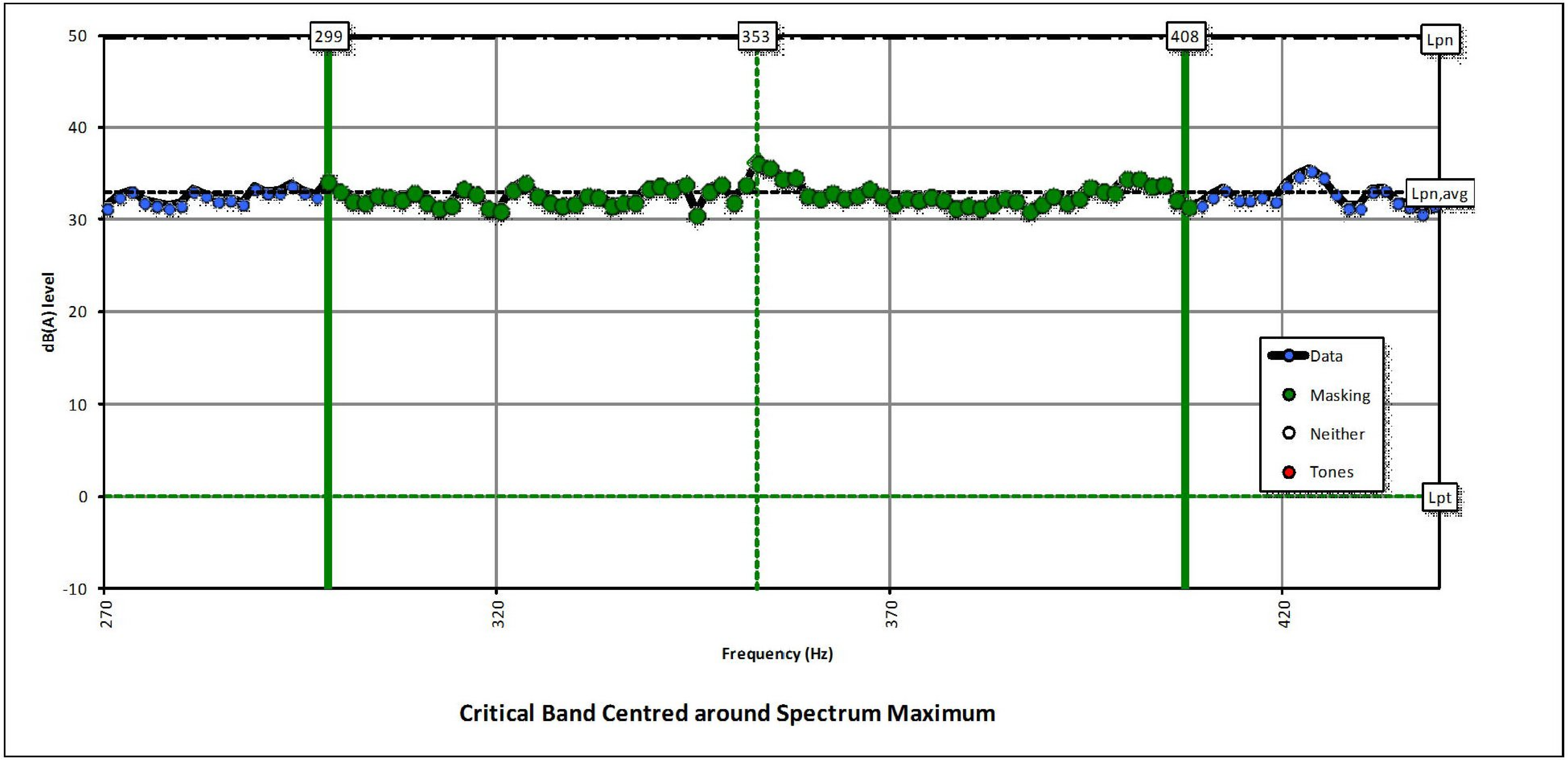


FIGURE 21b CRITICAL BAND WITH SPECTRUM MAXIMUM SHOWING TONES AND MASKING NOISE FOR 11 m/s WIND SPEED BIN. (Tonality -15 dB)

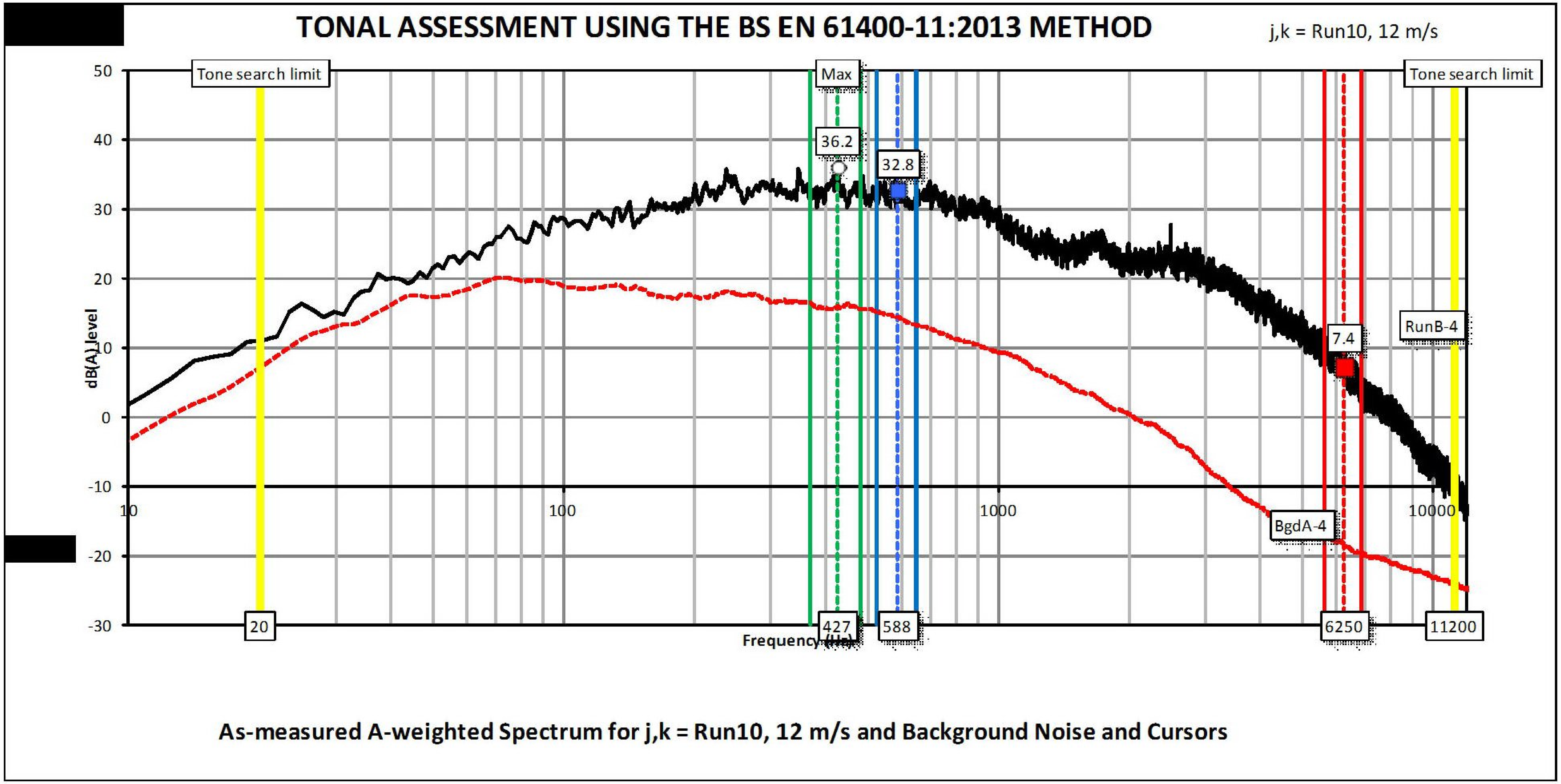


FIGURE 22a TONAL ASSESSMENT USING THE IEC 61400-11:2012 METHOD FOR THE 12 m/s HUB-HEIGHT WIND SPEED BIN

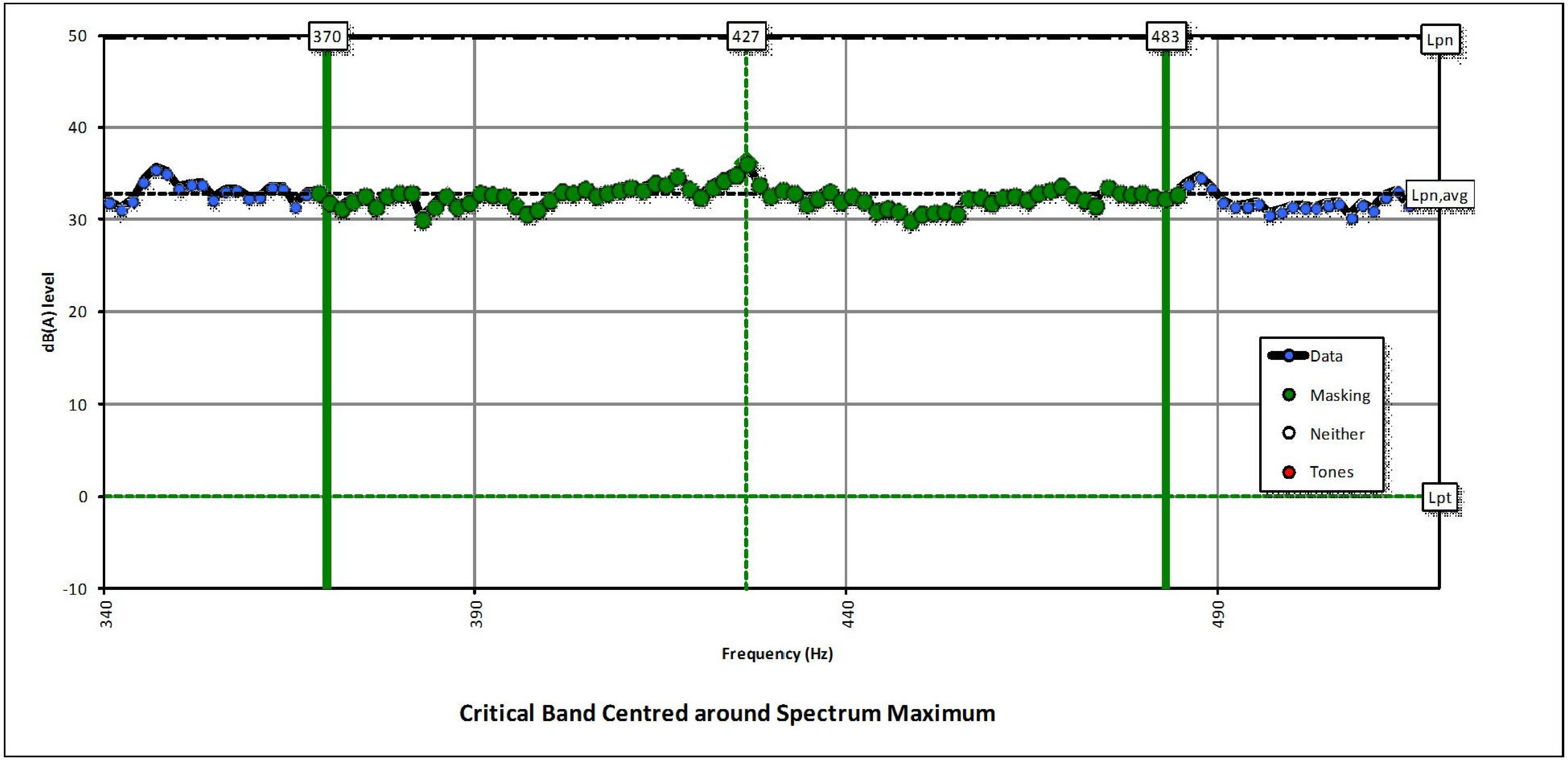


FIGURE 22b CRITICAL BAND WITH SPECTRUM MAXIMUM SHOWING TONES AND MASKING NOISE FOR 12 m/s WIND SPEED BIN. (Tonality -15 dB)

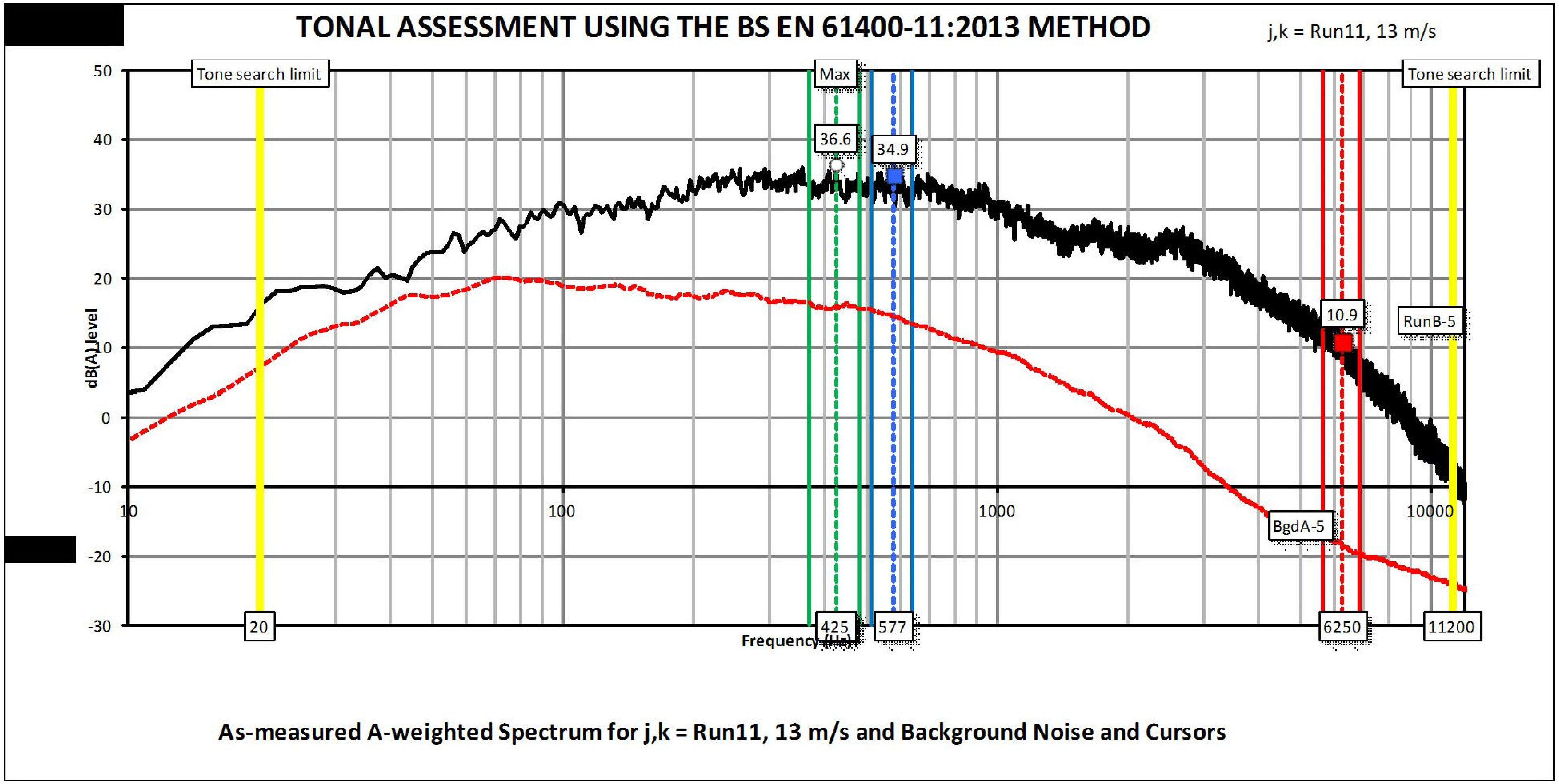


FIGURE 23a TONAL ASSESSMENT USING THE IEC 61400-11:2012 METHOD FOR THE 13 m/s HUB-HEIGHT WIND SPEED BIN

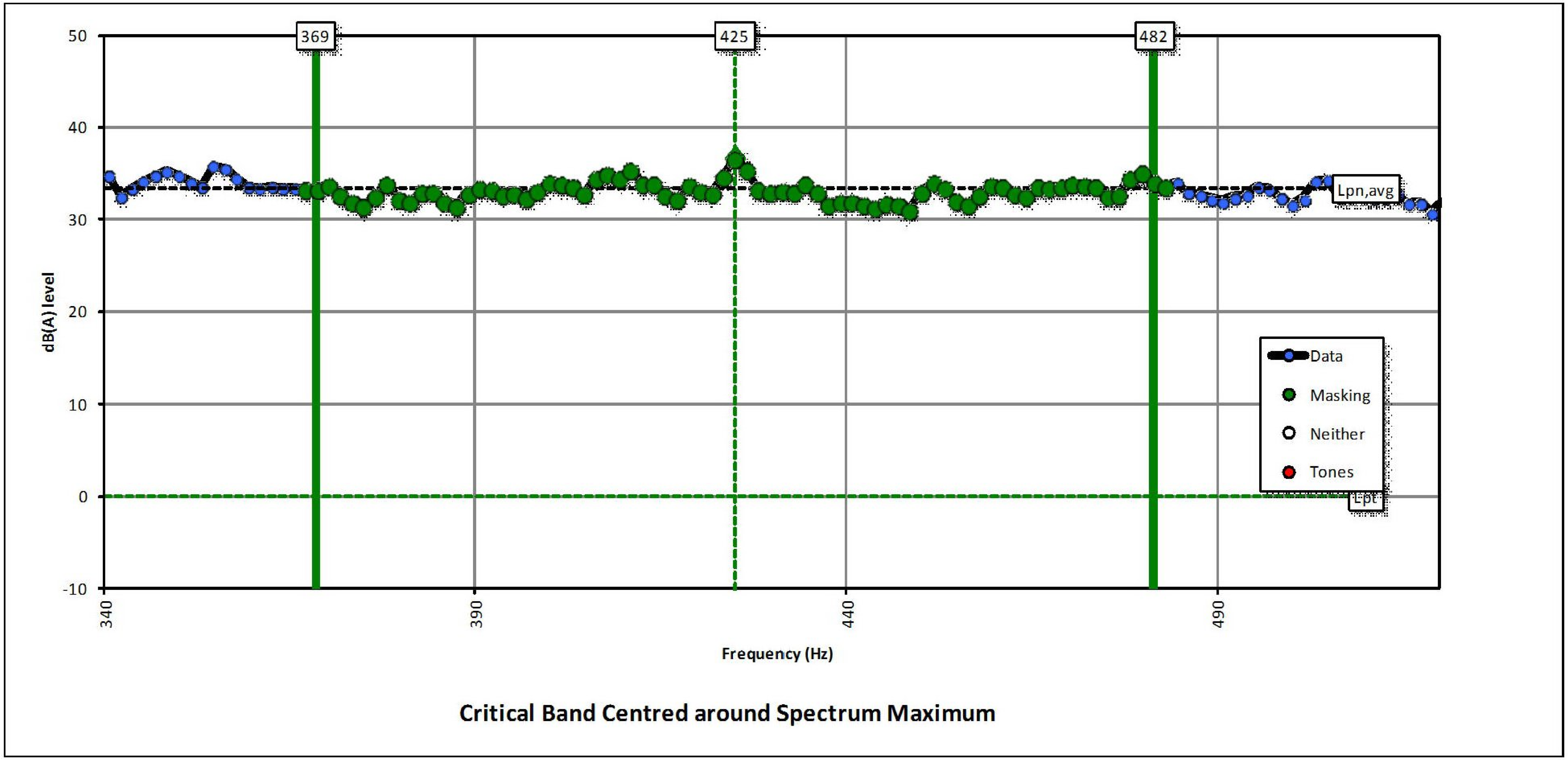


FIGURE 23b CRITICAL BAND WITH SPECTRUM MAXIMUM SHOWING TONES AND MASKING NOISE FOR 13 m/s WIND SPEED BIN. (Tonality -15 dB)

