Sheephouse Heights Windfarm

Environmental Statement
Technical Appendices

April 2008



3. PROJECT DESCRIPTION TECHNICAL APPENDIX

INTRODUCTION

This appendix contains information relating to the environmental requirements for subcontractors.

3.1 ENVIRONMENTAL REQUIREMENTS FOR SUBCONTRACTORS

Scope
These requirements have been developed to ensure that Evelop UK Limited and all its subcontractors comply with environmentally safe working procedures and standards when working on Evelop UK wind farm sites.

Procedure
These requirements will be supplied to all subcontractors during an environmental awareness induction of all subcontractors prior to commencing work on site.

The relevant construction or operation manager for the site must ensure that these requirements are displayed clearly on site for all subcontractors.

Environmental Requirements

Planning and Preparation
The construction or operation manager for the site must ensure that all contact numbers for relevant environmental bodies are displayed clearly on site for all site personnel and subcontractors.

Any remediation or disposal of contaminated land will be carried out in consultation with the relevant environmental body or Local Authority. If no work is required it will be fenced off to prevent disturbance.

Locations of underground services and pipelines are to be noted, clearly marked and protected. Maps of existing underground services to be kept on site.

Any existing storage tanks found are to be checked and emptied by a licensed waste carrier and removed.

Vandalism, theft and tipping are common causes of environmental pollution. Compound areas, plant and bowsers must be adequately fenced and/or secured where possible and when not in use.

Fuels, Oils, Chemicals
Contents of all tanks to be clearly marked and relevant warning notices to be displayed requiring that valves and trigger guns be locked when not in use.

Fuel and oil deliveries shall only take place within designated refuelling areas and be supervised by a responsible person. Storage tank levels are to be checked before delivery to prevent overfilling and ensure the product is delivered to the correct tank. Provide appropriate spill kits in an accessible location, ensure employees and subcontractors are trained in their use and follow the spill procedure in the event of any spill incident.

All fuels, oils and chemicals to be stored in designated area only (impervious base, bunded and secured) including mobile bowsers when not in use. Chemicals to be stored in accordance with COSHH and spill kits kept by subcontractor in accessible locations. Storage at or above roof level should be avoided. Generators powering the compound will be bunded. Bunds should be of adequate capacity.

Bowsers will not be stored next to watercourses when in use. Bowsers will be stored so as to minimise the risk of run-away and collision.

Any leaking or empty tanks/containers must be removed from site immediately and disposed of via a licensed waste disposal contractor. At the end of a contract no tanks/containers may be perforated, emptied or disposed of on site. Emptying and disposal only by competent authority off-site.

Plant

Plant should be well maintained and any leaking fluid repaired and removed from site. Servicing shall be carried out over a drip tray. Mobile plant shall be refuelled in designated areas (preferably on impermeable service) or take place over a drip try. Refuelling should not be carried out near watercourses or drains. Never leave a vehicle unattended during refuelling or jam open a delivery valve. Ensure valves are turned off and securely locked when not in use.

After use drip trays to be cleaned with appropriate absorbent material and material disposed of in accordance with relevant waste regulations.

Concrete

Concrete is highly alkaline and corrosive and can have a devastating impact on watercourses. Washing out of concrete lorries or mixing tools and equipment is not permitted on site unless in designated sealed wash-out area. Washings must not be allowed to flow into any drain or watercourse. Concrete mixing and storage to be away from drains and watercourses.

Sulphate resistant concrete to be used where geological conditions require it to prevent long term corrosion of concrete and release of alkaline compounds.

Waste Management

The Duty of Care requires waste producers to ensure waste does not escape their control and is passed only to an authorised waste person (registered with the relevant environment agency) accompanied by a full written description or receipt.

All waste to be stored (prior to removal) in designated areas away from watercourses and drains. Skips to be covered to prevent dust and litter being blown out and rainwater accumulation and should be regularly inspected and replaced when full. Where possible separate skips should be provided so wastes can be segregated for

recycling or to prevent cross contamination. Skips should be disposed of in accordance with legal waste requirements.

Special waste such as used chemical containers, used oil and filters, paints, hazardous refuse to be stored in bunded area away from watercourses and disposed of separately by licensed contractor.

Burning waste on site is forbidden as this will cause both pollution and annoyance to neighbours.

Silt and Earthworks

The production of silty water will be avoided wherever possible. Water will be prevented from entering excavations using cut-off ditches and the length of time which open excavations are left uncovered will be limited. Any water discharged by pumping out will be dealt with to avoid silty water pollution to water courses and drains (see below). Exposed ground and stockpiles and storage duration will be minimised to reduce production of dust and silty runoff. If long term storage required stockpiles should be seeded or covered or silt fences constructed from suitable geotextile. In dry weather dust suppression measures by water spraying may be necessary.

Where silty water occurs i.e. from excavations, exposed ground, stockpiles, site roads and plant and wheel washing it will not be directly discharged into watercourses or surface water drains. Where possible silty water will be disbursed into the ground via soakaways. Where soakaways can not be achieved due to ground conditions, run off will be conveyed to the water course via silt traps to mitigate the introduction of soil to water courses. Silt must first be allowed to settle out in suspension before entering a water course or drain. Do not allow plant or personnel to disturb water in such areas. Treatment methods can include: the use of existing grassed depressions to allow natural filtration of silt; settlement lagoons dug prior to drainage reaching a watercourse (the level of silt needs to be monitored and emptied if necessary with a sludge tanker); settlement/separation tanks which can include more sophisticated interceptors if oil contaminated water reaches the tank. Reference should be made to Environment Agency leaflet *Silt Pollution and How to Avoid It.*

Topsoil Stripping and Reinstatement – disturbance to flora and fauna will be minimised during construction and disturbed habitats will be reinstated ASAP to speed up regeneration. Topsoil and vegetation and subsoil should be stored separately and retained for reinstatement of track shoulders and other stripped areas ASAP to prevent erosion. Turf should be stored topside up. On wet marshy habitats it may be necessary to store excavated materials on geotextile matting to minimise disturbance to vegetation below.

Road Cleanliness

Site roads will be brushed/scraped to minimise mud and dust deposits. During dry weather dust suppression methods by spraying water to be used if necessary.

Public highways to be protected by use of wheel washing station for site vehicles before exiting onto public roads. Such plant washing facilities to be constructed with no overflow and water collected from this to pass through silt trap before discharging into a purpose made soakaway.

Wildlife

Wildlife and their dens to be protected from disturbance and entering and becoming trapped in any site works by use of fences, crossings or escape ramps and routes where necessary.

References

For further information refer to:

SEPA/Environment Agency Pollution Prevention Guideline *PPG6 Working at Construction and Demolition Sites.*

Environment Agency Leaflet *Silt Pollution and How to Avoid It.*

7. ECOLOGY & ORNITHOLOGY TECHNICAL APPENDIX

INTRODUCTION

This appendix contains information relating to the ecology and ornithology assessment of a technical nature that has not been included within Chapter 7 of the Environmental Statement. It contains the following:

- Target Notes
- Table of Bat Registrations
- Breeding Bird Species Summary

7.1 TARGET NOTES

The following pages contain target notes and descriptions of features.

Target Note Number	Description of Feature
1.	Narrow band of grassland, c.1-2m wide, on bank of Coal Pit Dyke. Apparently too steep and close to water course to receive the same high levels of improvement as the adjacent improved grassland field. The grassland contains high levels of acid indicator species, especially sheep sorrel and wavy hair-grass. A few small bilberry and heather plants were located along the strip. The strip is suspected to be a small remnant of previous more natural habitat in the surrounding area and is poorly connected to other higher value habitats and currently surrounded by heavily managed and improved grasslands. The very small area of this habitat at this location reduces its potential to hold valuable populations of plant or faunal species.
2.	Judd Field Quarry. Mostly bare ground with stands of rosebay willowherb and other willowherbs, nettles and thistles. A stand of Japanese Knotweed is present on the north-western edge of the quarry. The stand is c.5m by 3m in size. No knotweed was seen in the adjacent field at the time of survey.
3.	Acid grassland in north-west corner of field predominantly to the south and east of a flush. The flush shows no signs of acidification and is dominated by marsh thistle and *Juncus* sp. The acid grassland is dominated by fescues and mat-grass with abundant sheep's sorrel and more locally devil's-bit scabious, and frequent *Luzula* sp, tormentil, hawkweeds and occasional heath speedwell. This area showed relatively few signs of recent grazing i.e. poaching around the flush and droppings. The density of acid indicators and the general diversity of the sward decreases rapidly as the field continues south down the slope. The majority of the field is dominated by poor semi-improved grazing.
4.	The acid grassland detailed at Target note 3 gives way to a small patch of base rich grassland to the east. This area is dominated by common grass species dominating the semi-improved grassland sward to the south but includes frequent: carnation sedge (*Carex panicea*), yellow sedge (*C. viridula*), quaking grass (*Briza media*), betony (*Stachys betonica*) and birdsfoot trefoil (*Lotus corniculatus*). This area did not appear subject to heavy grazing.

7.2 TABLE OF BAT REGISTRATIONS

The following pages contain the summary table of bat registrations.

Survey Visit	Weather and time.	Registration Number	Details
16th May	Temp 13°C, light westerly wind, light shower between 21:20 and 21:33. Cloud 8/8. Survey from 20:50 until 23:33.	1	Single Common Pipistrelle foraging along trees and scrub adjacent to Underbank Lane at 20:57 and again at 22:26.
		2	Single Common Pipistrelle foraging along edge of plantation and adjacent walls at 21:36 and again at 22:46.
		3	Single Common Pipistrelle foraging along edge of Sheephouse Wood and occasionally continuing North along Cote Field Beck on first pass only at 21:49.
19th June	16°C, No wind, Dry, Cloud 7/8. Survey from 22:35 to 01:25.	4	Single Common Pipistrelle foraging along road adjacent to Doubting plantation at 22:38 and again at 00:55. Occasionally flew south along edge of plantation.
		5	Single Common Pipistrelle foraging around western end of Salter Hill Plantation at 22:38, just outside of survey boundary. Not recorded on second pass at 01:02.
		6	Single Common Pipistrelle foraging along trees and scrub adjacent to Underbank Lane at 22:42. Joined by second Common Pipistrelle on second pass at 00:47.
		7	Two Common Pipistrelles foraging along northern edge of Sheephouse Height Plantation at 23:37 and 01:14.
		8	Single Common Pipistrelle foraging along southern ends of Cote Field Beck and Spring Brook at 23:00 and 00:48
		9	Single Common Pipistrelle foraging around Cranberry Farm at 01:32. Not recorded on first pass at 22:42.
27th July	Temp 18°C, Dry, Still, Cloud 4/8. Survey from 21:27 until 01:17	10	Single Common Pipistrelle foraging along edge of Sheephouse Wood and north along field boundary wall at 22:17. Not present on second pass.
		11	Single Common Pipistrelle foraging along side of road between Mossley House and the covered reservoir at 22:19 and again at 00:55.
		12	Single Common Pipistrelle foraging at northern end of Doubting plantation at 22:30. Not recorded during second pass at 00:39.

		13	Single Common Pipistrelle foraging between Spring Brook and nearby plantation at 23:03. Not recorded during second pass at 00:41
		14	Two Common Pipistrelle foraging along northern edge of Sheephouse Height Plantation at 23:05 and again at 00:22.
		15	Single Common Pipistrelle foraging along trees and scrub adjacent to Underbank Lane at 23:26 and again at 00:19. Very brief registration of a probable Myotis sp. on western side of Underbank Lane at 00:19.
		16	Single Common Pipistrelle foraging around Cranberry Farm at 23:52 and again at 01:16.
18th August	20°C, Dry, light NW wind, Cloud 2/8. Survey from 20:20 until 22:55.	17	Single Common Pipistrelle foraging around small plantation north of Cranberry Road at 20:26. Not recorded on second pass at 21:55.
		18	Two Common Pipistrelle foraging along Spring Brook and section of Sheephouse Wood at 21:12. One bat still present on second pass at 22:26.
		19	Two Common Pipistrelle foraging along northern edge of Sheephouse Height Plantation on both passes at 21:20 and 22:38.
		20	Single Common Pipistrelle bat foraging around scrub in field north of Sheephouse Wood on second pass only at 22:32. Possibly one of bats recorded at number18 above.

7.3 BREEDING BIRD SURVEY SPECIES SUMMARIES

The following pages contain the species summary table of breeding bird surveys.

Key: *Recorded holding territory or with young/nest material/carrying food.

** Possible breeder within site due to regularity of records and presence of suitable habitat.

RL (Red List), S1 (Schedule 1 W&CAct 1981), UKB (UK Biodiversity Action Plan), LB (Local BAP).

Species	
Grey Heron (*Ardea cinerea*)	Single birds seen flying high over survey area in April and May.
Mallard** (*Anas platyrhynchos*)	Pairs seen in fields north of Sheephouse Wood in April and May. Possibly breeds in low numbers within the survey area.
Buzzard (*Buteo buteo*)	Single bird seen over Sheephouse Wood in June.
Sparrowhawk (*Accipiter nisus*)	Seen near Sheephouse Wood. Likely to breed in woodland areas outside of survey area. No breeding behaviour recorded from inside survey area.
Kestrel **(*Falco tinnunculus*)	Seen on every visit (max 2 in May). Likely to breed in either old buildings or mature trees within the survey area in low numbers.
Red-legged Partridge** (*Alectoris rufa*)	Present in fields either side of Mossley Road. Introduced.
Pheasant* (*Phasanius colchicus*)	Common in woodlands and fields throughout survey area.
Moorhen (*Gallinula chloropus*)	Seen in Sheephouse Wood in April.
Lapwing* (*Vanellus vanellus*)	4 birds recorded holding territory in fields north of Mossley Road.
Snipe* (Gallinago gallinago)	Drumming recorded over two rush pasture areas in fields north of Mossley Road.
Curlew** (*Numenius arquata*)	Single birds seen in fields north of Mossley Road in May and June. No breeding behaviour recorded but habitat suitable for breeding here.
Black-headed Gull (*Larus ridibundus*)	Seen in low numbers flying over survey area and in arable fields on every visit.
Herring Gull (*Larus argentatus*)	Seen in low numbers flying over the survey area in April.
Lesser Black-backed Gull (*Larus fuscus*)	Single birds seen flying high over the survey area in May and June.
Wood Pigeon *(*Columba palumbus*)	Very common breeder throughout survey area.
Little Owl **(*Athena noctua*)	Single bird seen on wall adjacent to Mossley Road. Likely to breed within survey area.
Tawny Owl** (*Strix aluco*)	Birds seen in Sheephouse Wood. Likely breeder.

Swift *(Apus apus)*	Common flying over survey area (max 25 in May).
Green Woodpecker (*Picus viridis*)	Seen near Sheephouse Wood. No breeding behaviour recorded from inside survey area.
Great Spotted Woodpecker (*Dendrocopos major*)	Drumming birds heard in Sheephouse Wood. No breeding behaviour recorded from inside survey area.
Skylark* *(Alauda arvensis)*; RD, UKB	A minimum of 5 singing birds recorded in May. Located in all parts of survey area with open field habitats.
Swallow* *(Hirundo rustica)*	Common throughout survey area. Breeding suspected at most farms within survey area.
House Martin** *(Delichon urbica)*	Maximum of 10 birds recorded over Brockholes in June. Possibly breeds on buildings within survey area but no nests found during survey.
Meadow Pipit* *(Anthus pratensis)*	Common in open field habitats within survey area.
Pied Wagtail* *(Motacilla alba yarellii)*	Common throughout survey area, particularly associated with farmyards.
Wren* *(Troglodytes troglodytes)*	Common throughout survey area.
Dunnock *(Prunella modularis)*	Common throughout survey area.
Robin *(Erithacus rubecula)*	Common throughout survey area.
Wheatear (*Oenanthe oenanthe*)	4 Birds recorded in fields at Little Doubting, c.100m west of survey area in April. Not recorded again and no nesting behaviour was seen.
Redwing (Turdus iliacus)	3 birds recorded flying over in April. Considered to be passage migrants passing through.
Blackbird *(Turdus merula)	Very common throughout survey area.
Blackcap* (*Sylvia atricapilla*)	At least 2 pairs present along boundary with Sheephouse Wood.
Willow Warbler *(Phylloscopus trochilus)	Common throughout all woodland and scrub habitats within survey area.
Chiffchaff* *(Phylloscopus collybita)*	Common throughout woodland habitats within survey area.
Great Tit *(Parus major)	Common throughout all woodland and scrub habitats within survey area.
Blue Tit *(Parus caerulus)	Common throughout all woodland and hedgerow habitats within survey area.
Long-tailed Tit *(Aegithalos caudatus)	Common throughout all woodland and hedgerow habitats within survey area.
Nuthatch (*Sitta europaea*)	Birds recorded from Sheephouse Wood during every visit. Probably breeds in all woodlands in wider area. No breeding behaviour recorded from inside survey area.
Treecreeper (*Certhia familiaris*)	Birds recorded from Sheephouse Wood during every visit. Probably breeds in all woodlands in wider area. No breeding behaviour recorded from inside survey area.
Magpie *(Pica pica)	Very common throughout all parts of survey area.
Jackdaw *(Corvus monedula)*	Common throughout survey area.

Rook *(Corvus frugilegus)*	Occasionally seen feeding in fields. No nesting behaviour seen within woodlands.
Carrion Crow *(Corvus corone corone)*	Very common throughout all parts of survey area.
Starling *(Sturnus vulgaris)*; RD	Common in small numbers throughout survey area. No breeding behaviour recorded.
Tree Sparrow (Passer montanus); RD, UKB	Single bird seen on fence surrounding covered reservoir off Mossley Road.
House Sparrow** (Passer domesticus); RD, UKB	Up to 12 seen at Sheephouse Farm. Likely to nest here and possibly in other farms throughout the survey area.
Chaffinch*(*Fringella coelebs)*	Very common throughout all parts of survey area.
Linnet* *(Carduelis cannabina)*; RD, UKB	5 territories recorded. 4 nr Doubting and a single at Cranberry Farm.
Lesser Redpoll (*Carduelis cabaret*)	Flock of 6 birds seen flying over Sheephouse Wood toward Underbank Reservoir in May.
Siskin (*Carduelis spinus*)	Singles heard flying over Sheephouse Wood in April and May. No breeding behaviour recorded.
Goldfinch *(*Carduelis carduelis)*	Common throughout hedgerow and scrub habitats within site.
Greenfinch *(*Carduelis chloris)*	Common throughout all parts of survey area.
Bullfinch* *(Pyrrhula pyrrhula)*; RD, UKB	1 territory recorded on boundary between survey area and Sheephouse Wood.
Reed Bunting* (Emberiza schoeniculus); RD, UKB	2 territories recorded. One adjacent to Cranberry Road in the marshy field and the other along the northern boundary of the site close to Milbrook House.
Yellowhammer* *(Emberiza citrinella)*; RD, LB	1 territory recorded at Cote Field Beck.

9. NOISE TECHNICAL APPENDIX

9.1 INTRODUCTION

This appendix contains information relating to the noise assessment of a technical nature that has not been included within Chapter 9 of the Environmental Statement. It contains the following:

- Consultation Correspondence
- Baseline Noise Survey Documentation – survey notes, rainfall record and equipment calibration certificates
- Manufacturer's Noise Data for Vestas V90 3.0MW Wind Turbine
- Noise Model outputs

9.2 CONSULTATION CORRESPONDENCE

The following pages contain copies of correspondence between Arcus Renewable Energy Consulting Ltd and Barnsley Metropolitan Borough Council Environmental Health Department.

Michael Reid

From: Newman , Sarah [SarahNewman@barnsley.gov.uk]
Sent: 17 May 2007 13:41
To: Michael Reid
Cc: Merryweather , Bob; Beighton , David
Subject: Pre-application for Wind Farm @ Midhopestones.

Dear Michael,

Following a visit to the location late last week it is recommended that background noise levels and noise impact assessments are undertaken at the following locations.

- Sheephouse, Mortimer Road.
- Farm to south west of Sheephouse, Mortimer Road.
- Judd Field Farm, Judd Field Lane.
- Mossley House, Mossley Road.
- Cranberry, Cranberry Road.
- Dyson Cote, Dyson Cote Lane.
- Salter Hill House, Back Lane.
- Throstle nest, Cranberry Road.

If you have any comments or queries do not hesitate to contact me.

Yours sincerely,

Sarah Newman
Senior Environmental Health Officer

Barnsley Metropolitan Borough Council
Regulatory Services

Tel - 01226 77(2454)
Mob - 07786 525 914
Fax - 01226 775699

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Michael Reid

From: Michael Reid
Sent: 17 May 2007 14:48
To: Newman , Sarah
Cc: Merryweather , Bob; Beighton , David; s.brooks@breezeenergy.co.uk
Subject: RE: Pre-application for Wind Farm @ Midhopestones.

Hi Sarah,

Thank you very much for your response.

Regarding the properties you have identified, we would certainly include all of these in the noise assessment.

I believe that we can obtain representative background noise data for this assessment by surveying at the following four properties:

1. Sheephouse
2. Throstle's Nest
3. Dyson Cote
4. Mossley House

For the other properties, I would propose the following:

- New farmhouse SW of Sheephouse - baseline data from sheephouse, which is within approx 250m
- Judd Field farm - baseline data from Mossley House, within 250m approx
- Salter Hill House - worst case of data from Throstle's Nest / Dyson Cote
- Cranberry - data from Throstle's nest

I believe that this would provide representative data for all the key properties, whilst focussing on those closest to the turbines and keeping the number of monitoring locations to a manageable four, which I think is appropriate for the size of development and geographic spread of the properties.

We may however, have difficulty obtaining agreement with the owners / occupiers of the houses at Dyson Cote, in which case we would use worst-case data from the other locations.

Please let me know if you are satisfied with this approach.

Regards,

Michael

From: Newman , Sarah [mailto:SarahNewman@barnsley.gov.uk]
Sent: Thu 17/05/2007 13:40
To: Michael Reid
Cc: Merryweather , Bob; Beighton , David
Subject: Pre-application for Wind Farm @ Midhopestones.

Dear Michael,

Following a visit to the location late last week it is recommended that background noise levels and noise impact assessments are undertaken at the following locations.

- Sheephouse, Mortimer Road.
- Farm to south west of Sheephouse, Mortimer Road.
- Judd Field Farm, Judd Field Lane.

Michael Reid

From: Newman , Sarah [SarahNewman@barnsley.gov.uk]
Sent: 17 May 2007 16:44
To: Michael Reid
Cc: Beighton , David; Merryweather , Bob
Subject: RE: Pre-application for Wind Farm @ Midhopestones.

Follow Up Flag: Follow up
Flag Status: Completed

Dear Michael,

Thank you for your comments.

In general it is preferred to have actual measured data in preference to extrapolated information. However, depending on the acoustic modelling software specification or techniques employed, calculated rather than measured figures can be considered to be representative.

The locations recommended in my previous email are intended to show, not only adversely affected properties, but also where it can be safely stated that noise impacts will be minimal/negligible. This gives both the public and the members of Planning Board a clear picture of noise impact when forming a view with regard to the application. The recommendations have been made given previous experience with similar applications in very similar locations.