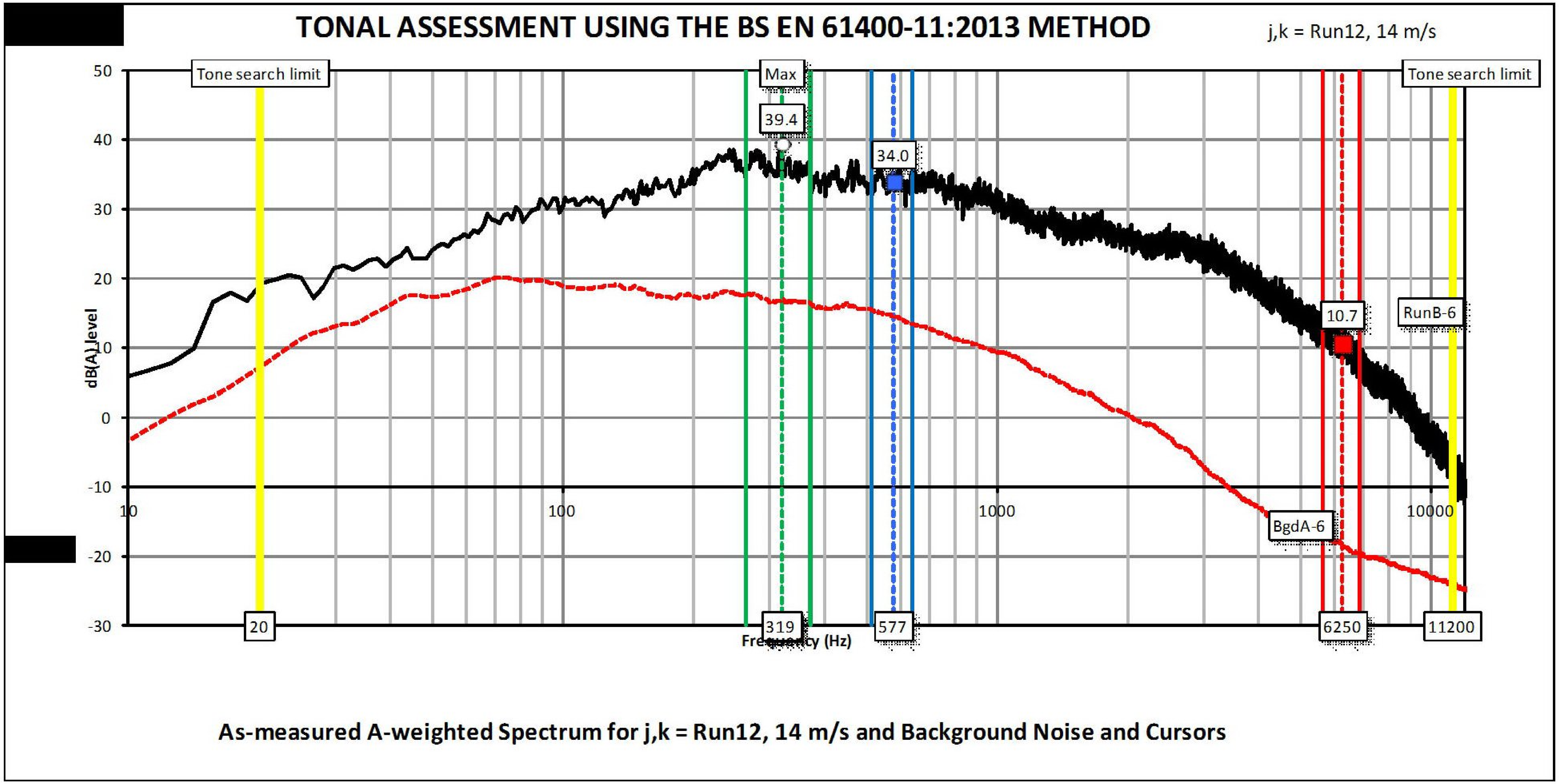


FIGURE 24a TONAL ASSESSMENT USING THE IEC 61400-11:2012 METHOD FOR THE 14 m/s HUB-HEIGHT WIND SPEED BIN

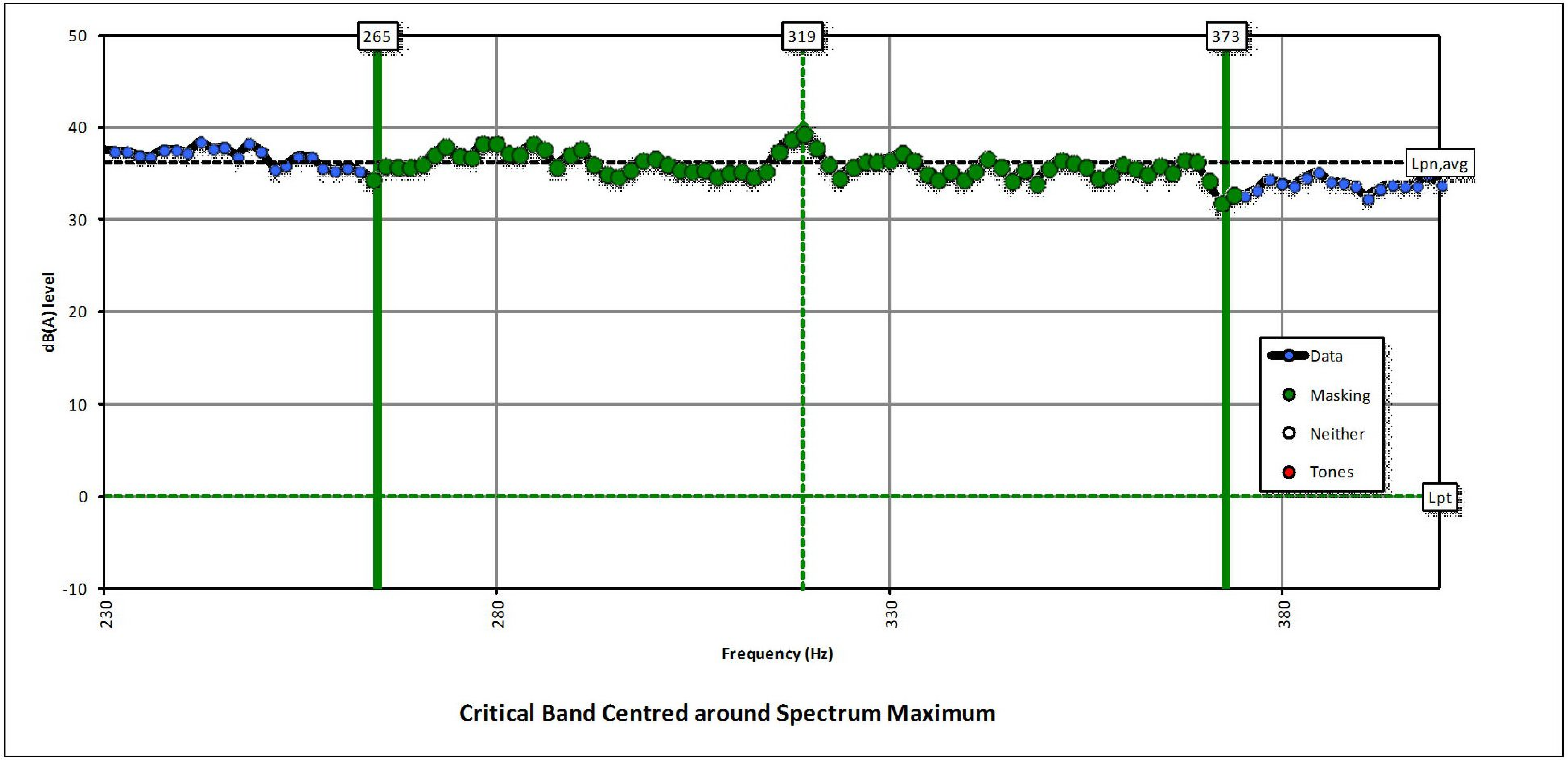


FIGURE 24b CRITICAL BAND WITH SPECTRUM MAXIMUM SHOWING TONES AND MASKING NOISE FOR 14 m/s WIND SPEED BIN. (Tonality -15 dB)

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]

0801

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

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): GP 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***
ZLF-Normal:	**18.1 dB***
ZLF-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

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]

UKAS CALIBRATION 0801

University of Salford MANCHESTER

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

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

Certificate of Calibration

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

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 [X] Andy Moorhouse [ ] [redacted]
Gary Phillips [ ] Danny McCaul [ ]

UKAS CALIBRATION 0801

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

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

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

[redacted]

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

Calibration certificate
Kalibrierschein

Acceptable [redacted]

Calibration mark
Kalibrierzeichen

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

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.

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

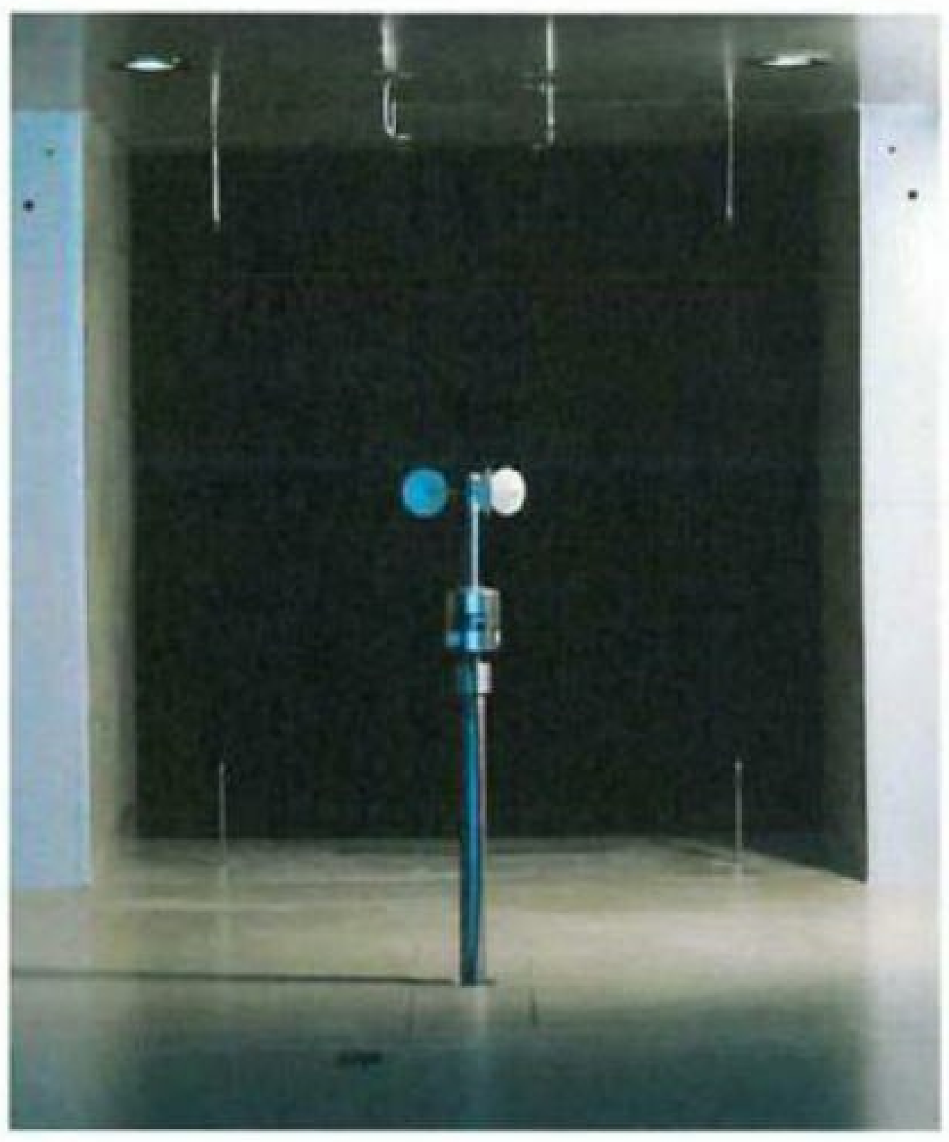
2 Instrumentation

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

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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

Graphical representation of the result
Grafische Darstellung des Ergebnisses

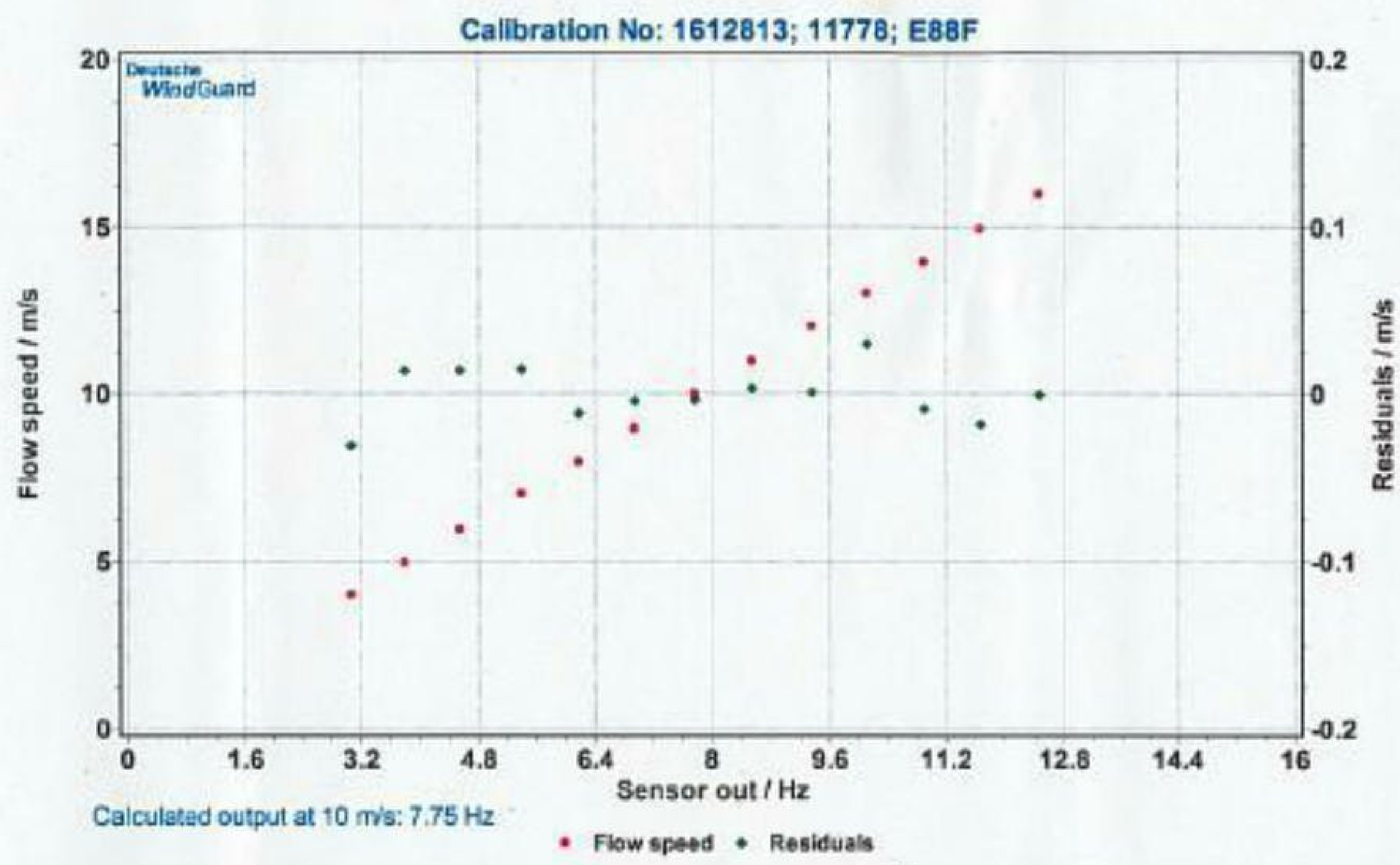
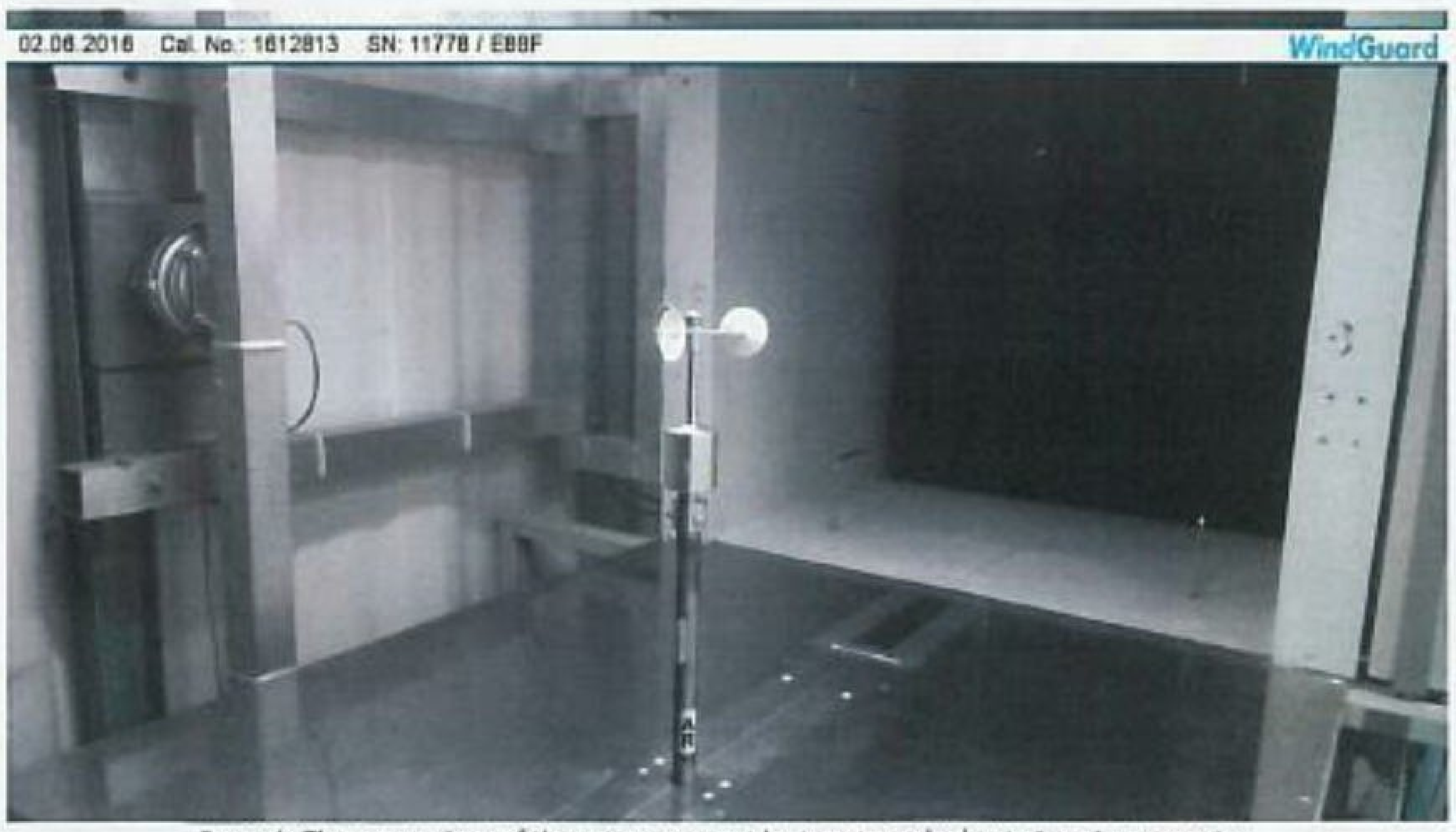