With regard to your suggestions:

The farmhouse SW of Sheephouse – this property is substantially further down the south facing slope, however, if the acoustic modelling software includes suitable topography inputs the use of baseline data from Sheephouse may be suitable. Please advise with regard to the specification/s of the model/techniques that you intend to use to undertake this extrapolation.

Judd Field Farm – again Judd Field Farm is significantly further down the slope to Mossley House, therefore – as for Sheephouse.

Salter Hill House – It is considered that Salter Hill House will receive noise output from more of the turbines consecutively (in comparison to Cranberry or Throstle's Nes), due to its position directly South West of the proposed dev. It is strongly recommended that this property is assessed by measured data.

Cranberry – Data from Throstle's Nest can be extrapolated for this location.

I hope this is helpful.

Yours sincerely,

Sarah Newman
Senior Environmental Health Officer

Barnsley Metropolitan Borough Council
Regulatory Services

Tel - 01226 77(2454)
Mob - 07786 525 914
Fax - 01226 775699

From: Michael Reid [mailto:MichaelR@arcusrenewables.co.uk]
Sent: 17 May 2007 14:48
To: Newman , Sarah
Cc: Merryweather , Bob; Beighton , David; s.brooks@breezeenergy.co.uk
Subject: RE: Pre-application for Wind Farm @ Midhopestones.

Hi Sarah,

Michael Reid

From: Michael Reid
Sent: 17 May 2007 17:09
To: Newman , Sarah
Cc: Beighton , David; Merryweather , Bob; s.brooks@breezeenergy.co.uk
Subject: RE: Pre-application for Wind Farm @ Midhopestones.

Hi Sarah,

To clarify: we would assess each property individually, carrying out noise calculations to predict the likely worst-case (downwind) noise levels at each property. These would be assessed against criteria derived from the background noise data as specified in ETSU-R-97. The prediction technique that we use is based on ISO9613-2:1996, with some minor modifications to reflect best practice as used within the wind industry based on research carried out for ESTU by Hayes McKenzie. Barrier attenuations are omitted, and in this case mixed hard and soft ground would be assumed - which is conservative for the site.

In terms of the baseline noise levels, we would not recalculate these for other locations. Rather, we would assume that the background noise levels at properties within a small area are identical. If it was necessary to use assumed levels at further locations, these would be the worst case of those measured at all locations (at individual integer wind speeds).

This approach has been acceptable at all of a large number of sites that I have previously worked on, and has also been used in almost every noise assessment that I have seen in an Environmental Statement, and I regard it to being keeping with standard practice.

I hope that this helps to clarify our intended approach and look forward to hearing from you further.

Regards,
Michael

From: Newman , Sarah [mailto:SarahNewman@barnsley.gov.uk]
Sent: Thu 5/17/2007 4:44 PM
To: Michael Reid
Cc: Beighton , David; Merryweather , Bob
Subject: RE: Pre-application for Wind Farm @ Midhopestones.

Dear Michael,

Thank you for your comments.

In general it is preferred to have actual measured data in preference to extrapolated information. However, depending on the acoustic modelling software specification or techniques employed, calculated rather than measured figures can be considered to be representative.

The locations recommended in my previous email are intended to show, not only adversely affected properties, but also where it can be safely stated that noise impacts will be minimal/negligible. This gives both the public and the members of Planning Board a clear picture of noise impact when forming a view with regard to the application. The recommendations have been made given previous experience with similar applications in very similar locations.

With regard to your suggestions:

The farmhouse SW of Sheephouse – this property is substantially further down the south facing slope, however, if the acoustic modelling software includes suitable topography inputs the use of baseline data from Sheephouse may be suitable. Please advise with regard to the specification/s of the model/techniques that you intend to use to undertake this extrapolation.

Michael Reid

From: Michael Reid
Sent: 21 May 2007 10:41
To: 'sarahnewman@barnsley.gov.uk'
Cc: 's.brooks@breezeenergy.co.uk'; Marsha Kebs; 'Beigh ton , David'; 'bobmerryweather@barnsley.gov.uk'
Subject: midhopestones windfarm noise survey
Attachments: MHSNoisecontours.pdf

Hi Sarah,

I thought I'd drop you a line to bring you up to date with where we are with the background noise survey for Midhopestones.

We have set up the four sets of monitoring equipment that we had ready to go at Sheephouse, Throstle's Nest, Dyson Cote and Mossley House. I am hoping that we can reach a compromise on the other monitoring locations that you requested.

I feel that as Judd Field Farm and the new farmhouse near Sheephouse are right on the edge of the 35dB contour (see attached) that specific baseline data for these properties will be of relatively little importance and that they can be adequately represented by data from other locations. In the case of Salter Hill House, I understand your concern that this property will be downwind of the turbines for much of the time, however, our predictions show that it would receive a lower (downwind) noise level than Cranberry, Throstle's Nest or Dyson Cote. Again, I believe that the background noise environment can be adequately represented by data obtained at another, nearby location.

There are a number of options which could be considered in the selection of representative background data for the locations where monitoring is not carried out:

1. The data from the closest monitoring location could be used, in the assumption that background noise levels will be consistent across the local area. As there are relatively few noise sources in the area, other than natural ones, this assumption should be valid.
2. Alternatively, a more conservative approach may be to choose the lowest quiet daytime and night-time background noise curves from all of the monitoring locations to represent the background noise environment at the non-monitored locations.
3. Still more conservatively, the lowest derived background noise level (from the regression analysis) for each integer wind speed from all of the monitoring locations (for quiet daytime and night-time data sets) could be used to provide an overall worst-case scenario.

I hope that one of these options would be able to provide you with the comfort that you require that the noise levels produced by the turbines would be capable of complying with the limits specified in ETSU-R-97.

I would be more than happy to discuss this with you further, either by telephone, or to come to meet with you.

Regards,

Michael Reid

Arcus Renewable Energy Consulting Ltd

27 Woodside Place
Glasgow G3 7QL
0141 332 9949

07878 530174
michael@arcusrenewables.co.uk
www.arcusrenewables.co.uk

No virus found in this outgoing message.
Checked by AVG Free Edition.
Version: 7.5.467 / Virus Database: 269.7.6/813 - Release Date: 20/05/2007 07:54

Michael Reid

From: Newman , Sarah [SarahNewman@barnsley.gov.uk]
Sent: 23 May 2007 15:03
To: Michael Reid
Subject: RE: midhopestones windfarm noise survey

Dear Michael,

Thank you for your emails of the 17th and 21st the contents are noted – the agreement from Dyson Cote came through I see.

With regard to the non measured backgrounds option 2 will be fine.

Yours sincerely,

Sarah Newman
Senior Environmental Health Officer

Barnsley Metropolitan Borough Council
Regulatory Services

Tel - 01226 77(2454)
Mob - 07786 525 914
Fax - 01226 775699

From: Michael Reid [mailto:MichaelR@arcusrenewables.co.uk]
Sent: 21 May 2007 10:41
To: Newman , Sarah
Cc: s.brooks@breezeenergy.co.uk; Marsha Krebs; Beighton , David; Merryweather , Bob
Subject: midhopestones windfarm noise survey

Hi Sarah,

I thought I'd drop you a line to bring you up to date with where we are with the background noise survey for Midhopestones.

We have set up the four sets of monitoring equipment that we had ready to go at Sheephouse, Throstle's Nest, Dyson Cote and Mossley House. I am hoping that we can reach a compromise on the other monitoring locations that you requested.

I feel that as Judd Field Farm and the new farmhouse near Sheephouse are right on the edge of the 35dB contour (see attached) that specific baseline data for these properties will be of relatively little importance and that they can be adequately represented by data from other locations. In the case of Salter Hill House, I understand your concern that this property will be downwind of the turbines for much of the time, however, our predictions show that it would receive a lower (downwind) noise level than Cranberry, Throstle's Nest or Dyson Cote. Again, I believe that the background noise environment can be adequately represented by data obtained at another, nearby location.

There are a number of options which could be considered in the selection of representative background data for the locations where monitoring is not carried out:

1. The data from the closest monitoring location could be used, in the assumption that background noise levels will be consistent across the local area. As there are relatively few noise sources in the area, other than natural ones, this assumption should be valid.



Breeze Renewable Energy Ltd

arcus
Arcus Renewable Energy Consulting Ltd

Key

- Financially Involved Properties
- Non-Involved Properties
- *Provisional Turbine Locations*

Predicted LA90,10min

- 30 dB(A)
- 35 dB(A)
- 40 dB(A)
- 45 dB(A)
- 50dB(A)

Noise contours calculated according to ISO 9613-2:1996. Mixed hard and soft ground assumed and barrier attenuation omitted.

25m vertical intervals, receiver height 1.5m.

Based on wind turbines with a typical Sound Power Level = 105 dB(A)

1:10,000 Scale @ A3

0 0.25 0.5 Km

N

Figure x.x
Noise Contour Plot

Midhopestones Windfarm Noise Assessment

9.3 BASELINE NOISE SURVEY

The following pages contain:

- Survey Notes
- Equipment Calibration Certificates

Wind Farm Noise Survey Record Sheet

Project No:	071	**Project Name:**	Sheephouse
Client:	Breeze	**Survey By:**	MR

Location No (x/y):	1 / 4	**Location Name:**	Throstle's Nest
Monitoring Location (GPS Grid Reference):			SE 52264 00717
Monitoring Location Description:	In adjacent field, 10m to south of garden, between house and outbuilding.		
Distance From Façade:		>10m	
Noise Sources Present:	Trees, vegetation, traffic		
Notes:			
Start Date & Time	18/05/07 1400	**End date & Time**	04/06/2007 14.45

Equipment			
Item	**Make**	**Model**	**Serial No.**
Microphone	Rion	NH-21	6420329
Sound Level Meter	Rion	NL-31	01062691
Calibrator	Rion	NC-74	34372738
Source of Equipment:		Arcus/ Bolsterstone	

Calibration			
	Date & Time	**Calibration Level**	**Level before calibration**
Initial	18/5/07 14.00	93.9	94.0
Mid-Survey Check 1	24/5/07 15.08	93.9	93.9
Final Check	04/06/07 14.45	93.9	94.0

Sketch Plan / Photo(s) of Monitoring Location:



Wind Farm Noise Survey Record Sheet

Project No:	071	**Project Name:**	Sheephouse
Client:	Breeze	**Survey By:**	MR

Location No (x/y):	2 / 4	**Location Name:**	Mossley House
Monitoring Location (GPS Grid Reference):			SE 25424 00976
Monitoring Location Description:	Yard to east of cottage		
Distance From Façade:		10m	
Noise Sources Present:	Trees, traffic, farm machinery and vehicles		
Notes:			
Start Date & Time	18/05/07 1430	**End date & Time**	04/06/2007 13.32

Equipment			
Item	**Make**	**Model**	**Serial No.**
Microphone	Rion	NH-21	20326
Sound Level Meter	Rion	NL-31	01062688
Calibrator	Rion	NC-74	34372738
Source of Equipment:		Arcus /Bolsterstone	

Calibration			
	Date & Time	**Calibration Level**	**Level before calibration**
Initial	18/5/07 14.30	93.9	93.9
Mid-Survey Check 1	24/5/07 15.30	93.9	94.0
Final Check	04/06/07 13.35	93.9	94.0

Sketch Plan / Photo(s) of Monitoring Location:



Wind Farm Noise Survey Record Sheet

Project No:	071	**Project Name:**	Sheephouse
Client:	Breeze	**Survey By:**	MR

Location No (x/y):	3 / 4	**Location Name:**	Dyson Cote
Monitoring Location (GPS Grid Reference):			SE 25830 00503
Monitoring Location Description:	In garden of property (road side)		
Distance From Façade:		>3.5m	
Noise Sources Present:	Trees, traffic, farm machinery and vehicles, birds, dogs		
Notes:	Making silage during working hours		
Start Date & Time	18/05/07 1530	**End date & Time**	04/06/2007 14.19

Equipment			
Item	**Make**	**Model**	**Serial No.**
Microphone	Rion	NH-21	20327
Sound Level Meter	Rion	NL-31	01062689
Calibrator	Rion	NC-74	34372738
Source of Equipment:		Arcus / Bolsterstone	

Calibration			
	Date & Time	**Calibration Level**	**Level before calibration**
Initial	18/5/07 15.30	93.9	93.9
Mid-Survey Check 1	24/5/07 16.00	93.9	94.0
Final Check	04/06/07 14.25	93.9	94.0

Sketch Plan / Photo(s) of Monitoring Location:



Wind Farm Noise Survey Record Sheet

Project No:	071	**Project Name:**	Sheephouse
Client:	Breeze	**Survey By:**	MR

Location No (x/y):	4 / 4	**Location Name:**	Sheephouse
Monitoring Location (GPS Grid Reference):			SE 24552 00349
Monitoring Location Description:	In garden of property between shed and house		
Distance From Façade:		7m	
Noise Sources Present:	Trees, farm machinery and vehicles, birds, dogs		
Notes:			
Start Date & Time	18/05/07 1600	**End date & Time**	04/06/2007 13.15

Equipment			
Item	**Make**	**Model**	**Serial No.**
Microphone	Rion	NH-21	20328
Sound Level Meter	Rion	NL-31	01062690
Calibrator	Rion	NC-74	34372738
Source of Equipment:		Arcus / Bolsterstone	

Calibration			
	Date & Time	**Calibration Level**	**Level before calibration**
Initial	18/5/07 15.30	93.9	93.9
Mid-Survey Check 1	24/5/07 16.00	93.9	94.0
Final Check	04/06/07 14.25	93.9	94.1

Sketch Plan / Photo(s) of Monitoring Location:



Measurement Systems

CERTIFICATE OF CONFORMANCE

Date of Issue	**26th April 2007**
Customer	**Bolsterstone PLC**
Certificate Number	**CONF040708**

	Manufacturer	**Type**	**Serial Number**
Sound Level Meter	Rion	NL-31	01062688
Preamplifier	Rion	NH-21	20326
Microphone	Rion	UC-53A	310533

This is to certify that the instrument was tested and calibrated at the Manufacturer's factory according to their specification and that the product satisfied all the relevant requirements of the following Standards:

IEC 60651:1979 Type 1;
IEC 60804:1985 Type 1; and
IEC 61672-1:2002 Class 1.

The instrument also received a functional check by ANV Measurement Systems prior to despatch in the UK, in accordance with our standard procedures.

ANV Measurement Systems recommend that the instrument is calibrated at an interval of 12 months.

Signed MRB Position DIRECTOR Date 26/4/07

BEAUFORT COURT, 17 ROEBUCK WAY, MILTON KEYNES, MK5 8HL
☎ 01908 642846 🖷 01908 642814
✉ info@noise-and-vibration.co.uk 💻 www.noise-and-vibration.co.uk

ACOUSTICS NOISE AND VIBRATION LIMITED. REGISTERED IN ENGLAND NO. 3549028. REGISTERED OFFICE AS ABOVE.

Measurement Systems

CERTIFICATE OF CONFORMANCE

Date of Issue	**26th April 2007**
Customer	**Bolsterstone PLC**
Certificate Number	**CONF040709**

	Manufacturer	**Type**	**Serial Number**
Sound Level Meter	Rion	NL-31	01062689
Preamplifier	Rion	NH-21	20327
Microphone	Rion	UC-53A	310534

This is to certify that the instrument was tested and calibrated at the Manufacturer's factory according to their specification and that the product satisfied all the relevant requirements of the following Standards:

IEC 60651:1979 Type 1;
IEC 60804:1985 Type 1; and
IEC 61672-1:2002 Class 1.

The instrument also received a functional check by ANV Measurement Systems prior to despatch in the UK, in accordance with our standard procedures.

ANV Measurement Systems recommend that the instrument is calibrated at an interval of 12 months.

Signed..... Position..DIRECTOR..... Date..26/4/07.....

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Measurement Systems

CERTIFICATE OF CONFORMANCE

Date of Issue	**26th April 2007**
Customer	**Bolsterstone PLC**
Certificate Number	**CONF040710**

	Manufacturer	**Type**	**Serial Number**
Sound Level Meter	Rion	NL-31	01062690
Preamplifier	Rion	NH-21	20328
Microphone	Rion	UC-53A	311678

This is to certify that the instrument was tested and calibrated at the Manufacturer's factory according to their specification and that the product satisfied all the relevant requirements of the following Standards:

IEC 60651:1979 Type 1;
IEC 60804:1985 Type 1; and
IEC 61672-1:2002 Class 1.

The instrument also received a functional check by ANV Measurement Systems prior to despatch in the UK, in accordance with our standard procedures.

ANV Measurement Systems recommend that the instrument is calibrated at an interval of 12 months.

Signed ..... Position Director Date 26/4/07

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Measurement Systems

CERTIFICATE OF CONFORMANCE

Date of Issue	**26th April 2007**
Customer	**Bolsterstone PLC**
Certificate Number	**CONF040711**

	Manufacturer	**Type**	**Serial Number**
Sound Level Meter	Rion	NL-31	01062691
Preamplifier	Rion	NH-21	20329
Microphone	Rion	UC-53A	309605

This is to certify that the instrument was tested and calibrated at the Manufacturer's factory according to their specification and that the product satisfied all the relevant requirements of the following Standards:

IEC 60651:1979 Type 1;
IEC 60804:1985 Type 1; and
IEC 61672-1:2002 Class 1.

The instrument also received a functional check by ANV Measurement Systems prior to despatch in the UK, in accordance with our standard procedures.

ANV Measurement Systems recommend that the instrument is calibrated at an interval of 12 months.

Signed ..... Position DIRECTOR Date 26/4/07

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Measurement Systems

CERTIFICATE OF CONFORMANCE

Date of Issue	**26th April 2007**
Customer	**Bolsterstone PLC**
Certificate Number	**CONF040712**

	Manufacturer	**Type**	**Serial Number**
Acoustic Calibrator	Rion	NC-74	34372738

This is to certify that the instrument was tested and calibrated at the Manufacturer's factory according to their specification and that the product satisfied all the relevant requirements of the following Standard:

IEC 60942 2003 Class 1 (Electroacoustics – Sound Calibrators)

The instrument also received a functional check by ANV Measurement Systems prior to despatch in the UK, in accordance with our standard procedures.

ANV Measurement Systems recommend that the instrument is calibrated at an interval of 12 months.

Signed ..... Position DIRECTOR Date 26/4/07

BEAUFORT COURT, 17 ROEBUCK WAY, MILTON KEYNES, MK5 8HL
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ACOUSTICS NOISE AND VIBRATION LIMITED. REGISTERED IN ENGLAND NO. 3549028. REGISTERED OFFICE AS ABOVE.

9.4 MANUFACTURER'S NOISE DATA

The following pages contain extracts of manufacturer's noise data for the Vestas V90 3.0MW wind turbine.

Detailed data for Mode 1 was provided. It has been assumed that the 1/3-octave spectrum for this mode at 8m/s is representative for Mode 4, after adjustment to the correct broadband sound power level.

2.3.5 Noise Curve V90 - 3.0 MW, 50 Hz, Mode 4 - 102.8 dB (A)

Guaranteed Sound Power Level at Hub Height: Noise mode 4				
Conditions for Sound Power Level:	Measurement standard IEC 61400-11 ed. 2 2002 Wind shear: 0.16 Max. turbulence at 10 meter height: 16% Inflow angle (vertical): 0 ± 2° Air density: 1.225 kg/m^3			
Hub Height	65m	80m	90m	105m
L_{wA} @ 4 m/s (10 m above ground) [dBA]	96.4	97.0	97.5	98.2
Wind speed at hh [m/sec]	5.4	5.6	5.7	5.8
L_{wA} @ 5 m/s (10 m above ground) [dBA]	101.5	102.0	102.2	102.4
Wind speed at hh [m/sec]	6.8	7.0	7.1	7.3
L_{wA} @ 6 m/s (10 m above ground) [dBA]	102.8	102.8	102.8	102.8
Wind speed at hh [m/sec]	8.1	8.4	8.5	8.7
L_{wA} @ 7 m/s (10 m above ground) [dBA]	102.8	102.8	102.8	102.8
Wind speed at hh [m/sec]	9.4	9.8	9.9	10.2
L_{wA} @ 8 m/s (10 m above ground) [dBA]	102.8	102.8	102.8	102.8
Wind speed at hh [m/sec]	10.8	11.2	11.4	11.7
L_{wA} @ 9 m/s (10 m above ground) [dBA]	102.8	102.8	102.8	102.8
Wind speed at hh [m/sec]	12.1	12.6	12.8	13.1
L_{wA} @ 10 m/s (10 m above ground) [dBA]	102.8	102.8	102.8	102.8
Wind speed at hh [m/sec]	13.5	14.0	14.3	14.6
L_{wA} @ 11 m/s (10 m above ground) [dBA]	102.8	102.8	102.9	103.6
Wind speed at hh [m/sec]	14.8	15.3	15.6	16.0
L_{wA} @ 12 m/s (10 m above ground) [dBA]	103.9	105.0	105.7	105.7
Wind speed at hh [m/sec]	16.2	16.7	17.1	17.5
L_{wA} @ 13 m/s (10 m above ground) [dBA]	105.6	105.7	105.7	105.7
Wind speed at hh [m/sec]	17.5	18.1	18.5	18.9

The noise level is guaranteed for the turbine configuration as described in the general specification.
The noise guarantee will be regarded as fulfilled, if a measured sound power level minus the inaccuracy of the measurement result is lower than the guaranteed value.

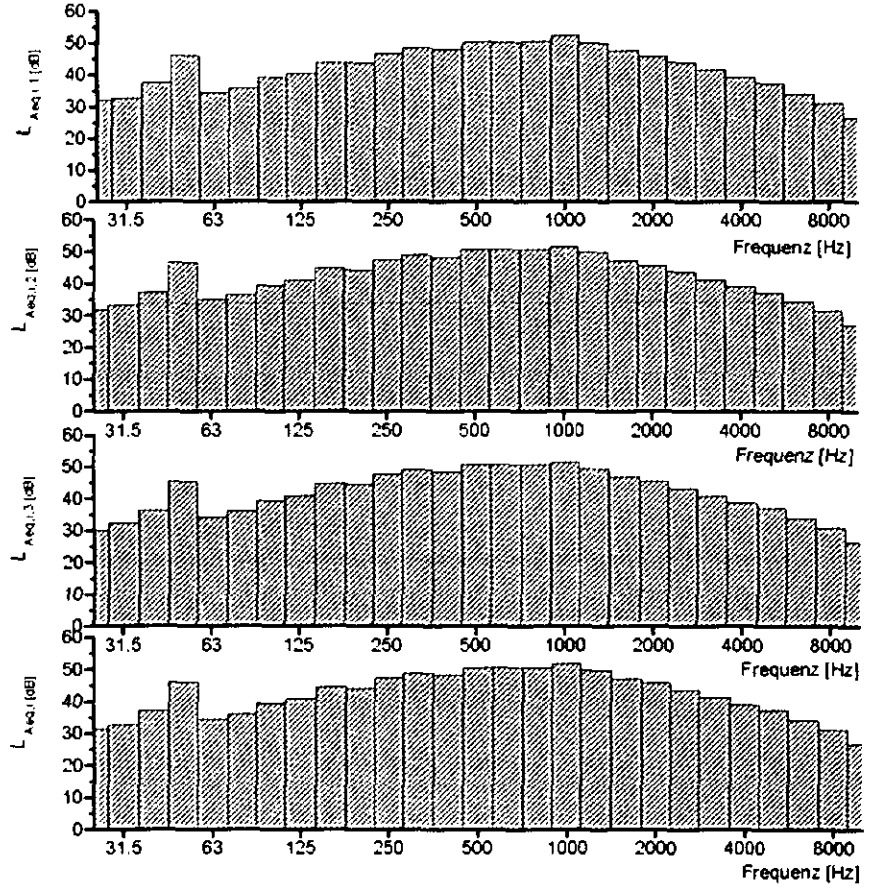
reference sound pressure/
Referenz - Schalldruck - Betrieb $L_{Aeq,c}$ = 60.0 dB

reference sound power
Referenz - Schallleistung L_{WA} = 107.8 dB

reference wind speed
Referenz - Windgeschwindigkeit WS 10m = 8 m/s

reference background sound pressure
Referenz - Schalldruck - Hintergrund $L_{Aeq,n}$ = 47.5 dB

f [Hz]	Spec. 1 [dB]	Spec. 2 [dB]	Spec. 3 [dB]	$L_{Aeq,i}$ [dB]	$L_{WA,i}$ [dB]	U_a [dB]	U_c [dB]
25	32.1	31.7	30.1	31.4	79.0	1.0	2.2
31.5	32.5	33.2	32.3	32.7	80.3	0.5	2.0
40	37.5	37.2	36.2	37.0	84.6	0.7	2.1
50	46.1	46.5	45.4	46.0	93.6	0.6	2.1
63	34.4	34.8	34.2	34.5	82.1	0.3	2.0
80	35.8	36.4	36.1	36.1	83.7	0.3	2.0
100	39.2	39.4	39.3	39.3	86.9	0.1	2.0
125	40.3	41.0	40.9	40.7	88.3	0.4	2.0
160	44.0	44.8	44.6	44.5	92.1	0.4	2.0
200	43.6	44.3	44.6	44.1	91.7	0.5	2.0
250	46.7	47.4	47.8	47.3	94.9	0.6	2.1
315	48.3	48.8	49.0	48.7	96.3	0.4	2.0
400	47.8	48.2	48.5	48.2	95.8	0.3	2.0
500	50.3	50.4	50.7	50.5	98.1	0.2	2.0
630	50.2	50.5	50.7	50.5	98.1	0.3	2.0
800	50.6	50.4	50.5	50.5	98.1	0.1	2.0
1000	52.4	51.4	51.5	51.8	99.4	0.5	2.0
1250	50.0	49.8	49.5	49.7	97.3	0.2	2.0
1600	47.5	47.1	46.9	47.2	94.8	0.3	2.0
2000	46.0	45.7	45.4	45.7	93.3	0.3	2.0
2500	43.8	43.5	43.2	43.5	91.1	0.3	2.0
3150	41.5	41.2	40.8	41.2	88.8	0.3	2.0
4000	39.3	39.1	38.7	39.0	86.6	0.3	2.0
5000	37.4	37.3	37.1	37.3	84.9	0.2	2.0
6300	34.2	34.1	33.9	34.1	81.7	0.2	2.0
8000	31.2	31.3	30.9	31.1	78.7	0.2	2.0
10000	26.6	27.0	26.4	26.7	74.3	0.3	2.0



WINDTEST
Kaiser-Wilhelm-Koog GmbH

Vestas V90-3MW (Mode 1)

One third octave analysis / Terzanalyse

Site / Standort:	Bökingharde
Measurem. / Messdatum:	2005-05-06
Standard / Messung:	FGW / IEC
In charge / Bearbeiter:	Dipl.-Ing. Jörg Dedert

9.5 NOISE MODEL OUTPUTS

The following pages contain noise model outputs, detailing

- Modelling parameters
- Predicted noise levels for each receptor for reference wind speed of 9 m/s at 10m AGL
- Source details
- Propagation Summary for each receptor

Note that the following assumptions have been made throughout:

- Acoustically soft ground
- Air pressure, temperature and humidity setting were chosen to provide the minimum level of atmospheric absorption
- Receiver height of 2.0m
- $L_{A90,10min}$ 2 dB(A) lower than $L_{Aeq,10min}$ which is assumed to be equal to the model output
- Receiver levels were calculated for a single reference wind speed, then adjusted to provide predictions for other wind speeds according to the variation in sound power level with wind speed for the candidate turbine.
- Relative contributions of each 1/3-octave band to broadband sound power level assumed to be consistent throughout wind speed range.

Project description

Project title:	Sheephouse Heights Windfarm
Engineer:	Michael Reid
Customer:	Stephen Brooks, Breeze Energy

Description:

Run description

Calculation:	Grid Noise Map
Title:	layout 20080220 grid map
Run file:	20080220.run
Result number:	3002
Calculation start:	20/02/2008 14:07:47
Calculation end:	20/02/2008 14:08:39
Calculation time [ms]:	45344
No. of points:	56481
No. of calculated points:	56481
Kernel version:	09/11/2007

Run parameters

Angle increment:	2.00 deg
Reflection depth:	0
Number of reflections:	3
Maximal search radius	5000
Weighting:	dB(A)

Source side reflection precalculation enabled

Standards:

Industry:	ISO 9613-2 : 1996	
Air absorption:	ISO 9613	

Using alternative method according to chapter 7.3.2

Limitation of screening loss:

single/multiple	0 dB /0 dB

Environment:

Air pressure	1013.25 mbar
rel. Humidity	70 %
Temperature	10 °C

Meteo. Corr. C0(7-19h)[dB]=0.0; C0(19-23h)[dB]=0.0; C0(23-7h)[dB]=0.0;

VDI-Parameters for diffraction

C1=3 C2=20

Dissection parameters:

Distance to diameter factor	2	
Minimal Distance [m]	1 m	
Max. Difference GND+Diffraction		1 dB

	Max. No. of Iterations	4
Assessment:	ESTU-R-97	
Grid Map:		
Grid space:	25.00 m	
Height above ground:	2.000 m	
Grid Interpolation:		
	Field size =	9x9
	Min/Max =	10.0 dB
	Difference =	0.1 dB
used DGM#9999		

Geometry data

20080220.sit	20/02/2008 10:49:02
- contains:	
calc area 1.geo	15/02/2007 11:55:26
receivers20071214.geo	17/12/2007 09:41:18
5 V90 20080220.geo	20/02/2008 13:59:44
RDGM9999.dgm	16/02/2007 16:50:14
- contains:	
calc area 1.geo	15/02/2007 11:55:26
receivers20071214.geo	17/12/2007 09:41:18
5 V90 20080220.geo	20/02/2008 13:59:44

Source	X	Y	Lw	KI	KT	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1 kHz	1,25 kHz	1,6 kHz	2 kHz	2,5 kHz	3,15 kHz	4 kHz	5 kHz	6,3 kHz	8 kHz	10 kHz
1	424420.0	400772.0	102.8	0	0	88.6	77.1	78.7	81.9	83.3	87.1	86.7	89.9	91.3	90.8	93.1	93.1	93.1	94.4	92.3	89.8	88.3	86.1	83.8	81.8	79.9	76.7	73.7	69.3
2	424836.5	400476.9	102.8	0	0	88.6	77.1	78.7	81.9	83.3	87.1	86.7	89.9	91.3	90.8	93.1	93.1	93.1	94.4	92.3	89.8	88.3	86.1	83.8	81.8	79.9	76.7	73.7	69.3
4	425316.1	400251.7	102.8	0	0	88.6	77.1	78.7	81.9	83.3	87.1	86.7	89.9	91.3	90.8	93.1	93.1	93.1	94.4	92.3	89.8	88.3	86.1	83.8	81.8	79.9	76.7	73.7	69.3
3	425051.9	400308.2	102.8	0	0	88.6	77.1	78.7	81.9	83.3	87.1	86.7	89.9	91.3	90.8	93.1	93.1	93.1	94.4	92.3	89.8	88.3	86.1	83.8	81.8	79.9	76.7	73.7	69.3
5	425586.0	400255.0	102.8	0	0	88.6	77.1	78.7	81.9	83.3	87.1	86.7	89.9	91.3	90.8	93.1	93.1	93.1	94.4	92.3	89.8	88.3	86.1	83.8	81.8	79.9	76.7	73.7	69.3

Legend

Source		Source name
X	m	X-Coordinate
Y	m	Y-Coordinate
Lw	dB(A)	Sound power per unit
KI	dB	Correction for impulsiveness
KT	dB	Correction for tonality
50 Hz	dB(A)	Sound power level 50 Hz
63 Hz	dB(A)	Sound power level 63 Hz
80 Hz	dB(A)	Sound power level 80 Hz
100 Hz	dB(A)	Sound power level 100 Hz
125 Hz	dB(A)	Sound power level 125 Hz
160 Hz	dB(A)	Sound power level 160 Hz
200 Hz	dB(A)	Sound power level 200 Hz
250 Hz	dB(A)	Sound power level 250 Hz
315 Hz	dB(A)	Sound power level 315 Hz
400 Hz	dB(A)	Sound power level 400 Hz
500 Hz	dB(A)	Sound power level 500 Hz
630 Hz	dB(A)	Sound power level 630 Hz
800 Hz	dB(A)	Sound power level 800 Hz
1 kHz	dB(A)	Sound power level 1000 Hz
1,25 kHz	dB(A)	Sound power level 1250 Hz
1,6 kHz	dB(A)	Sound power level 1600 Hz
2 kHz	dB(A)	Sound power level 2000 Hz
2,5 kHz	dB(A)	Sound power level 2500 Hz
3,15 kHz	dB(A)	Sound power level 3150 Hz
4 kHz	dB(A)	Sound power level 4000 Hz
5 kHz	dB(A)	Sound power level 5000 Hz
6,3 kHz	dB(A)	Sound power level 6300 Hz
8 kHz	dB(A)	Sound power level 8000 Hz
10 kHz	dB(A)	Sound power level 10000 Hz

Project description

Project title:	Sheephouse Heights Windfarm
Engineer:	Michael Reid
Customer:	Stephen Brooks, Breeze Energy

Description:

Run description

Calculation:	Single Point Sound
Title:	Layout 20080220 single point
Run file:	20080220.run
Result number:	3001
Calculation start:	27/02/2008 14:45:31
Calculation end:	27/02/2008 14:45:43
Calculation time [ms]:	7797
No. of points:	23
No. of calculated points:	23
Kernel version:	03/08/2007

Run parameters

Angle increment:	1.00 deg
Reflection depth:	0
Number of reflections:	3
Maximal search radius	5000
Weighting:	dB(A)

Source side reflection precalculation enabled

Standards:

Industry:	ISO 9613-2 : 1996	
Air absorption:	ISO 9613	

Using alternative method according to chapter 7.3.2

Limitation of screening loss:

single/multiple	0 dB /0 dB

Environment:

Air pressure	1013.25 mbar
rel. Humidity	70 %
Temperature	10 °C

Meteo. Corr. C0(7-19h)[dB]=0.0; C0(19-23h)[dB]=0.0; C0(23-7h)[dB]=0.0;

VDI-Parameters for diffraction

C1=3 C2=20

Dissection parameters:

Distance to diameter factor	2
Minimal Distance [m]	1 m
Max. Difference GND+Diffraction	1 dB