Photo of the measurement setup
Foto des Messaufbaus



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

CERTIFICATE OF CALIBRATION

ISSUED BY ANTECH

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

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: 12395.1-16-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
U80137-16

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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 < 0.15 mBar [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

Page 1 of 2

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

Uncertainty of measurement ± 0.30°C

Acceptable <0.9°C [redacted]

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_{B1}	0.2 dB
Instrument, U_{B2}	0.1 dB
Ground Board, U_{B3}	0.3 dB
Wind screen insertion loss, U_{B4}	N/A – primary screen with no secondary windscreen
Distance and direction of microphone, U_{B5}	0.1 dB
Air absorption (impedence), U_{B6}	0.2 dB
Weather, U_{B7}	0.5 dB
Wind speed (measured), U_{B8}	0.2 m/s
Wind speed (derived), U_{B8}	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_{B9}	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;
$V_{j,k}$ 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:

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

where

$V_{j,k}$ is the average value of wind speed at measurement period j;
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_{Vj} is calculated as:

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

where

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

Information about the sources are given in Table 6.

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

$$u_{V,k} = \sqrt{\frac{1}{N} \cdot \sum_{j=1}^{N} u_{Vj}^2}$$

The combined uncertainty $u_{com,V,k}$ can be expressed as:

$$u_{com,V,k} = \sqrt{s^2{}_{V,k} + u^2{}_{V,k}}$$

<u>**Uncertainty of average sound spectra**</u>

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

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

where

N is the number of measurements in wind speed bin k;
$L_{i,j,k}$ 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:

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

Where

$\overline{L}_{ik}$ 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:

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

The combined uncertainty can be expressed as:

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

<u>**Uncertainty of noise levels at bin centres**</u>

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

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

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:

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

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

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

where

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

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

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

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							
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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							
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	
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**	**-**

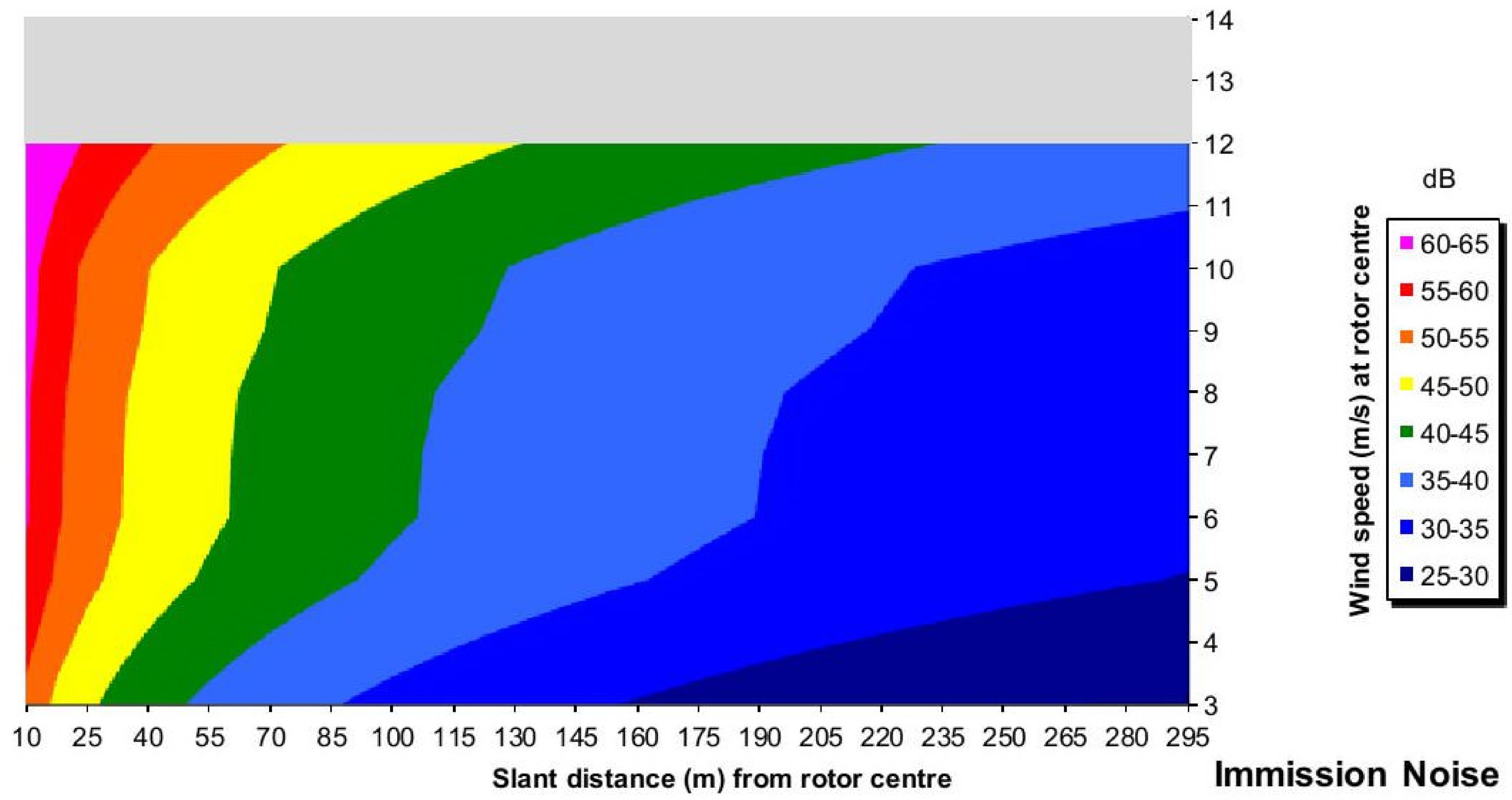
IEC 61400-11:2012 TONALITY

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.



Immission Noise

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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 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 MAINS OF PITLURG 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 – 343229 845608

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.

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Noise Assessment Report –Mains of Pitlurg

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 Mains of Pitlurg Farm. The turbine position lies in the region of 438m south of the B9115 and 1.37km South West of the A96. There is a further unclassified road 635m to the south of the development site. Keith lies 4.6km to the north and Huntly 10.8km south east. Lying 292m south of the proposed development site lies the Den of Pitlurg (SSSI).

The proposed location for the wind turbine sits at a height above sea level of approximately 250m AOD. The landowner occupies the premises known as Mains of Pitlurg 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 Little Pitlurg, Rinnes View, Taber-Chalic, Edintore, Edintore Cottage. None of these properties are believed to be within the landowners control apart from Little Pitlurg which currently is occupied by tenants.

Details of the noise limit criteria from Edintore Wind farm towards the aforementioned properties have been kindly provided by the Environmental Health Officer in order to be able to assess the cumulative noise impact to ensure compliance. Edintore wind farm consists of 6 x E92 wind turbines.

2. Data supplied

2.1. Project Description

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

Turbine location: 343229 845608
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 not dealt with in this report.

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 Mains of Pitlurg

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

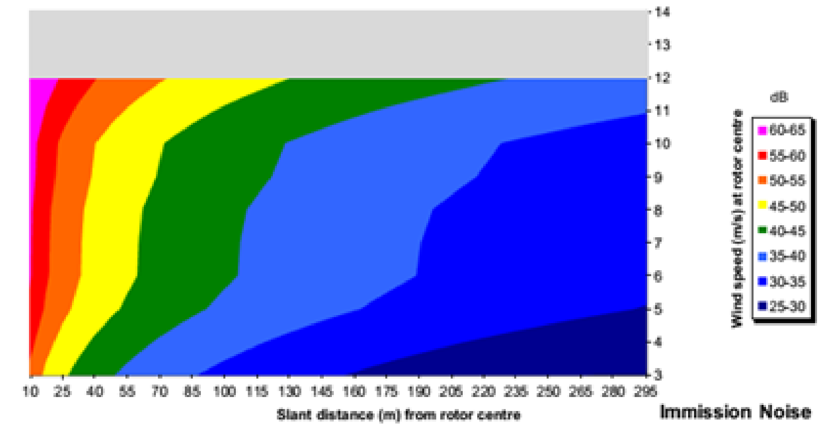
Wind Speed (m/s) at 10 m Height	2	3	4	5	6	7	8	9	10	11	12	13
Apparent Sound Power Level, L_{WA}, dB(A) re 10^{-12}W	-	84.8	87.5	90.2	91.5	91.6	91.8	92.7	93.1	95.6	98.4	-
Combined Uncertainty, U_c, dB	-	1.01	0.72	0.64	0.63	0.62	0.62	0.63	0.63	0.65	0.75	-
Declared Sound Power Level, L_{Wd}, dB(A) re 10^{-12}W	-	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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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)	-	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 shown in Appendix A, the proposed turbine has been deemed to exhibit such tones at windspeeds of 4.0-5.0m/s (10m standardised windspeeds) and hence the appropriate tonal penalty is applicable. A tonal Penalty of 1.5dB at 4 m/s and 0.1dB at 5m/s.

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 Mains of Pitlurg project, the ETSU-R-97 and IoA BPG methods will be followed. The ISO 9613-2 propagation model will be used.

Additional comments on cumulative noise will follow at the end of this report.

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 Mains of Pitlurg Farm is owner occupied and will receive financial benefit and therefore will be assessed at the 40dB level.

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 12m agl windspeed at each noise-sensitive property;
- A contour plot of noise at a specific windspeed (12m/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 (40db for involved properties) of any property in the vicinity of the project.

No Valley or screening effect has been applied to the calculations.

The properties assessed are listed below:

	Grid reference	Financial Involvement	IoA Valley Penalty	IoA Screening Benefit
A Little Pitlurg	**342737 845741**	No	Yes	No
B Mains of Pitlurg	**343721 845574**	Yes	Yes	No

C Rinnes View	**343068 846058**	No	Yes	No
D Taber-Chalich	**342802 845975**	No	Yes	No
E Edintore	**342619 846023**	No	Yes	No
F Edintore Cottage	**341984 845618**	No	Yes	No

3.3.3 Detailed Results

LITTLE PITLURG

Due to the results from Edintore Wind farm we are able to utilise the levels within the following results. The level of demand is as per that shown within Edintore results.

Wind Speed	Demand	WTG Noise Level	Demand Fulfilled	Exceedance
4.0 m/s	39.7dB	25.8dB	Yes	-13.9dB
5.0 m/s	41.6dB	26.8dB	Yes	-14.8dB
6. 0 m/s	45.3dB	28.0dB	Yes	-17.3dB
7.0 m/s	51.3dB	28.1dB	Yes	-23.1dB
8.0 m/s	53.6dB	28.3dB	Yes	-25.3dB
9.0 m/s	53.6dB	29.2dB	Yes	-24.4dB
10 m/s	53.6dB	29.6dB	Yes	-24.0dB

MAINS OF PITLURG

Wind Speed	Demand	WTG Noise Level	Demand Fulfilled	Exceedance
4.0 m/s	40.0dB	23.1dB	Yes	-16.9dB
5.0 m/s	40.0dB	24.1 dB	Yes	-15.9dB
6. 0 m/s	40.0dB	25.3dB	Yes	-14.7dB
7.0 m/s	40.0dB	25.4dB	Yes	-14.6dB
8.0 m/s	40.0dB	25.6dB	Yes	-14.4 dB
9.0 m/s	40.0dB	26.5dB	Yes	-13.5dB
10 m/s	40.0dB	26.9dB	Yes	-13.1dB

*RINNES VIEW

Wind Speed	Demand	WTG Noise Level	Demand Fulfilled	Exceedance
4.0 m/s	45.0dB	23.4dB	Yes	-21.6dB
5.0 m/s	45.0dB	24.4dB	Yes	-20.6dB
6. 0 m/s	45.3dB	25.6dB	Yes	-19.7dB
7.0 m/s	51.3dB	25.7dB	Yes	-25.6dB
8.0 m/s	53.6dB	25.9dB	Yes	-27.7dB
9.0 m/s	53.6dB	26.8dB	Yes	-26.8dB
10 m/s	53.6dB	27.2dB	Yes	-26.4dB

*TABER-CHALICH

Wind Speed	Demand	WTG Noise Level	Demand Fulfilled	Exceedance
4.0 m/s	45.0dB	24.8dB	Yes	-20.2dB
5.0 m/s	45.0dB	25.8dB	Yes	-19.2dB
6. 0 m/s	45.3dB	27.0dB	Yes	-18.3dB

7.0 m/s	51.3dB	27.1dB	Yes	-24.2dB
8.0 m/s	53.6dB	27.3dB	Yes	-2963dB
9.0 m/s	53.6dB	28.2dB	Yes	-25.4dB
10 m/s	53.6dB	28.6dB	Yes	-25.0dB

*EDINTORE FARMHOUSE

Wind Speed	Demand	WTG Noise Level	Demand Fulfilled	Exceedance
4.0 m/s	45.0dB	22.0dB	Yes	-23.0dB
5.0 m/s	45.0dB	23.0dB	Yes	-22.0dB
6. 0 m/s	45.3dB	24.2dB	Yes	-20.1dB
7.0 m/s	51.3dB	24.3dB	Yes	-10.7dB
8.0 m/s	53.6dB	24.5dB	Yes	-10.5dB
9.0 m/s	53.6dB	25.4dB	Yes	-09.6dB
10 m/s	53.6dB	25.8dB	Ye	-09.2dB

EDINTORE COTTAGE

Wind Speed	Demand	WTG Noise Level	Demand Fulfilled	Exceedance
4.0 m/s	39.7dB	13.8dB	Yes	-25.9dB
5.0 m/s	41.6dB	14.8dB	Yes	-26.8dB
6. 0 m/s	45.3dB	16.0dB	Yes	-29.3dB
7.0 m/s	51.3dB	16.1dB	Yes	-35.2dB
8.0 m/s	53.6dB	16.3dB	Yes	-37.3dB
9.0 m/s	53.6dB	17.2dB	Yes	-36.4dB
10 m/s	53.6dB	17.6dB	Yes	-36.0dB

*Properties associated with Edintore Wind farm and receiving benefit from the development.

Exceedances of existing noise limits (in dB) (negative values mean limits are not exceeded).

The detailed results show all properties lie outside the regions where noise is predicted to be above 35.0dB (or 40dB) or 5dB above background, or those shown from Edintore wind farm thus also meeting the limits and the simplified conditions of ETSU-R-97.

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 for properties around the proposed turbine location with or without financial involvement in the project and there is no need for the measurement of background noise.

3.6 Cumulative 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	Nature of development	Status
Edintore wind farm	6 x E92 wind turbines	Operational

Table 5. Nearest cumulative project

This 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 limit as seen in the results from Edintore Wind farm, 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".

Edintore Wind farm

The property known as Edintore farmhouse is assessed as being the closest dwelling to the Edintore wind farm turbine in the direction of the proposed development. Levels, as produced by the development and lodged have been utilised within the calculations

Table 6 shows the results of the headroom analysis at Edintore wind farm, and the application of the headroom to the next nearest property, Edintore farmhouse. In this case, the predictions for the turbines (as consented) are considered.

Windspeed at 10m agl (m/s)	4.0	5.0	6.0	7.0	8.0	9.0	10.0
Edintore Source (dB)	97.0	99.5	99.5	102.	102.	103.3	103.3
Edintore Tonal Penalty (dB)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Edintore f/h due Edintore (dB)	45	45	45.3	51.3	53.6	53.6	53.6
Headroom (capped to 10dB)	0	0	0	0	0	0	0
Edintore F/h due Mains Pi (dB)	22	23	24.2	24.3	24.5	25.4	25.8
Combined (dB)	22	23	24.2	24.3	24.5	25.4	25.8
Combined plus headroom(dB)	22	23	24.2	24.3	24.5	25.4	25.8

As is clearly shown the combined analysis of the Edintore wind farm and the proposed turbine at Mains of Pitlurg to Edintore Farmhouse shows no increase in the current limits approved previously for Edintore wind farm.

The closest property to the Mains of Pitlurg turbine, Mains of Pitlurg Farmhouse, is owner occupied. The results of the cumulative analysis is shown below:

Windspeed at 10m agl (m/s)	4.0	5.0	6.0	7.0	8.0	9.0	10.0
Main of Pitlurg Source (dB)	88.9	91.3	92.6	92.7	92.9	93.8	94.2
Main of P Tonal Penalty (dB)	1.5	0.1	0.0	0.0	0.0	0.0	0.0
Main of P f/h due Main P (dB	23.1	24.1	25.3	25.4	25.6	26.5	26.9
Headroom (capped to 10dB)	10	10	10	10	10	10	10
Mains P F/h due Edintore (dB)	24	26.5	29	30.3	31.2	32	32
Combined (dB)	26.6	28.5	30.6	31.5	32.3	33.1	33.2
Combined plus headroom(dB)	36.6	38.5	40.6	31.5	42.3	43.1	43.2

The calculation plus headroom shows compliance and all wind speeds.

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 Mains of Pitlurg 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:
* Tonal penalties calculated according to ETSU-R-97.
* Uncertainty of 1.645 times the stated measurement uncertainty according to IoA recommendations.

* atmospheric conditions of 10°C and 70% RH
* ground porosity of 0.5 (semi-porous ground - applicable as source noise data include measurement uncertainty)
* no barrier effects
* valley effect - 3dB penalty applied where applicable

The proposed development at Mains of Pitlurg meets the limits as set out in local and national guidance. The analysis has been carried out taking into consideration Edintore wind farm and the 6 x E92 wind turbines operational. The results show that there is no increase on the levels agreed and accepted for Edintore wind farm to those properties listed and taking into account the addition of Mains of Pitlurg and the proposed turbine the predicted levels are within those stated within ETSU-R-97.

Project:
Mains of Pitlurg

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:
06/12/2017 16:38/3.1.617

DECIBEL - Assumptions for noise calculation

Calculation: Nains of Pitlurg alone

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
Valley effect, Penalty: 3.0 dB
Topographic screening, Reduction: 2.0 dB
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 [db/km]	125 [db/km]	250 [db/km]	500 [db/km]	1,000 [db/km]	2,000 [db/km]	4,000 [db/km]	8,000 [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: Edintore Farmhouse-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]
45.0 dB(A)	45.0 dB(A)	45.3 dB(A)	51.3 dB(A)	53.6 dB(A)	53.6 dB(A)	53.6 dB(A)	53.6 dB(A)	53.6 dB(A)

Margin or Allowed additional exposure: 5.0 dB(A)
Sound level always accepted: 45.0 dB(A)
No distance demand

NSA: Edintore Cottage-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]
39.7 dB(A)	41.6 dB(A)	45.3 dB(A)	51.3 dB(A)	53.6 dB(A)	53.6 dB(A)	53.6 dB(A)	53.6 dB(A)	53.6 dB(A)

Margin or Allowed additional exposure: 5.0 dB(A)
Sound level always accepted: 35.0 dB(A)
No distance demand

DECIBEL - Assumptions for noise calculation

Calculation: Nains of Pitlurg alone
NSA: Little Pitlurg-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]
39.7 dB(A)	41.6 dB(A)	45.3 dB(A)	51.3 dB(A)	53.6 dB(A)	53.6 dB(A)	53.6 dB(A)	53.6 dB(A)	53.6 dB(A)

Margin or Allowed additional exposure: 5.0 dB(A)
Sound level always accepted: 35.0 dB(A)
No distance demand

NSA: Mains of Pitlurg-D
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]
45.0 dB(A)	45.0 dB(A)	45.0 dB(A)	45.0 dB(A)	45.0 dB(A)	45.0 dB(A)	45.0 dB(A)	45.0 dB(A)	45.0 dB(A)

Margin or Allowed additional exposure: 0.0 dB(A)
Sound level always accepted: 45.0 dB(A)
No distance demand

NSA: Rinnes View-E
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]
45.0 dB(A)	45.0 dB(A)	45.3 dB(A)	51.3 dB(A)	53.6 dB(A)	53.6 dB(A)	53.6 dB(A)	53.6 dB(A)	53.6 dB(A)

Margin or Allowed additional exposure: 5.0 dB(A)
Sound level always accepted: 45.0 dB(A)
No distance demand

NSA: Taber Chalich-F
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]
45.0 dB(A)	45.0 dB(A)	45.3 dB(A)	51.3 dB(A)	53.6 dB(A)	53.6 dB(A)	53.6 dB(A)	53.5 dB(A)	53.6 dB(A)

Margin or Allowed additional exposure: 5.0 dB(A)
Sound level always accepted: 45.0 dB(A)
No distance demand

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

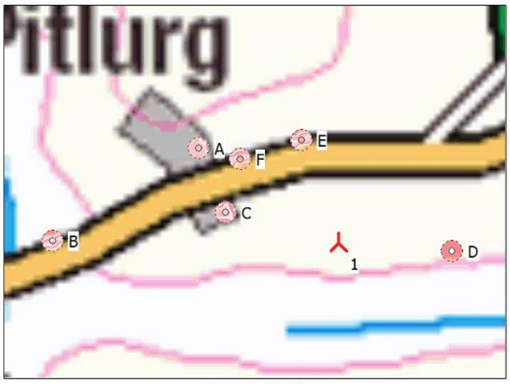
Adele / ae.associates@btinternet.com
Calculated:
06/12/2017 16:38/3.1.617

DECIBEL - Main Result

Calculation: Nains of Pitlurg alone

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
Valley effect, Penalty: 3.0 dB
Topographic screening, Reduction: 2.0 dB
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 1:25,000
New WTG   Noise sensitive area

WTGs

					WTG type						Noise data						
	Easting	Northing	Z	Row data/Description	Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	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	343,229	845,608	209.5	T1	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						Most critical demand		Predicted sound level			Demands fulfilled ?
No.	Name	Easting	Northing	Z	Imission height	Wind speed	Demand	WTG noise	Max exceedence	Distance to noise demand	Noise
				[m]	[m]	[m/s]	[dB(A)]	[dB(A)]	[dB(A)]	[m]	
A	Edintore Farmhouse	342,619	846,023	222.4	4.0	6.0	50.3	24.2	-26.1	719	Yes
B	Edintore Cottage	341,984	845,618	170.0	4.0	4.0	44.7	13.8	-30.9	1,201	Yes
C	Little Pitlurg	342,737	845,741	203.1	4.0	4.0	44.7	25.8	-18.9	463	Yes
D	Mains of Pitlurg	343,721	845,574	223.8	4.0	12.0	45.0	32.4	-12.6	322	Yes
E	Rinnes View	343,068	846,058	227.2	4.0	6.0	50.3	25.6	-24.7	458	Yes
F	Taber Chalich	342,802	845,975	217.3	4.0	6.0	50.3	27.0	-23.3	543	Yes

Distances (m)

	WTG
NSA	1
A	738
B	1245
C	510
D	493
E	478
F	563

DECIBEL - Detailed results

Calculation: Nains of Pitlurg alone**Noise calculation model:** ISO 9613-2 United Kingdom

Assumptions

Cmet:	Meteorological correction
Cvalley:	Valley effect
Cscreen:	Topographic screening

Calculation Results

Noise sensitive area: A Edintore Farmhouse

WTG **Wind speed: 4.0 m/s**

No.	Distance [m]	Sound distance [m]	Calculated [dB(A)]	LwA,ref [dB(A)]	Pure tones [dB]	Dc [dB]	Adiv [dB]	Aatm [dB]	Agr [dB]	Abar [dB]	Amisc [dB]	A [dB]	Cvalley [dB]
1	738	738	**21.96**	86.9	2	0.00	68.36	-	-	0.00	0.00	-	3.00

Sum 21.96

- Data undefined due to calculation with octave data

Noise sensitive area: B Edintore Cottage

WTG **Wind speed: 4.0 m/s**

No.	Distance [m]	Sound distance [m]	Calculated [dB(A)]	LwA,ref [dB(A)]	Pure tones [dB]	Dc [dB]	Adiv [dB]	Aatm [dB]	Agr [dB]	Abar [dB]	Amisc [dB]	A [dB]
1	1,245	1,246	**13.77**	86.9	2	0.00	72.91	-	-	0.00	0.00	-

Sum 13.77

- Data undefined due to calculation with octave data

Noise sensitive area: C Little Pitlurg

WTG **Wind speed: 4.0 m/s**

No.	Distance [m]	Sound distance [m]	Calculated [dB(A)]	LwA,ref [dB(A)]	Pure tones [dB]	Dc [dB]	Adiv [dB]	Aatm [dB]	Agr [dB]	Abar [dB]	Amisc [dB]	A [dB]	Cvalley [dB]
1	510	510	**25.76**	86.9	2	0.00	65.16	-	-	0.00	0.00	-	3.00

Sum 25.76

- Data undefined due to calculation with octave data

Noise sensitive area: D Mains of Pitlurg

WTG **Wind speed: 4.0 m/s**

No.	Distance [m]	Sound distance [m]	Calculated [dB(A)]	LwA,ref [dB(A)]	Pure tones [dB]	Dc [dB]	Adiv [dB]	Aatm [dB]	Agr [dB]	Abar [dB]	Amisc [dB]	A [dB]
1	493	493	**23.10**	86.9	2	0.00	64.86	-	-	0.00	0.00	-

Sum 23.10

- Data undefined due to calculation with octave data

Noise sensitive area: E Rinnes View

WTG **Wind speed: 4.0 m/s**

No.	Distance [m]	Sound distance [m]	Calculated [dB(A)]	LwA,ref [dB(A)]	Pure tones [dB]	Dc [dB]	Adiv [dB]	Aatm [dB]	Agr [dB]	Abar [dB]	Amisc [dB]	A [dB]
1	478	478	**23.42**	86.9	2	0.00	64.59	-	-	0.00	0.00	-

Sum 23.42

- Data undefined due to calculation with octave data

Noise sensitive area: F Taber Chalich

WTG **Wind speed: 4.0 m/s**

No.	Distance [m]	Sound distance [m]	Calculated [dB(A)]	LwA,ref [dB(A)]	Pure tones [dB]	Dc [dB]	Adiv [dB]	Aatm [dB]	Agr [dB]	Abar [dB]	Amisc [dB]	A [dB]	Cvalley [dB]
1	563	563	**24.76**	86.9	2	0.00	66.01	-	-	0.00	0.00	-	3.00

Sum 24.76

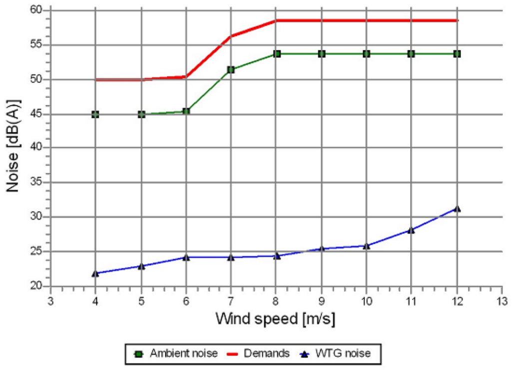
- Data undefined due to calculation with octave data

Project:	Description:	Licensed user:
Mains of Pitlurg	Installation of an Orenda wind turbine	**Orenda Energy Solutions Ltd** c/o MacRoberts, Excel House 30 Semple Street GB-EDINBURGH EH3 8BL Adele / ae.associates@btinternet.com Calculated: 06/12/2017 16:38/3.1.617

DECIBEL - Detailed results, graphic

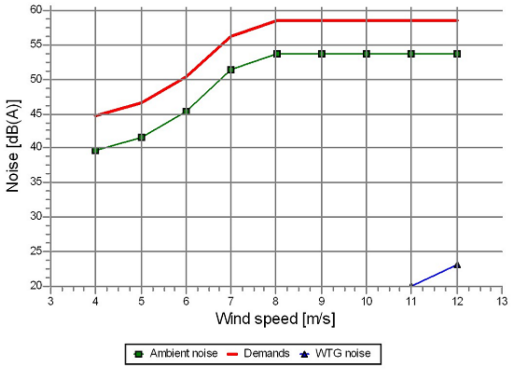
Calculation: Nains of Pitlurg alone**Noise calculation model:** ISO 9613-2 United Kingdom

Edintore Farmhouse (A)



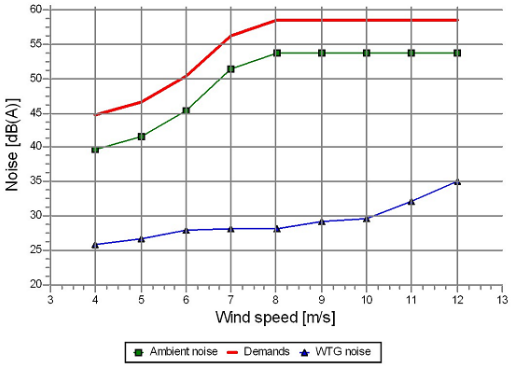
		Demands		Sound level	
Wind speed	Ambient noise	Margin	Demands	WTG noise	Demands fulfilled ?
[m/s]	[dB(A)]	[dB(A)]	[dB(A)]	[dB(A)]	
4.0	45.0	5.0	50.0	22.0	Yes
5.0	45.0	5.0	50.0	23.0	Yes
6.0	45.3	5.0	50.3	24.2	Yes
7.0	51.3	5.0	56.3	24.3	Yes
8.0	53.6	5.0	58.6	24.5	Yes
9.0	53.6	5.0	58.6	25.4	Yes
10.0	53.6	5.0	58.6	25.8	Yes
11.0	53.6	5.0	58.6	28.3	Yes
12.0	53.6	5.0	58.6	31.3	Yes

Edintore Cottage (B)



		Demands		Sound level	
Wind speed	Ambient noise	Margin	Demands	WTG noise	Demands fulfilled ?
[m/s]	[dB(A)]	[dB(A)]	[dB(A)]	[dB(A)]	
4.0	39.7	5.0	44.7	13.8	Yes
5.0	41.6	5.0	46.6	14.8	Yes
6.0	45.3	5.0	50.3	16.0	Yes
7.0	51.3	5.0	56.3	16.1	Yes
8.0	53.6	5.0	58.6	16.3	Yes
9.0	53.6	5.0	58.6	17.2	Yes
10.0	53.6	5.0	58.6	17.6	Yes
11.0	53.6	5.0	58.6	20.1	Yes
12.0	53.6	5.0	58.6	23.1	Yes

Little Pitlurg (C)

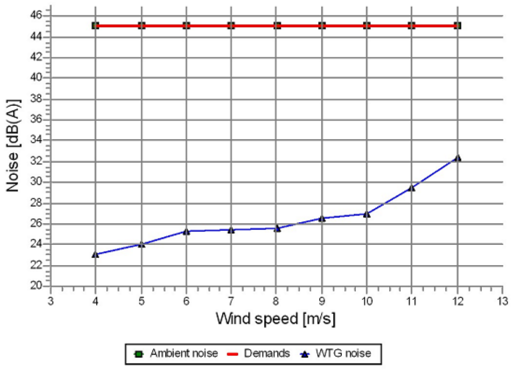


		Demands		Sound level	
Wind speed	Ambient noise	Margin	Demands	WTG noise	Demands fulfilled ?
[m/s]	[dB(A)]	[dB(A)]	[dB(A)]	[dB(A)]	
4.0	39.7	5.0	44.7	25.8	Yes
5.0	41.6	5.0	46.6	26.8	Yes
6.0	45.3	5.0	50.3	28.0	Yes
7.0	51.3	5.0	56.3	28.1	Yes
8.0	53.6	5.0	58.6	28.3	Yes
9.0	53.6	5.0	58.6	29.2	Yes
10.0	53.6	5.0	58.6	29.6	Yes
11.0	53.6	5.0	58.6	32.1	Yes
12.0	53.6	5.0	58.6	35.1	Yes

DECIBEL - Detailed results, graphic

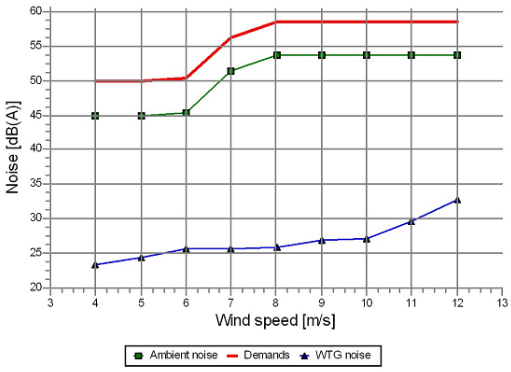
Calculation: Nains of Pitlurg alone**Noise calculation model:** ISO 9613-2 United Kingdom

Mains of Pitlurg (D)



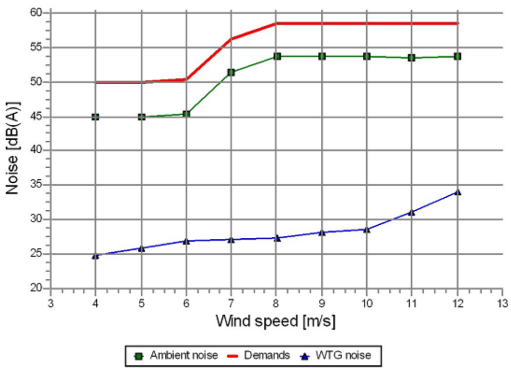
Wind speed	Demands Ambient noise	Demands Margin	Demands	Sound level WTG noise	Demands fulfilled ?
[m/s]	[dB(A)]	[dB(A)]	[dB(A)]	[dB(A)]	
4.0	45.0	0.0	45.0	23.1	Yes
5.0	45.0	0.0	45.0	24.1	Yes
6.0	45.0	0.0	45.0	25.3	Yes
7.0	45.0	0.0	45.0	25.4	Yes
8.0	45.0	0.0	45.0	25.6	Yes
9.0	45.0	0.0	45.0	26.5	Yes
10.0	45.0	0.0	45.0	26.9	Yes
11.0	45.0	0.0	45.0	29.4	Yes
12.0	45.0	0.0	45.0	32.4	Yes