Max. No. of Iterations	4
Assessment:	ESTU-R-97

Geometry data

RDGM9999.dgm	16/02/2007 16:50:14
20080220.sit	20/02/2008 10:49:02
- contains:	
5 V90 20080220.geo	20/02/2008 13:59:44
calc area 1.geo	15/02/2007 11:55:26
receivers20071214.geo	27/02/2008 14:45:32

Name	X m	Y m	LAeq dB(A)	La90 dB(A)	
Carr Head Farm 1	425821.000	399721.000	38.2	36.2	
Carr Head Farm 2	425869.000	399721.000	37.8	35.8	
Chapel farm	426126.000	400526.000	37.0	35.0	
Cliff House	424543.000	401412.000	36.3	34.3	
Cloth Hall Farm	426126.000	400612.000	36.3	34.3	
Cranberry	424757.000	400806.000	45.8	43.8	
Dyson Cote 1	425815.000	400470.000	44.4	42.4	
Dyson Cote 2	425828.000	400497.000	43.3	41.3	
Dyson Cote 3	425845.000	400529.000	42.3	40.3	
High Walls	426109.000	400580.000	36.8	34.8	
House at Doubting	423784.000	400907.000	35.5	33.5	
Judd Field Farm	423895.000	400716.000	37.7	35.7	
Millbrook House	424791.000	401252.000	37.8	35.8	
Mossley House	424290.000	400960.000	46.5	44.5	
New Farmhouse 2	423998.000	399949.000	34.1	32.1	
Salter Hill House	425515.000	400789.000	40.6	38.6	
Sheephouse 1	424550.000	400340.000	45.2	43.2	
Sheephouse 2	424430.000	400385.000	43.6	41.6	
Tenter House	426238.000	400529.000	35.3	33.3	
Tenter House Farm	426193.000	400583.000	35.6	33.6	
Throstle's Nest	425145.000	400744.000	44.0	42.0	
Underbank Hall 1	425548.000	399683.000	39.5	37.5	
Underwood Hall 2	425584.000	399652.000	38.7	36.7	

Source	SrcType	Lw dB(A)	Lw' dB(A)	KI dB	KT dB	Ko dB	s m	Adiv dB	Agr dB	Amisc dB	Abar dB	Aatm dB	DI dB	Re dB(A)	Ls dB(A)	LAeq dB(A)	La90 dB(A)
Name Carr Head Farm 1	X 425821.000 m	Y 399721.000 m	LAeq 38.2 dB(A)	La90 36.2 dB(A)													
1	Point	102.8	102.8	0	0	3.0	1757.	75.9	3.9		0.0	4.1	0.0		21.9	21.9	19.9
2	Point	102.8	102.8	0	0	3.0	1248.	72.9	3.4		0.0	3.2	0.0		26.3	26.3	24.3
4	Point	102.8	102.8	0	0	3.0	739.9	68.4	2.8		0.0	2.1	0.0		32.6	32.6	30.6
3	Point	102.8	102.8	0	0	3.0	974.1	70.8	3.1		0.0	2.6	0.0		29.3	29.3	27.3
5	Point	102.8	102.8	0	0	3.0	595.5	66.5	2.3		0.0	1.7	0.0		35.3	35.3	33.3
Name Carr Head Farm 2	X 425869.000 m	Y 399721.000 m	LAeq 37.8 dB(A)	La90 35.8 dB(A)													
1	Point	102.8	102.8	0	0	3.0	1796.	76.1	3.9		0.0	4.2	0.0		21.7	21.7	19.7
2	Point	102.8	102.8	0	0	3.0	1285.	73.2	3.4		0.0	3.2	0.0		26.0	26.0	24.0
4	Point	102.8	102.8	0	0	3.0	772.9	68.8	2.8		0.0	2.2	0.0		32.1	32.1	30.1
3	Point	102.8	102.8	0	0	3.0	1012.	71.1	3.1		0.0	2.7	0.0		28.9	28.9	26.9
5	Point	102.8	102.8	0	0	3.0	615.2	66.8	2.3		0.0	1.8	0.0		34.9	34.9	32.9
Name Chapel farm	X 426126.000 m	Y 400526.000 m	LAeq 37.0 dB(A)	La90 35.0 dB(A)													
1	Point	102.8	102.8	0	0	3.0	1726.	75.7	3.9		0.0	4.1	0.0		22.1	22.1	20.1
2	Point	102.8	102.8	0	0	3.0	1292.	73.2	3.7		0.0	3.2	0.0		25.6	25.6	23.6
4	Point	102.8	102.8	0	0	3.0	856.4	69.6	3.5		0.0	2.3	0.0		30.3	30.3	28.3
3	Point	102.8	102.8	0	0	3.0	1097.	71.8	3.7		0.0	2.9	0.0		27.5	27.5	25.5
5	Point	102.8	102.8	0	0	3.0	607.5	66.7	2.8		0.0	1.8	0.0		34.5	34.5	32.5
Name Cliff House	X 424543.000 m	Y 401412.000 m	LAeq 36.3 dB(A)	La90 34.3 dB(A)													
1	Point	102.8	102.8	0	0	3.0	660.5	67.4	2.4		0.0	1.9	0.0		34.1	34.1	32.1
2	Point	102.8	102.8	0	0	3.0	984.0	70.9	3.5		0.0	2.6	0.0		28.8	28.8	26.8
4	Point	102.8	102.8	0	0	3.0	1395.	73.9	4.1		0.0	3.4	0.0		24.4	24.4	22.4
3	Point	102.8	102.8	0	0	3.0	1217.	72.7	3.9		0.0	3.1	0.0		26.1	26.1	24.1
5	Point	102.8	102.8	0	0	3.0	1559.	74.9	4.0		0.0	3.8	0.0		23.2	23.2	21.2

Source	SrcType	Lw dB(A)	Lw' dB(A)	KI dB	KT dB	Ko dB	s m	Adiv dB	Agr dB	Amisc dB	Abar dB	Aatm dB	DI dB	Re dB(A)	Ls dB(A)	LAeq dB(A)	La90 dB(A)
Name Cloth Hall Farm	X 426126.000 m	Y 400612.000 m	LAeq 36.3 dB(A)	La90 34.3 dB(A)													
1	Point	102.8	102.8	0	0	3.0	1716.	75.7	4.0		0.0	4.0	0.0		22.1	22.1	20.1
2	Point	102.8	102.8	0	0	3.0	1299.	73.3	3.8		0.0	3.3	0.0		25.5	25.5	23.5
4	Point	102.8	102.8	0	0	3.0	888.1	70.0	3.7		0.0	2.4	0.0		29.7	29.7	27.7
3	Point	102.8	102.8	0	0	3.0	1118.	72.0	3.8		0.0	2.9	0.0		27.1	27.1	25.1
5	Point	102.8	102.8	0	0	3.0	651.1	67.3	3.1		0.0	1.9	0.0		33.6	33.6	31.6
Name Cranberry	X 424757.000 m	Y 400806.000 m	LAeq 45.8 dB(A)	La90 43.8 dB(A)													
1	Point	102.8	102.8	0	0	3.0	350.1	61.9	0.7		0.0	1.1	0.0		42.1	42.1	40.1
2	Point	102.8	102.8	0	0	3.0	345.5	61.8	0.8		0.0	1.1	0.0		42.1	42.1	40.1
4	Point	102.8	102.8	0	0	3.0	788.3	68.9	3.3		0.0	2.2	0.0		31.4	31.4	29.4
3	Point	102.8	102.8	0	0	3.0	580.7	66.3	2.6		0.0	1.7	0.0		35.2	35.2	33.2
5	Point	102.8	102.8	0	0	3.0	997.0	71.0	3.4		0.0	2.6	0.0		28.8	28.8	26.8
Name Dyson Cote 1	X 425815.000 m	Y 400470.000 m	LAeq 44.4 dB(A)	La90 42.4 dB(A)													
1	Point	102.8	102.8	0	0	3.0	1430.	74.1	3.7		0.0	3.5	0.0		24.5	24.5	22.5
2	Point	102.8	102.8	0	0	3.0	981.1	70.8	3.3		0.0	2.6	0.0		29.1	29.1	27.1
4	Point	102.8	102.8	0	0	3.0	546.3	65.7	2.4		0.0	1.6	0.0		36.1	36.1	34.1
3	Point	102.8	102.8	0	0	3.0	781.8	68.9	3.0		0.0	2.2	0.0		31.8	31.8	29.8
5	Point	102.8	102.8	0	0	3.0	319.7	61.1	0.5		0.0	1.0	0.0		43.2	43.2	41.2
Name Dyson Cote 2	X 425828.000 m	Y 400497.000 m	LAeq 43.3 dB(A)	La90 41.3 dB(A)													
1	Point	102.8	102.8	0	0	3.0	1437.	74.1	3.7		0.0	3.5	0.0		24.4	24.4	22.4
2	Point	102.8	102.8	0	0	3.0	994.2	70.9	3.3		0.0	2.6	0.0		28.9	28.9	26.9
4	Point	102.8	102.8	0	0	3.0	569.3	66.1	2.5		0.0	1.7	0.0		35.5	35.5	33.5
3	Point	102.8	102.8	0	0	3.0	800.4	69.1	3.1		0.0	2.2	0.0		31.4	31.4	29.4
5	Point	102.8	102.8	0	0	3.0	347.4	61.8	0.9		0.0	1.1	0.0		41.9	41.9	39.9

Source	SrcType	Lw dB(A)	Lw' dB(A)	KI dB	KT dB	Ko dB	s m	Adiv dB	Agr dB	Amisc dB	Abar dB	Aatm dB	DI dB	Re dB(A)	Ls dB(A)	LAeq dB(A)	La90 dB(A)
Name Dyson Cote 3	X 425845.000 m	Y 400529.000 m	LAeq 42.3 dB(A)	La90 40.3 dB(A)													
1	Point	102.8	102.8	0	0	3.0	1448.	74.2	3.7		0.0	3.5	0.0		24.3	24.3	22.3
2	Point	102.8	102.8	0	0	3.0	1012.	71.1	3.3		0.0	2.7	0.0		28.7	28.7	26.7
4	Point	102.8	102.8	0	0	3.0	598.7	66.5	2.7		0.0	1.7	0.0		34.8	34.8	32.8
3	Point	102.8	102.8	0	0	3.0	824.9	69.3	3.2		0.0	2.3	0.0		31.0	31.0	29.0
5	Point	102.8	102.8	0	0	3.0	381.7	62.6	1.4		0.0	1.2	0.0		40.6	40.6	38.6
Name High Walls	X 426109.000 m	Y 400580.000 m	LAeq 36.8 dB(A)	La90 34.8 dB(A)													
1	Point	102.8	102.8	0	0	3.0	1702.	75.6	3.9		0.0	4.0	0.0		22.2	22.2	20.2
2	Point	102.8	102.8	0	0	3.0	1279.	73.1	3.8		0.0	3.2	0.0		25.7	25.7	23.7
4	Point	102.8	102.8	0	0	3.0	859.7	69.7	3.6		0.0	2.4	0.0		30.2	30.2	28.2
3	Point	102.8	102.8	0	0	3.0	1093.	71.8	3.8		0.0	2.8	0.0		27.4	27.4	25.4
5	Point	102.8	102.8	0	0	3.0	619.5	66.8	3.0		0.0	1.8	0.0		34.2	34.2	32.2
Name House at Doubting	X 423784.000 m	Y 400907.000 m	LAeq 35.5 dB(A)	La90 33.5 dB(A)													
1	Point	102.8	102.8	0	0	3.0	654.1	67.3	2.7		0.0	1.9	0.0		33.9	33.9	31.9
2	Point	102.8	102.8	0	0	3.0	1138.	72.1	3.7		0.0	2.9	0.0		27.0	27.0	25.0
4	Point	102.8	102.8	0	0	3.0	1666.	75.4	4.2		0.0	3.9	0.0		22.3	22.3	20.3
3	Point	102.8	102.8	0	0	3.0	1402.	73.9	4.0		0.0	3.5	0.0		24.4	24.4	22.4
5	Point	102.8	102.8	0	0	3.0	1916.	76.6	4.1		0.0	4.4	0.0		20.7	20.7	18.7
Name Judd Field Farm	X 423895.000 m	Y 400716.000 m	LAeq 37.7 dB(A)	La90 35.7 dB(A)													
1	Point	102.8	102.8	0	0	3.0	533.0	65.5	2.4		0.0	1.6	0.0		36.3	36.3	34.3
2	Point	102.8	102.8	0	0	3.0	972.9	70.8	3.5		0.0	2.6	0.0		29.0	29.0	27.0
4	Point	102.8	102.8	0	0	3.0	1495.	74.5	4.0		0.0	3.6	0.0		23.7	23.7	21.7
3	Point	102.8	102.8	0	0	3.0	1227.	72.8	3.7		0.0	3.1	0.0		26.2	26.2	24.2
5	Point	102.8	102.8	0	0	3.0	1753.	75.9	3.9		0.0	4.1	0.0		21.9	21.9	19.9