Rinnes View (E)



Wind speed	Demands Ambient noise	Demands Margin	Demands	Sound level WTG noise	Demands fulfilled ?
[m/s]	[dB(A)]	[dB(A)]	[dB(A)]	[dB(A)]	
4.0	45.0	5.0	50.0	23.4	Yes
5.0	45.0	5.0	50.0	24.4	Yes
6.0	45.3	5.0	50.3	25.6	Yes
7.0	51.3	5.0	56.3	25.7	Yes
8.0	53.6	5.0	58.6	25.9	Yes
9.0	53.6	5.0	58.6	26.8	Yes
10.0	53.6	5.0	58.6	27.2	Yes
11.0	53.6	5.0	58.6	29.7	Yes
12.0	53.6	5.0	58.6	32.7	Yes

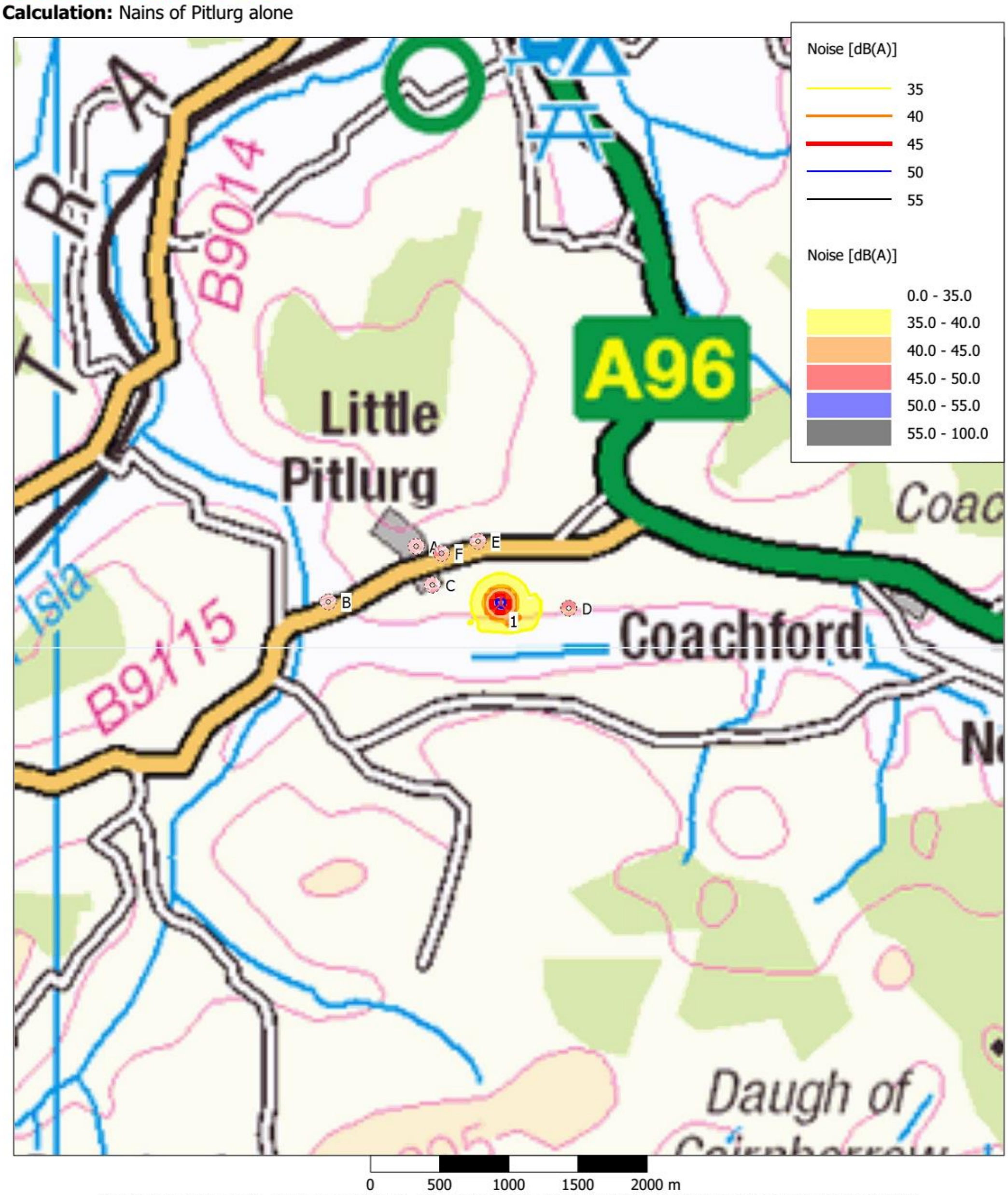
Taber Chalich (F)



Wind speed	Demands Ambient noise	Demands Margin	Demands	Sound level WTG noise	Demands fulfilled ?
[m/s]	[dB(A)]	[dB(A)]	[dB(A)]	[dB(A)]	
4.0	45.0	5.0	50.0	24.8	Yes
5.0	45.0	5.0	50.0	25.8	Yes
6.0	45.3	5.0	50.3	27.0	Yes
7.0	51.3	5.0	56.3	27.1	Yes
8.0	53.6	5.0	58.6	27.3	Yes
9.0	53.6	5.0	58.6	28.2	Yes
10.0	53.6	5.0	58.6	28.6	Yes
11.0	53.5	5.0	58.5	31.1	Yes
12.0	53.6	5.0	58.6	34.1	Yes

DECIBEL - Map 10.0 m/s

Calculation: Nains of Pitlurg alone



Map: Bitmap map: NJ.tif , Print scale 1:40,000, Map center British TM-OSGB36/Airy (GB/IE) East: 343,229 North: 845,608

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

DECIBEL - Assumptions for noise calculation

Calculation: Mains of Pitlurg & Edintore

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
Valley effect, Penalty: 3.0 dB
Topographic screening, Reduction: 2.0 dB
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 [db/km]	125 [db/km]	250 [db/km]	500 [db/km]	1,000 [db/km]	2,000 [db/km]	4,000 [db/km]	8,000 [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

DECIBEL - Assumptions for noise calculation

Calculation: Mains of Pitlurg & Edintore
WTG: ENERCON E-92 2,3 MW 2300 92.0 !-!
Noise: Level 0 - calculated - Op.Mode I - 06/2012

Source	Source/Date	Creator	Edited
Manufacturer	01/06/2012	EMD	21/12/2012 11:26

According to manufacturer specification document "SIAS-04-SPL-E-92 OM I 2 3 MW Rev1 3-ger-ger.pdf" dated 06/2012

Status	Hub height	Wind speed	LwA,ref	Pure tones		Octave data 63	125	250	500	1000	2000	4000	8000
	[m]	[m/s]	[dB(A)]			[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]
ExtraPolated	84.6	4.0	97.0	No	Generic data	78.6	85.6	89.0	91.6	91.4	88.5	83.7	74.2
From other hub height		5.0	99.5	No	Generic data	81.1	88.1	91.5	94.1	93.9	91.0	86.2	76.7
From Windcat	85.0	5.0	99.5	No	Generic data	81.1	88.1	91.5	94.1	93.9	91.0	86.2	76.7
From Windcat	85.0	6.0	102.0	No	Generic data	83.6	90.6	94.0	96.6	96.4	93.5	88.7	79.2
From other hub height		6.0	102.0	No	Generic data	83.6	90.6	94.0	96.6	96.4	93.5	88.7	79.2
From other hub height		7.0	103.3	No	Generic data	84.9	91.9	95.3	97.9	97.7	94.8	90.0	80.5
From Windcat	85.0	7.0	103.3	No	Generic data	84.9	91.9	95.3	97.9	97.7	94.8	90.0	80.5
From Windcat	85.0	8.0	104.2	No	Generic data	85.8	92.8	96.2	98.8	98.6	95.7	90.9	81.4
From other hub height		8.0	104.2	No	Generic data	85.8	92.8	96.2	98.8	98.6	95.7	90.9	81.4
From other hub height		9.0	105.0	No	Generic data	86.6	93.6	97.0	99.6	99.4	96.5	91.7	82.2
From Windcat	85.0	9.0	105.0	No	Generic data	86.6	93.6	97.0	99.6	99.4	96.5	91.7	82.2
From other hub height		10.0	105.0	No	Generic data	86.6	93.6	97.0	99.6	99.4	96.5	91.7	82.2
From Windcat	85.0	10.0	105.0	No	Generic data	86.6	93.6	97.0	99.6	99.4	96.5	91.7	82.2
From Windcat	85.0	11.0	105.0	No	Generic data	86.6	93.6	97.0	99.6	99.4	96.5	91.7	82.2
From other hub height		11.0	105.0	No	Generic data	86.6	93.6	97.0	99.6	99.4	96.5	91.7	82.2
From other hub height		12.0	105.0	No	Generic data	86.6	93.6	97.0	99.6	99.4	96.5	91.7	82.2
From Windcat	85.0	12.0	105.0	No	Generic data	86.6	93.6	97.0	99.6	99.4	96.5	91.7	82.2

NSA: Edintore Farmhouse-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]
45.0 dB(A)	45.0 dB(A)	45.3 dB(A)	51.3 dB(A)	53.6 dB(A)	53.6 dB(A)	53.6 dB(A)	53.6 dB(A)	53.6 dB(A)

Margin or Allowed additional exposure: 5.0 dB(A)
Sound level always accepted: 45.0 dB(A)
No distance demand

NSA: Edintore Cottage-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]
39.7 dB(A)	41.6 dB(A)	45.3 dB(A)	51.3 dB(A)	53.6 dB(A)	53.6 dB(A)	53.6 dB(A)	53.6 dB(A)	53.6 dB(A)

Margin or Allowed additional exposure: 5.0 dB(A)
Sound level always accepted: 35.0 dB(A)
No distance demand

NSA: Little Pitlurg-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]
39.7 dB(A)	41.6 dB(A)	45.3 dB(A)	51.3 dB(A)	53.6 dB(A)	53.6 dB(A)	53.6 dB(A)	53.6 dB(A)	53.6 dB(A)

Margin or Allowed additional exposure: 5.0 dB(A)
Sound level always accepted: 35.0 dB(A)
No distance demand

DECIBEL - Assumptions for noise calculation

Calculation: Mains of Pitlurg & Edintore

NSA: Mains of Pitlurg-D
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]
45.0 dB(A)	45.0 dB(A)	45.0 dB(A)	45.0 dB(A)	45.0 dB(A)	45.0 dB(A)	45.0 dB(A)	45.0 dB(A)	45.0 dB(A)

Margin or Allowed additional exposure: 0.0 dB(A)
Sound level always accepted: 45.0 dB(A)
No distance demand

NSA: Rinnes View-E
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]
45.0 dB(A)	45.0 dB(A)	45.3 dB(A)	51.3 dB(A)	53.6 dB(A)	53.6 dB(A)	53.6 dB(A)	53.6 dB(A)	53.6 dB(A)

Margin or Allowed additional exposure: 5.0 dB(A)
Sound level always accepted: 45.0 dB(A)
No distance demand

NSA: Taber Chalich-F
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]
45.0 dB(A)	45.0 dB(A)	45.3 dB(A)	51.3 dB(A)	53.6 dB(A)	53.6 dB(A)	53.6 dB(A)	53.5 dB(A)	53.6 dB(A)

Margin or Allowed additional exposure: 5.0 dB(A)
Sound level always accepted: 45.0 dB(A)
No distance demand

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

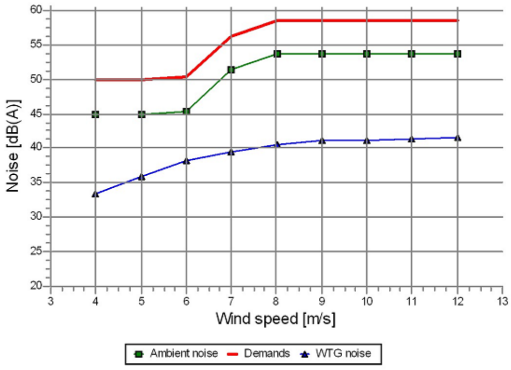
Adele / ae.associates@btinternet.com

Calculated:
06/12/2017 16:23/3.1.617

DECIBEL - Detailed results, graphic

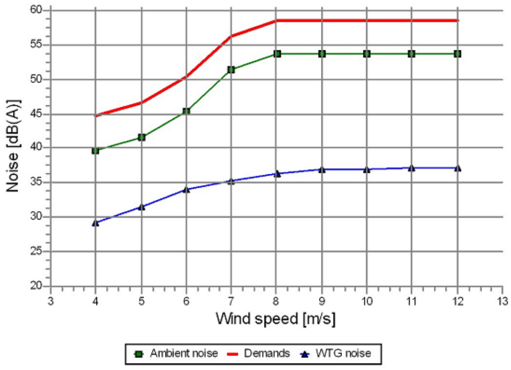
Calculation: Mains of Pitlurg & Edintore**Noise calculation model:** ISO 9613-2 United Kingdom

Edintore Farmhouse (A)



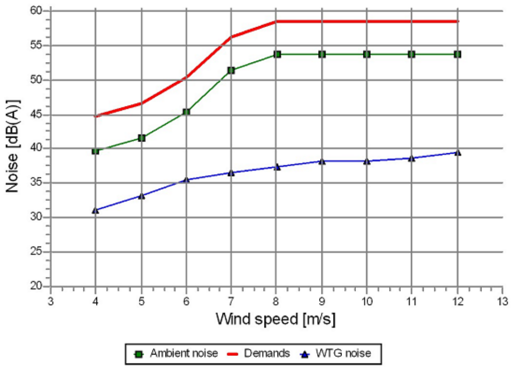
		Demands		Sound level	
Wind speed	Ambient noise	Margin	Demands	WTG noise	Demands fulfilled ?
[m/s]	[dB(A)]	[dB(A)]	[dB(A)]	[dB(A)]	
4.0	45.0	5.0	50.0	33.4	Yes
5.0	45.0	5.0	50.0	35.9	Yes
6.0	45.3	5.0	50.3	38.3	Yes
7.0	51.3	5.0	56.3	39.5	Yes
8.0	53.6	5.0	58.6	40.4	Yes
9.0	53.6	5.0	58.6	41.2	Yes
10.0	53.6	5.0	58.6	41.2	Yes
11.0	53.6	5.0	58.6	41.3	Yes
12.0	53.6	5.0	58.6	41.5	Yes

Edintore Cottage (B)



		Demands		Sound level	
Wind speed	Ambient noise	Margin	Demands	WTG noise	Demands fulfilled ?
[m/s]	[dB(A)]	[dB(A)]	[dB(A)]	[dB(A)]	
4.0	39.7	5.0	44.7	29.1	Yes
5.0	41.6	5.0	46.6	31.6	Yes
6.0	45.3	5.0	50.3	34.1	Yes
7.0	51.3	5.0	56.3	35.3	Yes
8.0	53.6	5.0	58.6	36.2	Yes
9.0	53.6	5.0	58.6	37.0	Yes
10.0	53.6	5.0	58.6	37.0	Yes
11.0	53.6	5.0	58.6	37.1	Yes
12.0	53.6	5.0	58.6	37.2	Yes

Little Pitlurg (C)

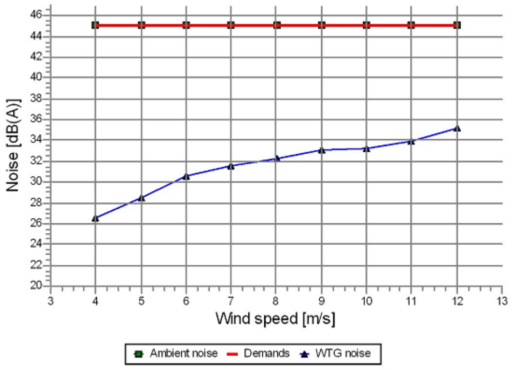


		Demands		Sound level	
Wind speed	Ambient noise	Margin	Demands	WTG noise	Demands fulfilled ?
[m/s]	[dB(A)]	[dB(A)]	[dB(A)]	[dB(A)]	
4.0	39.7	5.0	44.7	31.1	Yes
5.0	41.6	5.0	46.6	33.2	Yes
6.0	45.3	5.0	50.3	35.4	Yes
7.0	51.3	5.0	56.3	36.5	Yes
8.0	53.6	5.0	58.6	37.3	Yes
9.0	53.6	5.0	58.6	38.1	Yes
10.0	53.6	5.0	58.6	38.2	Yes
11.0	53.6	5.0	58.6	38.6	Yes
12.0	53.6	5.0	58.6	39.5	Yes

DECIBEL - Detailed results, graphic

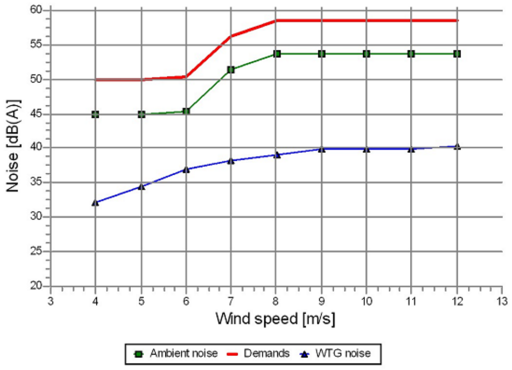
Calculation: Mains of Pitlurg & Edintore**Noise calculation model:** ISO 9613-2 United Kingdom

Mains of Pitlurg (D)



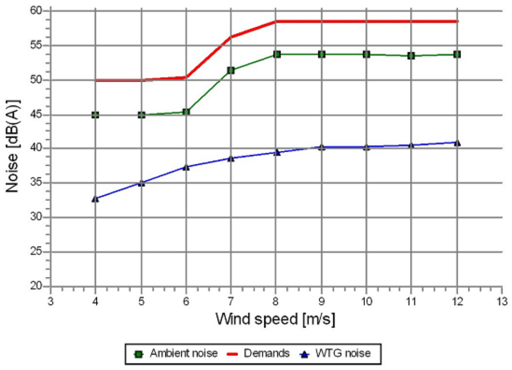
Wind speed	Demands Ambient noise	Demands Margin	Demands	Sound level WTG noise	Demands fulfilled ?
[m/s]	[dB(A)]	[dB(A)]	[dB(A)]	[dB(A)]	
4.0	45.0	0.0	45.0	26.6	Yes
5.0	45.0	0.0	45.0	28.5	Yes
6.0	45.0	0.0	45.0	30.6	Yes
7.0	45.0	0.0	45.0	31.5	Yes
8.0	45.0	0.0	45.0	32.3	Yes
9.0	45.0	0.0	45.0	33.1	Yes
10.0	45.0	0.0	45.0	33.2	Yes
11.0	45.0	0.0	45.0	33.9	Yes
12.0	45.0	0.0	45.0	35.2	Yes

Rinnes View (E)



Wind speed	Demands Ambient noise	Demands Margin	Demands	Sound level WTG noise	Demands fulfilled ?
[m/s]	[dB(A)]	[dB(A)]	[dB(A)]	[dB(A)]	
4.0	45.0	5.0	50.0	32.2	Yes
5.0	45.0	5.0	50.0	34.5	Yes
6.0	45.3	5.0	50.3	36.9	Yes
7.0	51.3	5.0	56.3	38.1	Yes
8.0	53.6	5.0	58.6	39.0	Yes
9.0	53.6	5.0	58.6	39.8	Yes
10.0	53.6	5.0	58.6	39.8	Yes
11.0	53.6	5.0	58.6	40.0	Yes
12.0	53.6	5.0	58.6	40.4	Yes

Taber Chalich (F)

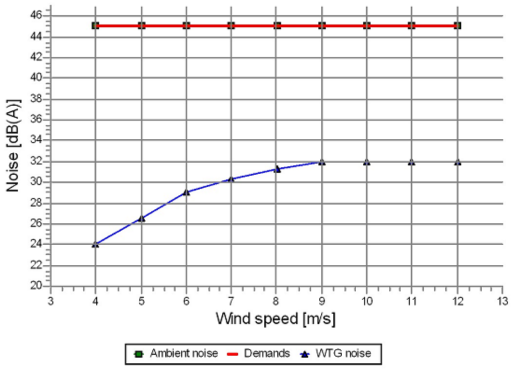


Wind speed	Demands Ambient noise	Demands Margin	Demands	Sound level WTG noise	Demands fulfilled ?
[m/s]	[dB(A)]	[dB(A)]	[dB(A)]	[dB(A)]	
4.0	45.0	5.0	50.0	32.8	Yes
5.0	45.0	5.0	50.0	35.1	Yes
6.0	45.3	5.0	50.3	37.4	Yes
7.0	51.3	5.0	56.3	38.6	Yes
8.0	53.6	5.0	58.6	39.5	Yes
9.0	53.6	5.0	58.6	40.3	Yes
10.0	53.6	5.0	58.6	40.3	Yes
11.0	53.5	5.0	58.5	40.5	Yes
12.0	53.6	5.0	58.6	41.0	Yes

DECIBEL - Detailed results, graphic

Calculation: Mains of Pitlurg due to Edintore**Noise calculation model:** ISO 9613-2 United Kingdom

Mains of Pitlurg (A)



		Demands		Sound level	
Wind speed	Ambient noise	Margin	Demands	WTG noise	Demands fulfilled ?
[m/s]	[dB(A)]	[dB(A)]	[dB(A)]	[dB(A)]	
4.0	45.0	0.0	45.0	24.0	Yes
5.0	45.0	0.0	45.0	26.5	Yes
6.0	45.0	0.0	45.0	29.0	Yes
7.0	45.0	0.0	45.0	30.3	Yes
8.0	45.0	0.0	45.0	31.2	Yes
9.0	45.0	0.0	45.0	32.0	Yes
10.0	45.0	0.0	45.0	32.0	Yes
11.0	45.0	0.0	45.0	32.0	Yes
12.0	45.0	0.0	45.0	32.0	Yes

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

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

æ associates

VISUAL MONTAGE

LAND AT MAINS OF PITLURG

TURBINE POSITION:343229 845608

INSTALLATION OF AN ORENDA 49kw WIND TURBINE

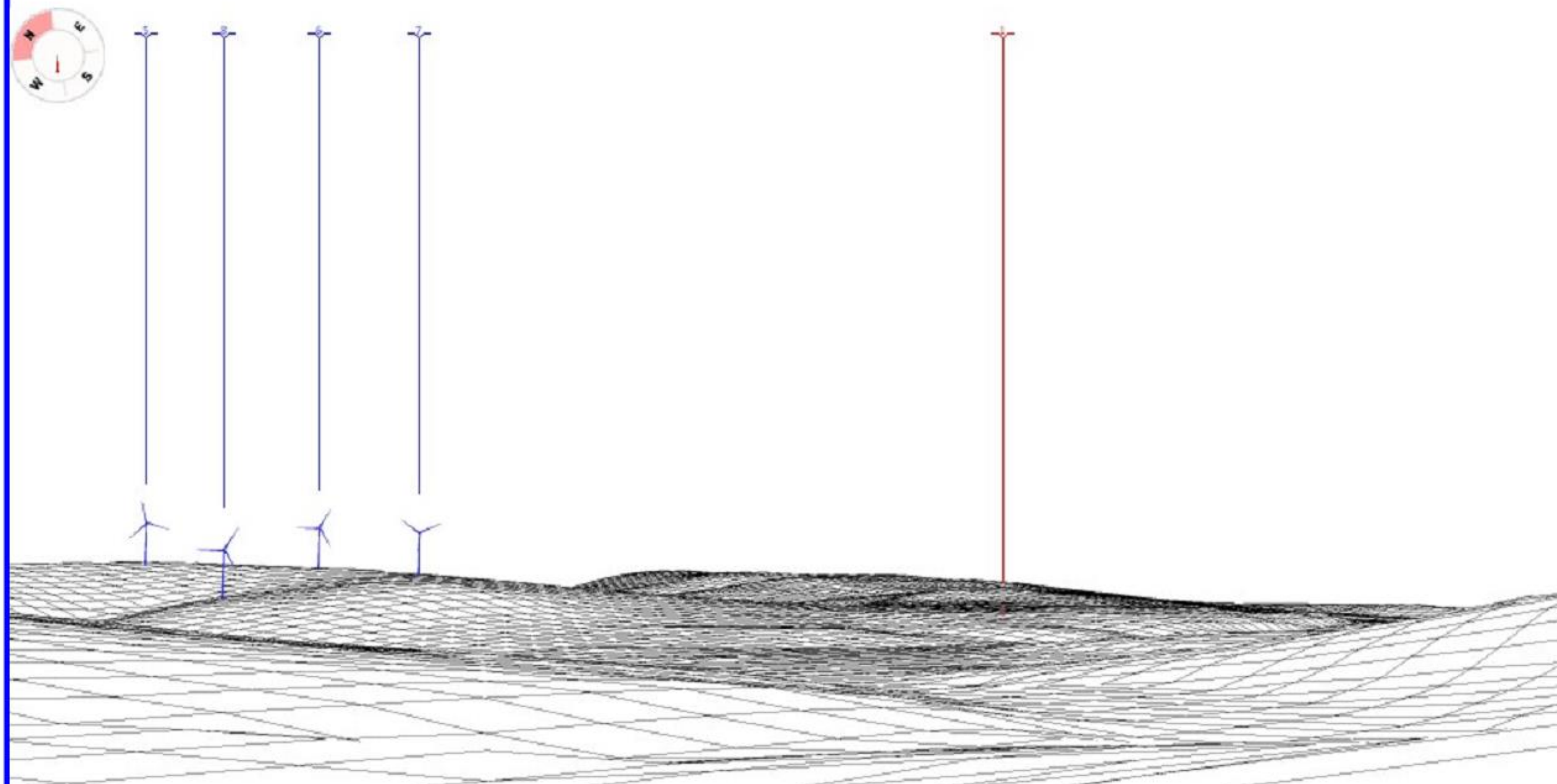
EXISTING VIEW

Project:
Mains of Pitlurg

	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	3,421
5 Exist	Yes	ENERCON	E-82 E2-2,300	2,300	82.0	78.3	3,828
6 Exist	Yes	ENERCON	E-82 E2-2,300	2,300	82.0	78.3	3,909
7 Exist	Yes	ENERCON	E-82 E2-2,300	2,300	82.0	78.3	3,660
8 Exist	Yes	ENERCON	E-82 E2-2,300	2,300	82.0	78.3	3,278

Recommended observation distance: 30 cm
Photo exposed: 17/09/2017 14:27:52
Lens: 50 mm Film: 36x24 mm Pixels: 2448x1633
Eye point: British TM-OSGB36/Airy (GB/IE) East: 340,273 North: 843,886
Wind direction: 0° Direction of photo: 53°
Camera: A
Photo: C:\...\Adele\Dropbox\Adams photos\Mains of Pitlurg\340273 843886.jpg

Created by:
Adele Ellis / whichturbine@btinternet.com



Project:
Mains of Pitlurg

	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	3,421
5 Exist	Yes	ENERCON	E-82 E2-2,300	2,300	82.0	78.3	3,828
6 Exist	Yes	ENERCON	E-82 E2-2,300	2,300	82.0	78.3	3,909
7 Exist	Yes	ENERCON	E-82 E2-2,300	2,300	82.0	78.3	3,660
8 Exist	Yes	ENERCON	E-82 E2-2,300	2,300	82.0	78.3	3,278

Recommended observation distance: 35 cm

Photo exposed: 17/09/2017 14:27:52
Lens: 50 mm Film: 39x19 mm Pixels: 1000x500
Eye point: British TM-OSGB36/Airy (GB/IE) East: 340,273 North: 843,886
Wind direction: 0° Direction of photo: 53°
Camera: A
Photo: C:\...\Adele\Dropbox\Adams photos\Mains of Pitlurg\340273 843886.jpg

Created by:
Adele Ellis / whichturbine@btinternet.com

EXISTING VIEW

Project:
Mains of Pitlurg

	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	3,004
7 Exist	Yes	ENERCON	E-82 E2-2,300	2,300	82.0	78.3	2,369
8 Exist	Yes	ENERCON	E-82 E2-2,300	2,300	82.0	78.3	1,887

Recommended observation distance: 30 cm
Photo exposed: 17/09/2017 14:52:55
Lens: 50 mm Film: 36x24 mm Pixels: 2448x1633
Eye point: British TM-OSGB36/Airy (GB/IE) East: 340,420 North: 846,673
Wind direction: 0° Direction of photo: 110°
Camera: B
Photo: C:\...\Adele\Dropbox\Adams photos\Mains of Pitlurg\340420 846673.jpg

Created by:
Adele Ellis / whichturbine@btinternet.com

Project:
Mains of Pitlurg

	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	3,004
7 Exist	Yes	ENERCON	E-82 E2-2,300	2,300	82.0	78.3	2,369
8 Exist	Yes	ENERCON	E-82 E2-2,300	2,300	82.0	78.3	1,887

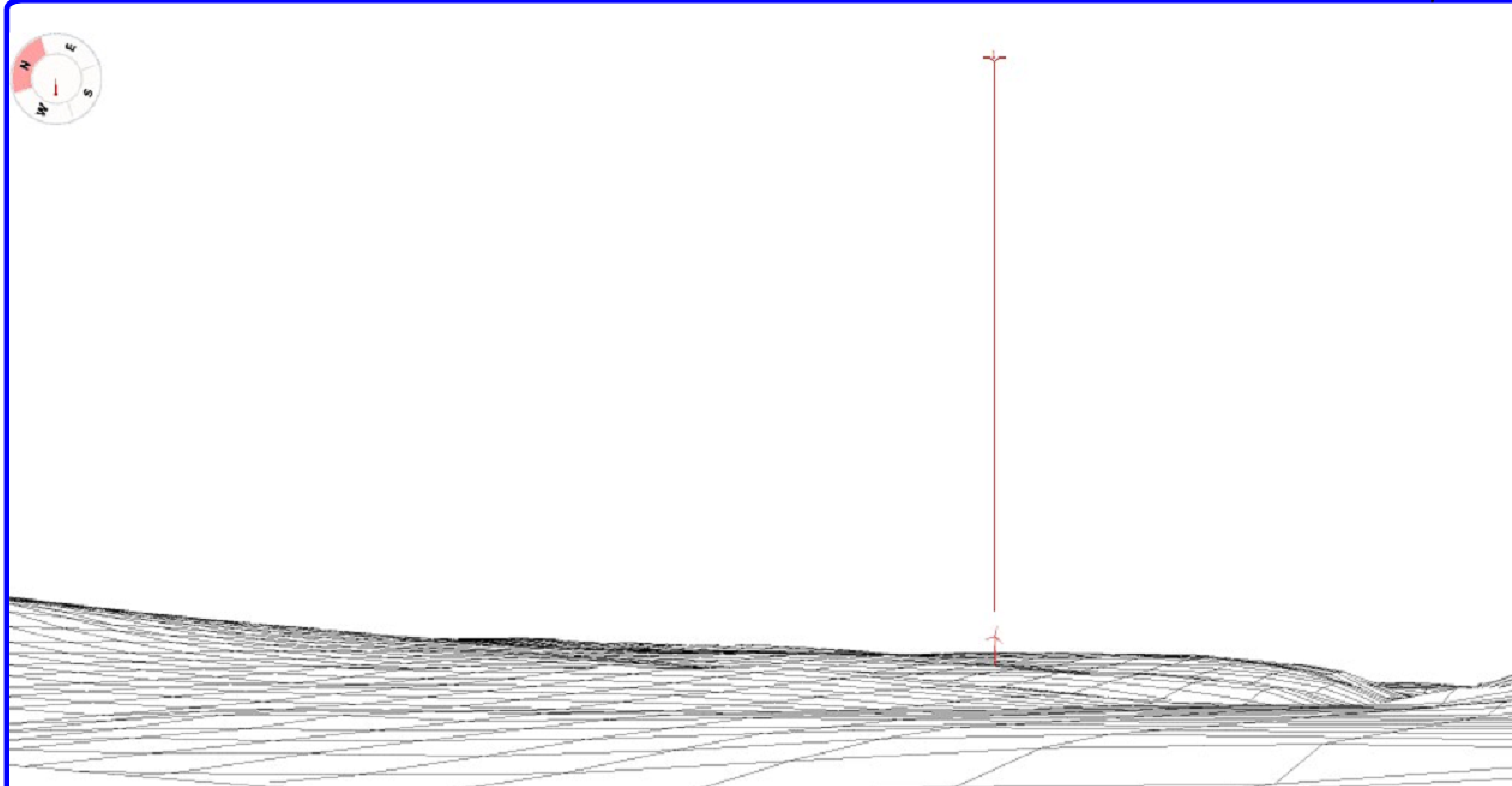
Recommended observation distance: 35 cm
Photo exposed: 17/09/2017 14:52:55
Lens: 50 mm Film: 39x19 mm Pixels: 1000x500
Eye point: British TM-OSGB36/Airy (GB/IE) East: 340,420 North: 846,673
Wind direction: 0° Direction of photo: 110°
Camera: B
Photo: C:\...\Adele\Dropbox\Adams photos\Mains of Pitlurg\340420 846673.jpg

Created by:
Adele Ellis / whichturbine@btinternet.com

Project:		Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Distance [m]
Mains of Pitlurg								
	1 New	Yes	Orenda	-51	51	19.1	24.5	1,749

Recommended observation distance: 30 cm
Photo exposed: 17/09/2017 14:36:32
Lens: 50 mm Film: 36x24 mm Pixels: 2448x1633
Eye point: British TM-OSGB36/Airy (GB/IE) East: 341,559 North: 845,089
Wind direction: 0° Direction of photo: 65°
Camera: C
Photo: C:\...\Adele\Dropbox\Adams photos\Mains of Pitlurg\341559 845089.jpg

Created by:
Adele Ellis / whichturbine@btinternet.com



Project:		Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Distance [m]
Mains of Pitlurg								
	1 New	Yes	Orenda	-51	51	19.1	24.5	1,749

Recommended observation distance: 35 cm

Photo exposed: 17/09/2017 14:36:32
Lens: 50 mm Film: 39x19 mm Pixels: 1000x500
Eye point: British TM-OSGB36/Airy (GB/IE) East: 341,559 North: 845,089
Wind direction: 0° Direction of photo: 65°
Camera: C
Photo: C:\...\Adele\Dropbox\Adams photos\Mains of Pitlurg\341559 845089.jpg