Source	SrcType	Lw dB(A)	Lw' dB(A)	KI dB	KT dB	Ko dB	s m	Adiv dB	Agr dB	Amisc dB	Abar dB	Aatm dB	DI dB	Re dB(A)	Ls dB(A)	LAeq dB(A)	La90 dB(A)
Name Millbrook House	X 424791.000 m	Y 401252.000 m	LAeq 37.8 dB(A)	La90 35.8 dB(A)													
1	Point	102.8	102.8	0	0	3.0	617.2	66.8	2.4		0.0	1.8	0.0		34.8	34.8	32.8
2	Point	102.8	102.8	0	0	3.0	782.1	68.9	3.3		0.0	2.2	0.0		31.5	31.5	29.5
4	Point	102.8	102.8	0	0	3.0	1131.	72.1	4.1		0.0	2.9	0.0		26.8	26.8	24.8
3	Point	102.8	102.8	0	0	3.0	982.0	70.8	3.8		0.0	2.6	0.0		28.5	28.5	26.5
5	Point	102.8	102.8	0	0	3.0	1277.	73.1	4.0		0.0	3.2	0.0		25.5	25.5	23.5
Name Mossley House	X 424290.000 m	Y 400960.000 m	LAeq 46.5 dB(A)	La90 44.5 dB(A)													
1	Point	102.8	102.8	0	0	3.0	244.4	58.8	0.0		0.0	0.8	0.0		46.2	46.2	44.2
2	Point	102.8	102.8	0	0	3.0	732.5	68.3	3.1		0.0	2.1	0.0		32.3	32.3	30.3
4	Point	102.8	102.8	0	0	3.0	1247.	72.9	4.0		0.0	3.2	0.0		25.8	25.8	23.8
3	Point	102.8	102.8	0	0	3.0	1003.	71.0	3.7		0.0	2.7	0.0		28.4	28.4	26.4
5	Point	102.8	102.8	0	0	3.0	1476.	74.4	3.9		0.0	3.6	0.0		23.9	23.9	21.9
Name New Farmhouse 2	X 423998.000 m	Y 399949.000 m	LAeq 34.1 dB(A)	La90 32.1 dB(A)													
1	Point	102.8	102.8	0	0	3.0	940.6	70.5	3.6		0.0	2.5	0.0		29.2	29.2	27.2
2	Point	102.8	102.8	0	0	3.0	1002.	71.0	3.6		0.0	2.7	0.0		28.6	28.6	26.6
4	Point	102.8	102.8	0	0	3.0	1358.	73.7	3.9		0.0	3.4	0.0		24.9	24.9	22.9
3	Point	102.8	102.8	0	0	3.0	1121.	72.0	3.8		0.0	2.9	0.0		27.2	27.2	25.2
5	Point	102.8	102.8	0	0	3.0	1623.	75.2	3.9		0.0	3.9	0.0		22.8	22.8	20.8
Name Salter Hill House	X 425515.000 m	Y 400789.000 m	LAeq 40.6 dB(A)	La90 38.6 dB(A)													
1	Point	102.8	102.8	0	0	3.0	1099.	71.8	3.4		0.0	2.9	0.0		27.7	27.7	25.7
2	Point	102.8	102.8	0	0	3.0	750.8	68.5	3.0		0.0	2.1	0.0		32.2	32.2	30.2
4	Point	102.8	102.8	0	0	3.0	575.0	66.2	3.0		0.0	1.7	0.0		35.0	35.0	33.0
3	Point	102.8	102.8	0	0	3.0	670.1	67.5	3.1		0.0	1.9	0.0		33.3	33.3	31.3
5	Point	102.8	102.8	0	0	3.0	542.6	65.7	2.6		0.0	1.6	0.0		35.9	35.9	33.9

Source	SrcType	Lw dB(A)	Lw' dB(A)	KI dB	KT dB	Ko dB	s m	Adiv dB	Agr dB	Amisc dB	Abar dB	Aatm dB	DI dB	Re dB(A)	Ls dB(A)	LAeq dB(A)	La90 dB(A)
Name Sheephouse 1	X 424550.000 m	Y 400340.000 m	LAeq 45.2 dB(A)	La90 43.2 dB(A)													
1	Point	102.8	102.8	0	0	3.0	464.2	64.3	1.9		0.0	1.4	0.0		38.2	38.2	36.2
2	Point	102.8	102.8	0	0	3.0	330.1	61.4	0.5		0.0	1.1	0.0		42.8	42.8	40.8
4	Point	102.8	102.8	0	0	3.0	773.6	68.8	3.1		0.0	2.2	0.0		31.7	31.7	29.7
3	Point	102.8	102.8	0	0	3.0	507.9	65.1	2.3		0.0	1.5	0.0		36.9	36.9	34.9
5	Point	102.8	102.8	0	0	3.0	1042.	71.4	3.3		0.0	2.7	0.0		28.4	28.4	26.4
Name Sheephouse 2	X 424430.000 m	Y 400385.000 m	LAeq 43.6 dB(A)	La90 41.6 dB(A)													
1	Point	102.8	102.8	0	0	3.0	402.0	63.1	1.5		0.0	1.3	0.0		40.0	40.0	38.0
2	Point	102.8	102.8	0	0	3.0	426.3	63.6	1.5		0.0	1.3	0.0		39.4	39.4	37.4
4	Point	102.8	102.8	0	0	3.0	898.1	70.1	3.4		0.0	2.4	0.0		29.9	29.9	27.9
3	Point	102.8	102.8	0	0	3.0	630.5	67.0	2.8		0.0	1.8	0.0		34.2	34.2	32.2
5	Point	102.8	102.8	0	0	3.0	1165.	72.3	3.5		0.0	3.0	0.0		27.0	27.0	25.0
Name Tenter House	X 426238.000 m	Y 400529.000 m	LAeq 35.3 dB(A)	La90 33.3 dB(A)													
1	Point	102.8	102.8	0	0	3.0	1836.	76.3	4.0		0.0	4.2	0.0		21.3	21.3	19.3
2	Point	102.8	102.8	0	0	3.0	1404.	73.9	3.9		0.0	3.5	0.0		24.5	24.5	22.5
4	Point	102.8	102.8	0	0	3.0	964.0	70.7	3.7		0.0	2.6	0.0		28.8	28.8	26.8
3	Point	102.8	102.8	0	0	3.0	1207.	72.6	3.8		0.0	3.1	0.0		26.3	26.3	24.3
5	Point	102.8	102.8	0	0	3.0	710.4	68.0	3.2		0.0	2.0	0.0		32.6	32.6	30.6
Name Tenter House Farm	X 426193.000 m	Y 400583.000 m	LAeq 35.6 dB(A)	La90 33.6 dB(A)													
1	Point	102.8	102.8	0	0	3.0	1785.	76.0	4.0		0.0	4.2	0.0		21.6	21.6	19.6
2	Point	102.8	102.8	0	0	3.0	1363.	73.7	3.8		0.0	3.4	0.0		24.9	24.9	22.9
4	Point	102.8	102.8	0	0	3.0	938.9	70.4	3.7		0.0	2.5	0.0		29.1	29.1	27.1
3	Point	102.8	102.8	0	0	3.0	1175.	72.4	3.8		0.0	3.0	0.0		26.6	26.6	24.6
5	Point	102.8	102.8	0	0	3.0	693.4	67.8	3.2		0.0	2.0	0.0		32.8	32.8	30.8

Source	SrcType	Lw dB(A)	Lw' dB(A)	KI dB	KT dB	Ko dB	s m	Adiv dB	Agr dB	Amisc dB	Abar dB	Aatm dB	DI dB	Re dB(A)	Ls dB(A)	LAeq dB(A)	La90 dB(A)
Name Throstle's Nest	X 425145.000 m	Y 400744.000 m	LAeq 44.0 dB(A)	La90 42.0 dB(A)													
1	Point	102.8	102.8	0	0	3.0	731.4	68.3	2.8		0.0	2.1	0.0		32.7	32.7	30.7
2	Point	102.8	102.8	0	0	3.0	414.5	63.3	1.3		0.0	1.3	0.0		39.9	39.9	37.9
4	Point	102.8	102.8	0	0	3.0	523.0	65.4	2.5		0.0	1.6	0.0		36.3	36.3	34.3
3	Point	102.8	102.8	0	0	3.0	448.8	64.0	1.9		0.0	1.4	0.0		38.5	38.5	36.5
5	Point	102.8	102.8	0	0	3.0	661.2	67.4	2.8		0.0	1.9	0.0		33.7	33.7	31.7
Name Underbank Hall 1	X 425548.000 m	Y 399683.000 m	LAeq 39.5 dB(A)	La90 37.5 dB(A)													
1	Point	102.8	102.8	0	0	3.0	1576.	74.9	3.8		0.0	3.8	0.0		23.2	23.2	21.2
2	Point	102.8	102.8	0	0	3.0	1075.	71.6	3.2		0.0	2.8	0.0		28.1	28.1	26.1
4	Point	102.8	102.8	0	0	3.0	624.7	66.9	2.4		0.0	1.8	0.0		34.7	34.7	32.7
3	Point	102.8	102.8	0	0	3.0	807.5	69.1	2.8		0.0	2.2	0.0		31.6	31.6	29.6
5	Point	102.8	102.8	0	0	3.0	587.7	66.4	2.2		0.0	1.7	0.0		35.5	35.5	33.5
Name Underwood Hall 2	X 425584.000 m	Y 399652.000 m	LAeq 38.7 dB(A)	La90 36.7 dB(A)													
1	Point	102.8	102.8	0	0	3.0	1623.	75.2	3.9		0.0	3.9	0.0		22.8	22.8	20.8
2	Point	102.8	102.8	0	0	3.0	1122.	72.0	3.4		0.0	2.9	0.0		27.5	27.5	25.5
4	Point	102.8	102.8	0	0	3.0	667.6	67.5	2.7		0.0	1.9	0.0		33.7	33.7	31.7
3	Point	102.8	102.8	0	0	3.0	854.5	69.6	3.0		0.0	2.3	0.0		30.9	30.9	28.9
5	Point	102.8	102.8	0	0	3.0	617.9	66.8	2.4		0.0	1.8	0.0		34.8	34.8	32.8

Legend

Source		Source name
SrcType		Type of source (point, line, area)
Lw	dB(A)	Sound power per unit
Lw'	dB(A)	Sound power per m,m²
KI	*dB*	*Correction for impulsiveness*
KT	dB	Correction for tonality
Ko	dB	Correction for non spherical emission
s	m	Distance source - receiver
Adiv	dB	Mean spreading loss
Agr	dB	Mean ground effect
Amisc	*dB*	*Miscellaneous losses (mitigation, ...)*
Abar	dB	Mean barrier loss
Aatm	dB	Mean air absorption loss
DI	dB	Directivity correction
Re	dB(A)	Reflection part
Ls	dB(A)	Unassessed sound pressure at receiver
LAeq	dB(A)	LAeq
La90	dB(A)	LA90

12. EXISTING INFRASTRUCTURE TECHNICAL APPENDIX

INTRODUCTION

This appendix contains information relating to microwave, television and radio communication studies conducted by Pager Power.