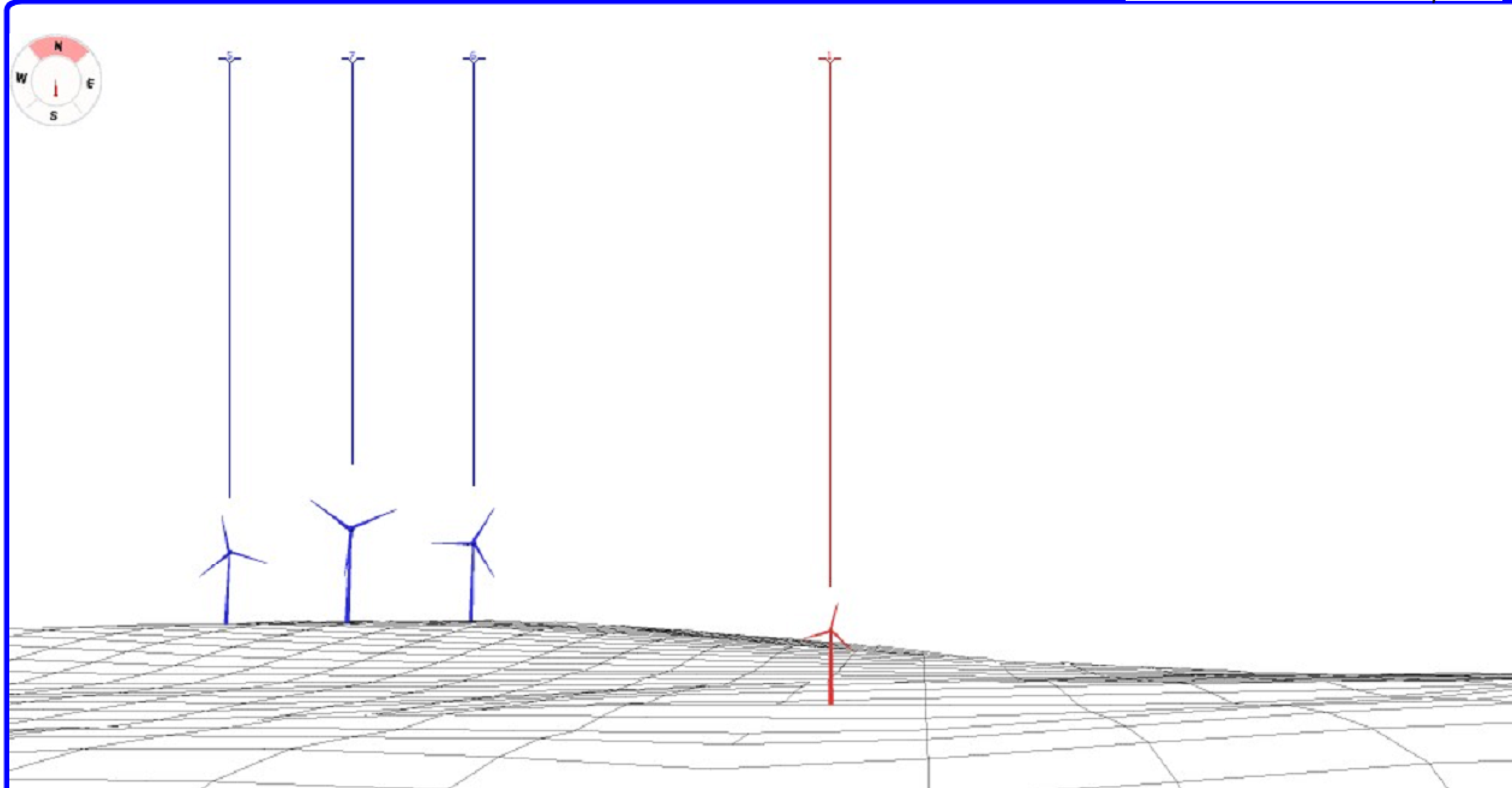
Created by:
Adele Ellis / whichturbine@btinternet.com

Project:
Mains of Pitlurg

	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	657
5 Exist	Yes	ENERCON	E-82 E2-2,300	2,300	82.0	78.3	2,156
6 Exist	Yes	ENERCON	E-82 E2-2,300	2,300	82.0	78.3	1,951
7 Exist	Yes	ENERCON	E-82 E2-2,300	2,300	82.0	78.3	1,664

Recommended observation distance: 30 cm
Photo exposed: 17/09/2017 14:40:28
Lens: 50 mm Film: 36x24 mm Pixels: 2448x1633
Eye point: British TM-OSGB36/Airy (GB/IE) East: 343,259 North: 844,952
Wind direction: 0° Direction of photo: 355°
Camera: D
Photo: C:\...\Adele\Dropbox\Adams photos\Mains of Pitlurg\343259 844952.jpg

Created by:
Adele Ellis / whichturbine@btinternet.com



Project:
Mains of Pitlurg

	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	657
5 Exist	Yes	ENERCON	E-82 E2-2,300	2,300	82.0	78.3	2,156
6 Exist	Yes	ENERCON	E-82 E2-2,300	2,300	82.0	78.3	1,951
7 Exist	Yes	ENERCON	E-82 E2-2,300	2,300	82.0	78.3	1,664

Recommended observation distance: 35 cm
Photo exposed: 17/09/2017 14:40:28
Lens: 50 mm Film: 39x19 mm Pixels: 1000x500
Eye point: British TM-OSGB36/Airy (GB/IE) East: 343,259 North: 844,952
Wind direction: 0° Direction of photo: 355°
Camera: D
Photo: C:\...\Adele\Dropbox\Adams photos\Mains of Pitlurg\343259 844952.jpg

Created by:
Adele Ellis / whichturbine@btinternet.com

Project:
Mains of Pitlurg

	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	544

Recommended observation distance: 30 cm
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Lens: 50 mm Film: 36x24 mm Pixels: 2448x1633
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Wind direction: 0° Direction of photo: 110°
Camera: E
Photo: C:\...\Adele\Dropbox\Adams photos\Mains of Pitlurg\342791 845931.jpg

Created by:
Adele Ellis / whichturbine@btinternet.com

Project:
Mains of Pitlurg

	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	544

Recommended observation distance: 35 cm
Photo exposed: 24/09/2017 14:02:55
Lens: 50 mm Film: 39x19 mm Pixels: 1000x500
Eye point: British TM-OSGB36/Airy (GB/IE) East: 342,791 North: 845,931
Wind direction: 0° Direction of photo: 110°
Camera: E
Photo: C:\...\Adele\Dropbox\Adams photos\Mains of Pitlurg\342791 845931.jpg

Created by:
Adele Ellis / whichturbine@btinternet.com

Project:
Mains of Pitlurg

Description:
Installation of an Orenda wind turbine

Printed/Page
03/10/2017 12:13 / 1

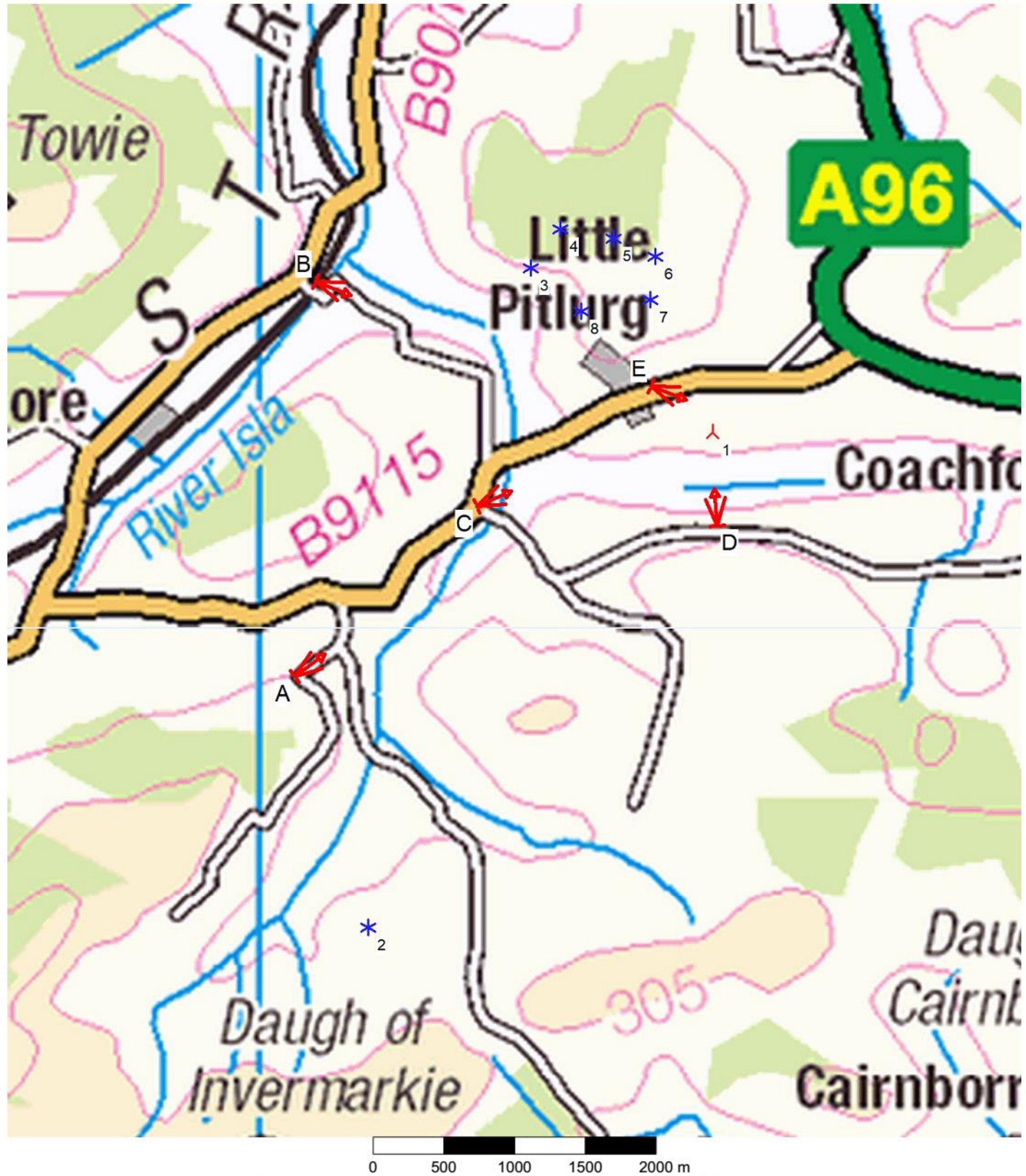
Licensed user:

Adele Ellis / whichturbine@btinternet.com

Calculated:
03/10/2017 11:36/2.9.285

VISUAL - Map

Calculation: photomontage



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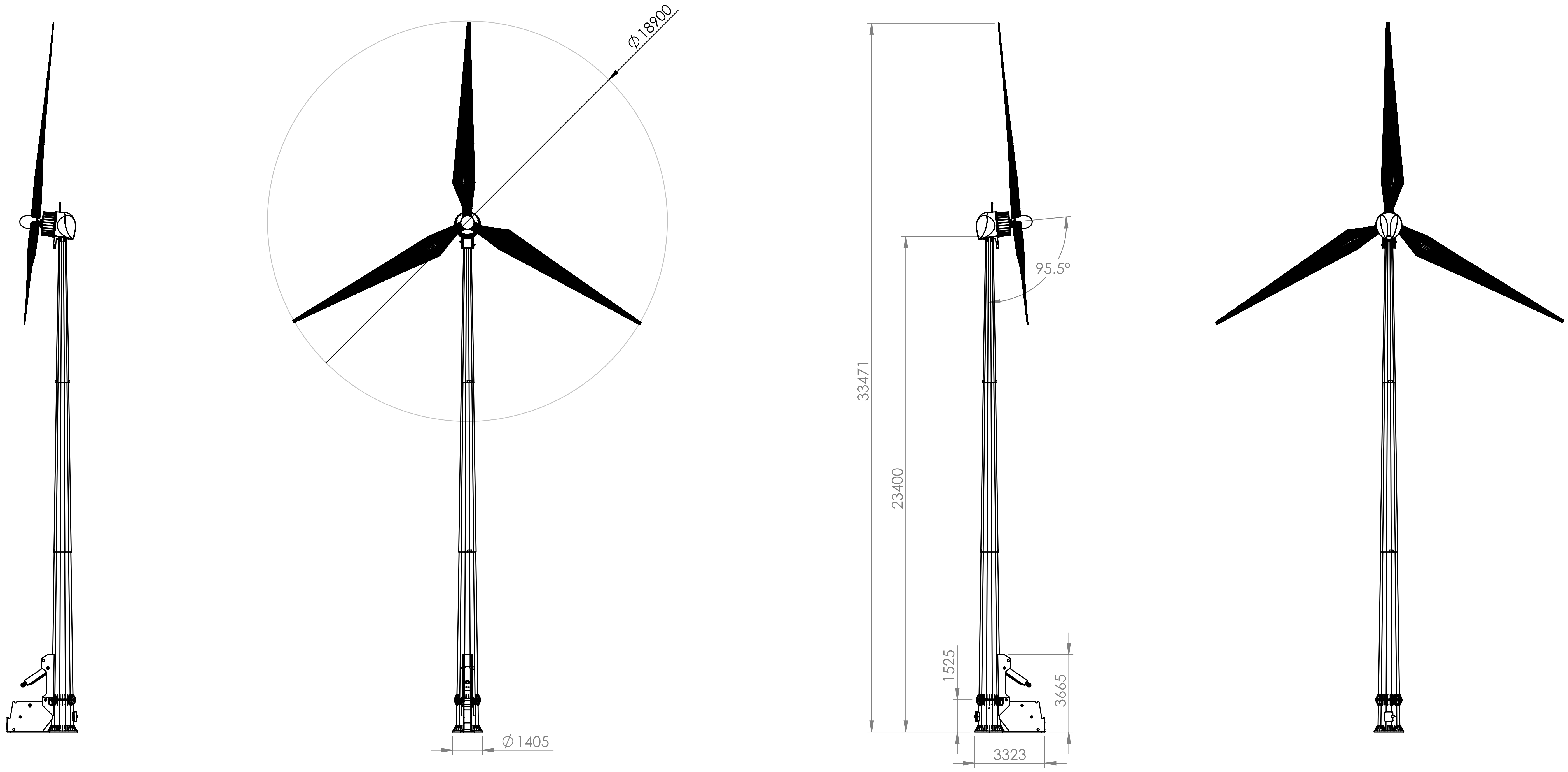
New WTG   Existing WTG   Camera



UNLESS OTHERWISE SPECIFIED:		NAME	DATE
DIMENSIONS ARE IN MM TOLERANCES: ANGULAR: MACH ±0.5° ONE PLACE DECIMAL ±0.25 TWO PLACE DECIMAL ±0.1	DRAWN	CW	13/12/12
	CHECKED	PD	13/12/13
	ENG APPR.		
	MFG APPR.		
INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
MATERIAL	COMMENTS:		
FINISH			
DO NOT SCALE DRAWING			

Orenda Energy Solutions

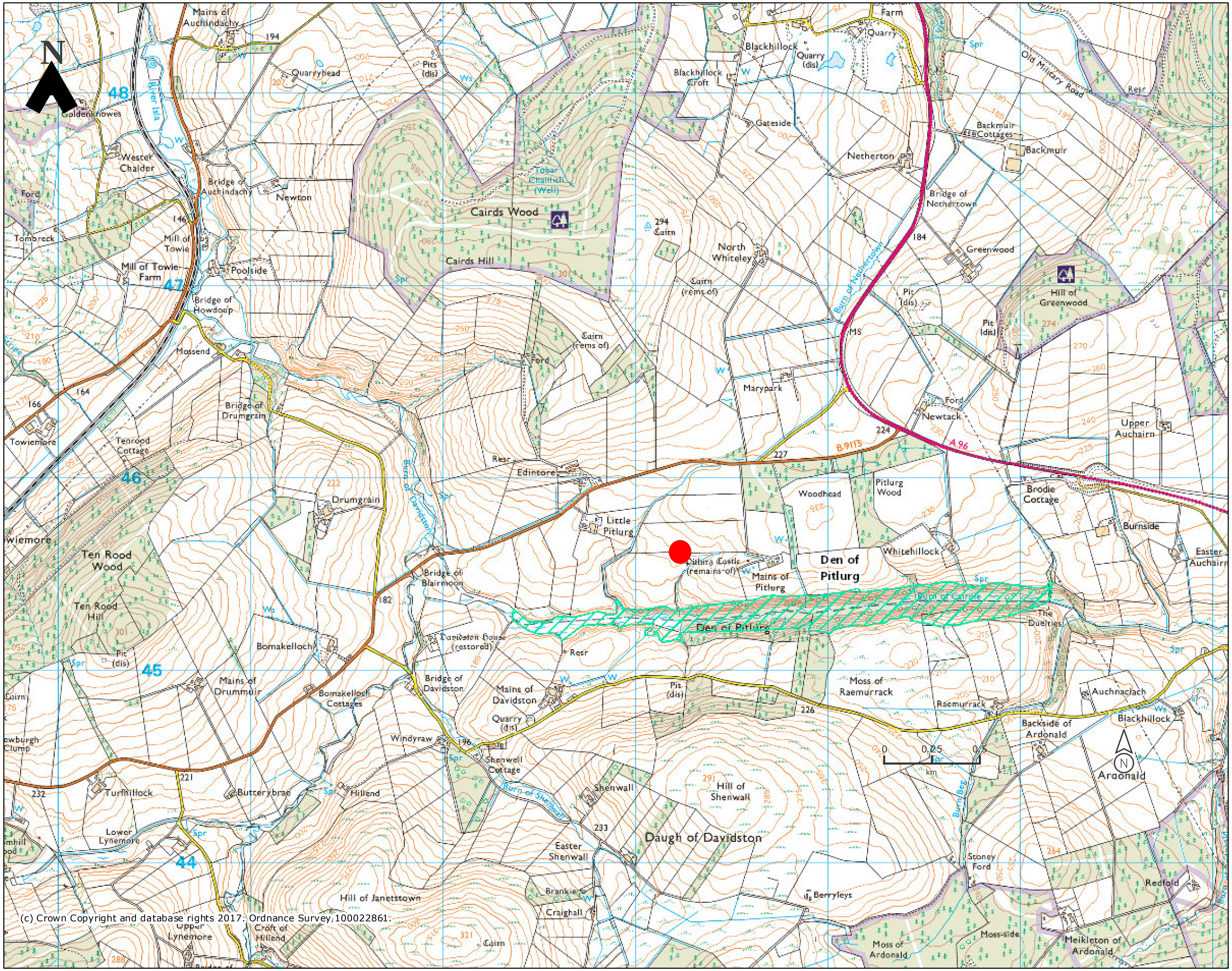
TITLE:

SKYE 23.4m TOWER INSTALLATION PLANNING DRAWING

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

SCALE: 1:200 WEIGHT: SHEET 1 OF 1

DESIGNATIONS



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)

TURBINE POSITION: 343229 845608

0 — 1km

scale 1:20,000 @ A3

Project:
Mains of Pitlurg

Description:
Installation of an Orenda wind turbine

Printed/Page
25/08/2017 11:30 / 1

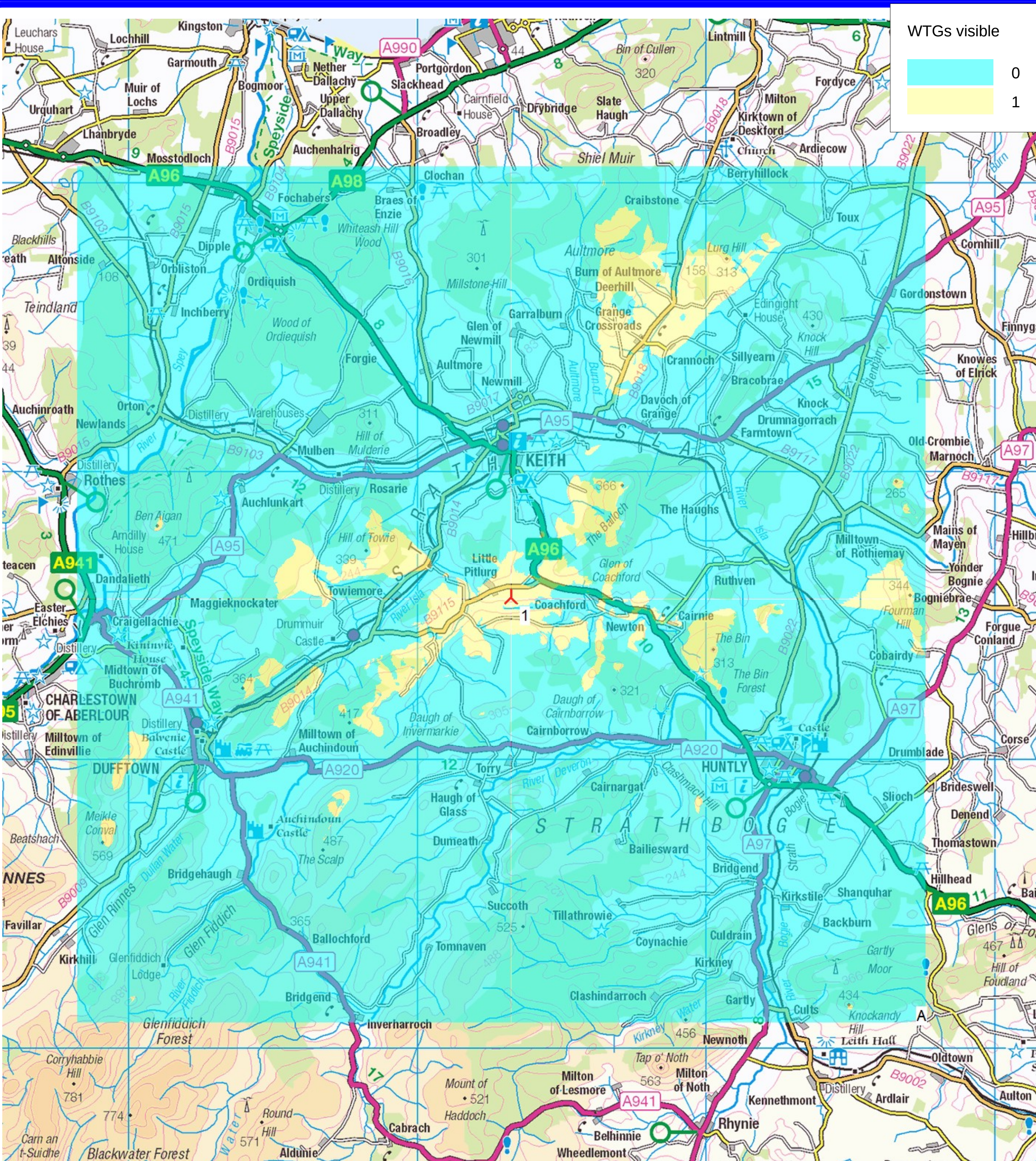
Licensed user:

Adele Ellis / whichturbine@btinternet.com

Calculated:
25/08/2017 11:28/2.9.285

ZVI - Map

Calculation: ZTV to tip

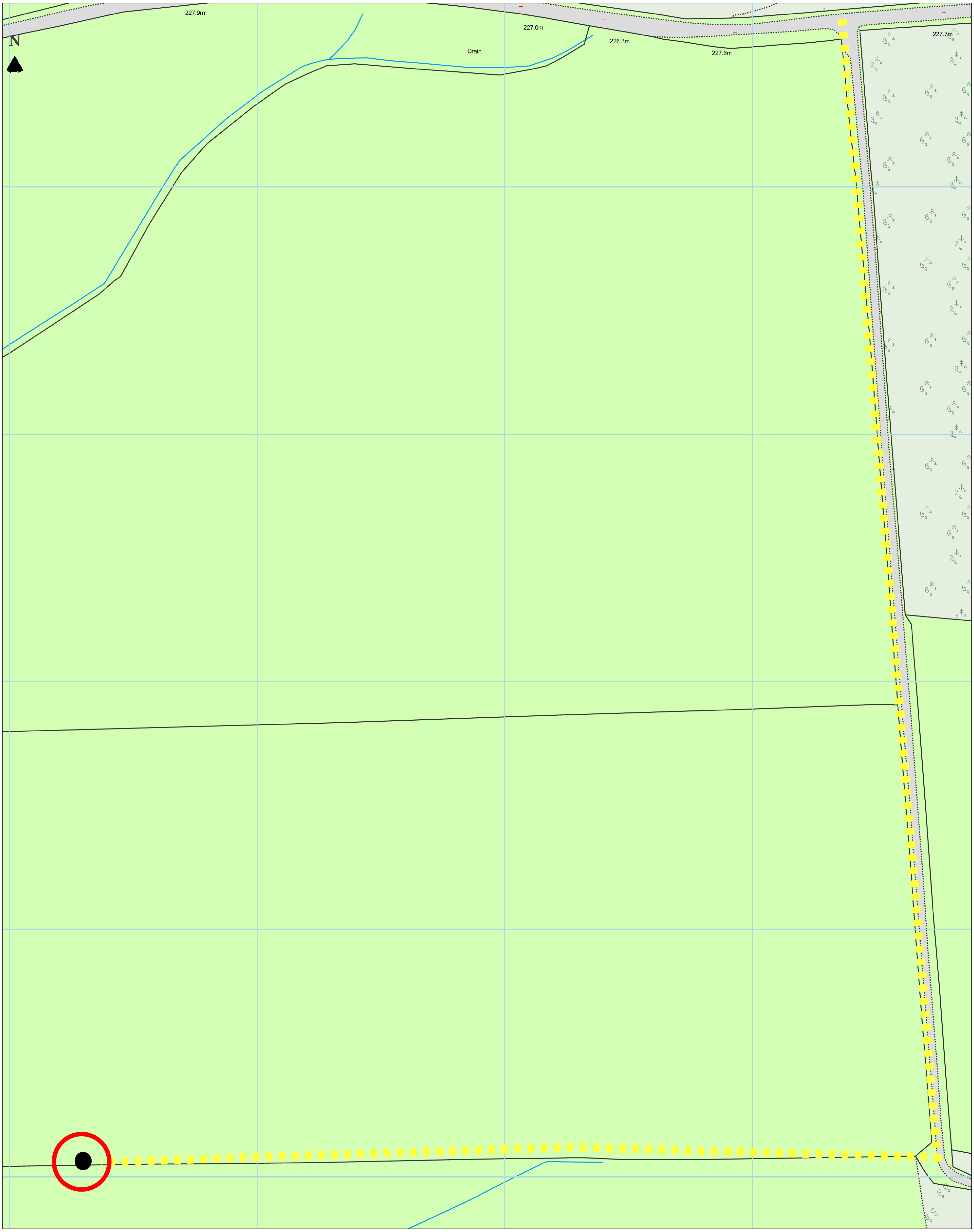


0 2.5 5 7.5 10km

Map: Bitmap map: NJ.tif , Print scale 1:200,000, Map center British TM-OSGB36/Airy (GB/IE) East: 343,229 North: 845,608

New WTG Obstacle

BLOCK PLAN



LAND AT MAINS OF PITLURG

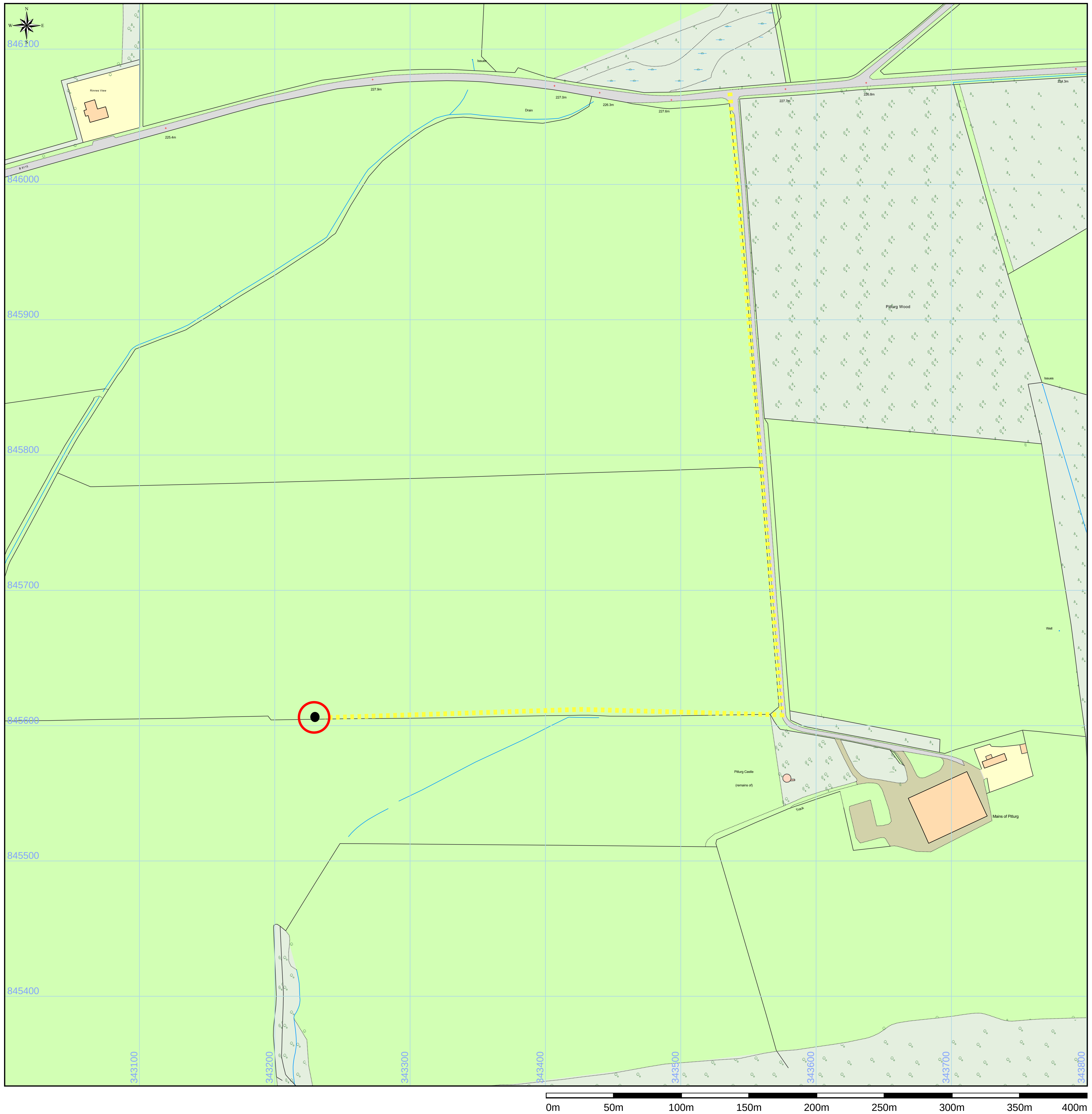
0 ——— 100m

SCALE 1:500 @ A0

TURBINE POSITION:
343229 845608

ACCESS ROUTE

LAND AT MAINS OF PITLURG



Turbine location - 343229 845608

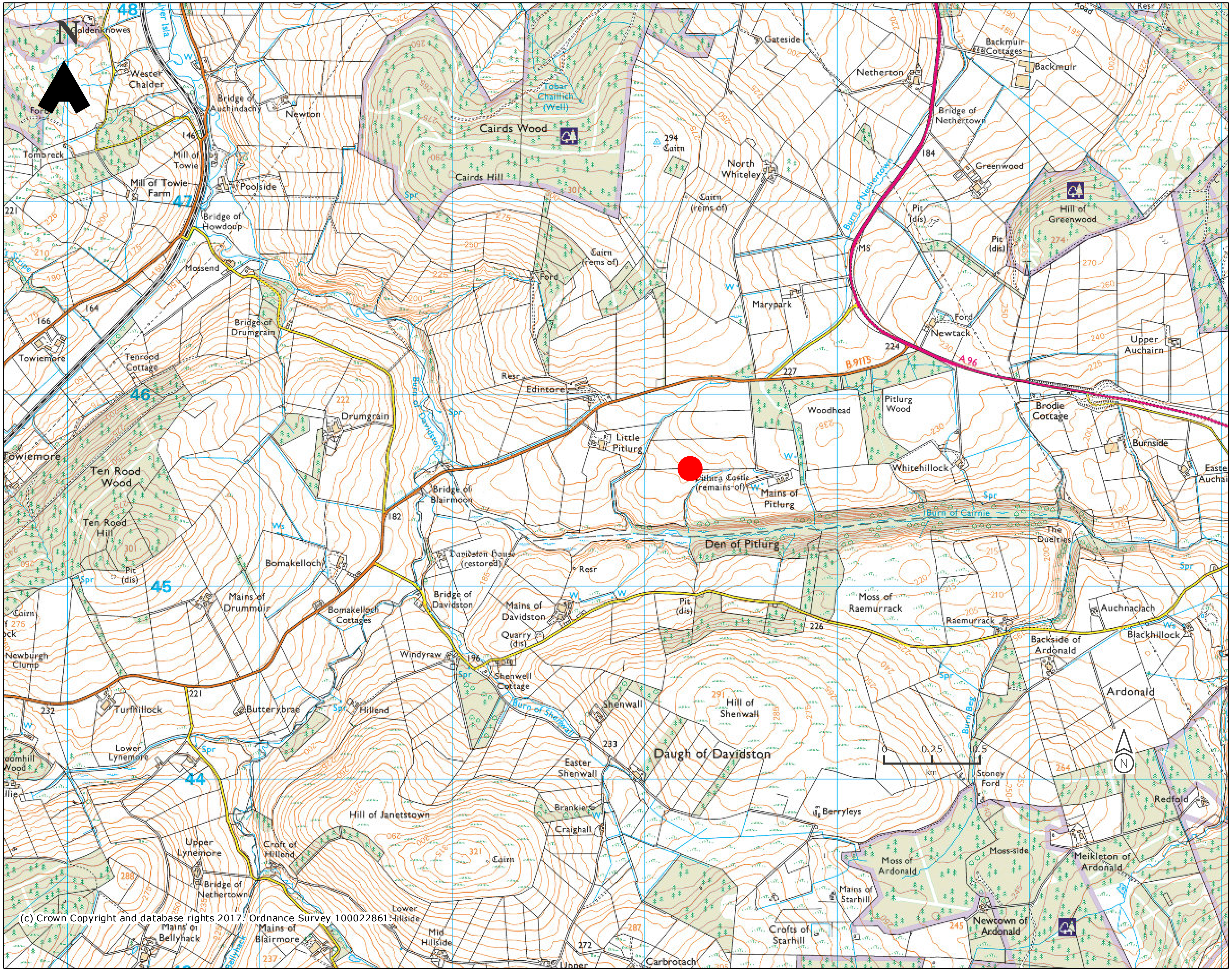
Access route

Scale: 1:2500, paper size: A2

plans ahead by emapsite™

Prepared by: Craig Allan, 04-07-2017

SITE LOCATION



TURBINE POSITION:
343229 845608

0 1km

SCALE 1:20,000 @ A3

ECOLOGICAL APPRAISAL

PROPOSAL TO INSTALL A 49kW ORENDA WIND TURBINE

LAND AT MAINS OF PITLURG

Turbine Location:
TURBINE 1 – 343229 845608

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 Mains of Pitlurg 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 Mains of Pitlurg Farm. The turbine position lies in the region of 438m south of the B9115 and 1.37km South West of the A96. There is a further unclassified road 635m to the south of the development site. Keith lies 4.6km to the north and Huntly 10.8km south east. Lying 292m south of the proposed development site lies the Den of Pitlurg (SSSI).
The proposed location for the wind turbine sits at a height above sea level of approximately 250m 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 do not have any further comment to make other than that stated previously, 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:

Roe Deer	13
Red Deer	3
Hedgehog	5
Wild Cat	7

Brown Hare
Mountain Hare
Otter
Pine Marten
Badger
Field Vole
Stoat
American Mink
Rabbit
45 Khz Pipistrelle
Pipistrelle
55 Khz Pipistrelle
Brown Long-Eared Bat
Red Squirrel
Common Shrew
Mole
Fox

BATS

Given that there is recorded bat activity [redacted] 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 recorded sightings of Red squirrel [redacted] however 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 recorded 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 is identified sites of badgers [redacted]. However not within the vicinity of the turbine development. 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 [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 a Orenda 49kw wind turbine [33.47m high to blade tip, rotor diameter 18.9m] at Land At Mains Of Pitlurg Keith Moray AB55 5PJ

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

Date of Notice: **14 December 2017**

[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 turbine by reason of its siting and height would appear as an unduly prominent feature in the landscape due to its position within the central area of a field, unrelated to other turbines, on a sloping ridgeline with no adjacent features (such as woodland and/or buildings) to mitigate its scale and impact. 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 proposed wind turbine taken together with the larger wind turbines at the nearby windfarm at Edintore would result in adverse cumulative landscape and visual clutter effects associated with multiple developments, which would be detrimental to the character of the surrounding area. The Moray Wind Energy Landscape Study specifically states that small typology turbines should avoid being sited close to operational/consented wind farms and large turbines. The current proposed turbine would be located within close proximity to the operational Edintore Wind Farm of six turbines 125m high situated on Cairds Hill to the north, with the closest turbine being 1km distant and would contrast directly and be seen in close juxtaposition with these larger turbines, causing confusion and visual clutter in the landscape. This would be experienced principally from the nearby B9115 (in views from the north/southwest/east) and other minor roads and settlement in the surrounding area.

3. The MWELCS (at Appendix D) further highlights 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 into this area alongside the adjacent wind farm (and other smaller turbines in the wider area) would result in 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
		Block plan
EN-404-A	A	Elevations
		Location plan
		Site location plan

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.