12.1 TELEVISION IMPACT ASSESSMENT

The following pages contain the Television Impact Assessment, conducted by Pager Power in August 2007.

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Arcus

Sheephouse Heights Wind Farm

Television Impact Assessment
BBC Emley Moor, Millhouse Green and Stocksbridge Transmitters

Stephen Donoghue BSc AMInstP

10 August 2007

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Television Impact Assessment

Sheephouse Heights

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Glossary

agl	- Above ground level,
amsl	- Above mean sea level, effectively the same as AOD.
Blocking point	- The piece of land that physically prevents or limits television or radio coverage
CIR	- Carrier to Interference Ratio (due to wind turbines)
dB	- decibel
DTM	- Digital Terrain Model
FSPL	- Free Space Path Loss
ft	- Feet
G	- Grid (e.g., grid north)
Ha	- Hectares
IGR	- Irish Grid Reference
ING	- Irish National Grid
ITU	- International Telecommunications Union
k	- Refraction constant, typically 4/3 (i.e., 1.33), the correction factor used on the Earth's circumference to account for radio horizon in models.
km	- Kilometres.
LOS	- Line-of-Sight
m	- Metres.
N	- Measure of refractivity, hence *N*/km.
NI	- Northern Ireland
nm	- Nautical miles
OSNI	- Ordnance Survey of Northern Ireland
RCS	- Radar Cross Section
ROI	- Republic of Ireland
SRTM	- Shuttle Radar Topography Mission
TV	- Television
UHF	- Ultra High Frequency
UK	- United Kingdom
VHF	- Very High Frequency
WGS 84	- World Geodetic Survey of 1984, an international mapping standard.
X	- Denotes horizontal left to right axis, or eastings axis.
Y	- Denotes horizontal up and down axis, or northings axis.
Z	- Denotes vertical axis, or height axis.

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Introduction

The Arcus, Sheephouse Heights development is to be situated approximately 15KM Northeast of Sheffield, South Yorkshire. The turbines are expected to have tower height of 80m, blade length of 45m and a tip height of 125m.

UK Terrestrial Television services are provided from transmitters operated by either Five or the BBC. In many cases five use the same transmitters as the BBC.

It is known that wind turbines can interfere with television and other radio systems. The rotating blades scatter and reflect radio signals causing interference. Unacceptable interference does not occur at all receivers, however, the likelihood of interference depends on overall geometry and terrain features.

The wind farm developer has a requirement to better understand where interference is likely so as to assist in assessing the requirement for mitigation solutions at affected homes.

A number of papers have been written on the subject of wind farms and radio interference and a number of computer models have been developed. There was no comprehensive computer modelling tool generally available to predict areas of interference from complex wind farms.

Pager Power has enhanced its existing Sight Lines radio and radar modelling tool to enable these effects to be assessed. The potential Sheephouse Heights development has been assessed with respect to the BBC transmitters at Emley Moor, Millhouse Green and Stocksbridge.

Emley Moor Transmitter

Emley Moor is one of the main television transmitters in the UK and with Belmont is one of the two main transmitters in the BBC North region. It is located on approximately 8KM South East of Huddersfield in West Yorkshire.

Services

The transmitter is horizontally polarized and transmits at 100KW. The transmitter broadcasts BBC1, BBC2, ITV1, Channel4 and Five to Sheffield, South and West Yorkshire. Below are the services and channels transmitted from Emley Moor.

Emley Moor Transmitter

BBC1	BBC2	ITV	Ch4	Five
44	51	47	41	37

Location and Height

The transmitter aerials are 309 metres above ground height – the site height is 258m above ordnance datum (aod). The published national grid coordinates are SE222128

Millhouse Green Transmitter

Millhouse Green is one of approximately fifty television transmitters slaved to Emley Moor in the BBC North region. It is located on approximately 1KM West of Penistone in South Yorkshire. Millhouse Green is used to fill a small gap in the Emley Moor coverage area.

Services

The transmitter is vertically polarized and transmits at 10W. The transmitter broadcasts BBC1, BBC2, ITV1 and Channel4 to the Penistone, Millhouse Green and Thurlstone areas. Below are the services and channels transmitted from Millhouse Green.

Millhouse Green Transmitter				
BBC1	BBC2	ITV	Ch4	Five
58	64	61	54	n/a

Location and Height

The transmitter aerials are 20 metres above ground height – the site height is 287m above ordnance datum (aod). The published national grid coordinates are SE229028

Stocksbridge Transmitter

Stocksbridge is one of approximately fifty television transmitters slaved to Emley Moor in the BBC North region. It is located on approximately 0.5KM North of Stocksbridge in South Yorkshire. Stocksbridge is used to fill a small gap in the Emley Moor coverage area.

Services

The transmitter is vertically polarized and transmits at 12W. The transmitter broadcasts BBC1, BBC2, ITV1 and Channel4 to the Stocksbridge and Deepcar area. Below are the services and channels transmitted from Stocksbridge.

Stocksbridge Transmitter

BBC1	BBC2	ITV	Ch4	Five
58	64	61	54	n/a

Location and Height

The transmitter aerials are 34 metres above ground height – the site height is 288m above ordnance datum (aod). The published national grid coordinates are SK275991

Proposed Wind Farm

Background

The proposed Sheephouse Heights wind farm comprises 5 turbines. The turbines are to be sited at the below British National Grid coordinates.

Turbine	Easting	Northing	Altitude
1	424385	400721	317
2	424693	400545	303
3	424965	400451	291
4	425287	400318	277
5	425634	400170	276

Wind Turbines

The turbines are expected to have a maximum tower height of 80m and maximum tip height of 125m.

The following dimensions have been used for calculation purposes:

Blade Width: 2 metres
Blade Area: 50 square meters

Television Analysis – General Principles

Television Interference

Terrestrial television signals propagate from transmitters to receiving aerials which in turn are connected to television receiving equipment. Transmissions are in the UHF frequency range and may be either analogue or digital. Television channels have a bandwidth of 8 MHz.

When considering interference from buildings or wind farms it is usual to consider direct signals – those that pass from transmitter to receiver in a straight line and reflected, or indirect, signals. The reflected signal goes from transmitter to turbine (or building) to receiver.

Standard receiving aerials are directional meaning that signals from the transmitter direction are amplified and signals from the sides and rear of the aerial are attenuated.

Carrier to Interference Ratio

The likelihood of television interference is therefore determined by considering the strength of the direct, or carrier, signal in comparison to the reflected, or interfering, signal. The Carrier to Interference Ratio quantifies the relative strength of the direct and reflected signals.

A high Carrier to Interference ratio means interference is less likely. A low Carrier to Interference ratio means that interference is more likely. CI Ratio is normally expressed in decibels (dB).

Free Space Path Loss

Radio signals weaken over distance. The closer a receiver is to a transmitter the stronger its received signal will be. This reduction in signal strength due to separation distance is referred to a Free Space Path Loss (FSPL).

Radio Propagation by Diffraction

A radio signal may travel between two points, even when no direct line of sight exists between those two points. This is because radio energy travels as waves rather than as a direct ray. When no direct line of sight exists between the two points the signal is considerably weakened. This weakening is known as a diffraction loss.

International Telecommunications Union (ITU) Recommendation ITU-R P526-7 describes a method for calculating diffraction losses over regular terrain.

Total radio path loss for a specific path is determined by adding Free Space Path Loss to Diffraction Loss.

Radar Cross Section

The size of the interfering signal is dependent on the amount of energy that is reflected from the wind turbine. This reflective quality is known as the Radar Cross Section and can be expressed in metres squared or in dBm^2.

A lot of work has been carried out to help determine wind turbine RCS by various parties although little work has been carried out at UHF frequencies. Values cited typically vary between 25 and 300 m^2 with instantaneous peaks reaching 3000 m^2 for a single wind turbine.

The moving and static parts of the turbine are often considered separately.

Nature of Television Interference from wind turbines

Determining whether a television picture is impaired by wind turbines or whether the impairment is significant enough to cause picture quality to become unacceptable is considered a subjective matter. The level of effect is determined by looking at the picture when the turbine is operating.

There is a subjective system for grading television picture impairment with grades from 5 down to 1 described in ITU-R 500. The impairments are shown in the table below:

Impairment Grade	Description
5	Imperceptible
4	Perceptible, but not annoying
3	Slightly annoying
2	Annoying
1	Very Annoying

Where interference is marked it is generally clear that it is being caused by wind turbines. The picture regularly distorts with a time base matching the passing of turbine blades. This means that it is fairly easy to determine whether a viewer's interference problem is related to a wind turbine.

Conditions for Wind Turbine Interference

Simplistically the television picture is likely to be unacceptably affected by wind turbine interference when the CI Ratio is low. In practice interference is most noticeable when some or all of the following conditions are satisfied:

1. Received signal strength is weak and/or
2. The direct signal path between transmitter and receiver is physically obscured.
3. There is a clear signal path between transmitter and wind turbine.
4. There is a clear signal path between wind turbine and receiver.
5. The wind turbine lies directly between the transmitter and receiver.

Field observations

Observations of television interference from wind turbines normally occur when:

- Terrain is hilly and the turbines are on high ground
- Received signal is weak
- Turbine is directly between transmitter and receiver

Published Works

A number of documents relate to the interference effects of wind turbines on television and radio systems. These include:

1. BBC, **The impact of large buildings and structures (including wind farms) on terrestrial televisions reception**

2. International Telecommunications Union, **Assessment of impairment caused to television reception by a wind turbine**, Recommendation ITU-R BT805*, 1992

3. Bacon, DF, **A proposed method for establishing an exclusion zone around a terrestrial fixed radio link outside of which a wind turbine will cause negligible degradation of the radio link performance**, Radio Communications Agency, 2002

4. Hall, SH, **The assessment and avoidance of electromagnetic interference due to wind farms**, Wind Engineering Vol 16 No 6, 1992

5. Dabis, HS, **The provision of guidelines for the installation of wind turbines near aeronautical radio stations**, Civil Aviation Authority, CAA Paper 99002, 1999

6. ETSU, **Feasibility of mitigating the effects of wind farms on primary radar**, ETSU W/14/00623/REP, 2003

7. Dabis, HS, **The establishment of guidelines for the installation of wind turbines near radio systems**, Proceedings of the eighteenth BWEA Wind Energy Conference, 1996

8. FES, **Wind farms impact on aviation interests – final report**, FES W/16/00614/00/REP, 2003

9. S Vila-Moreno, **A Methodology to Assess Interference to TV Reception due to Wind Farms**, RES, 2005

The two Dabis papers describe a method for determining the likely interference from a wind turbine based on it behaving like a reflector. This methodology is generally used for interference predictions. The methodology in these papers does not address a significant increase in the level of interference observed when the wind turbine is on the direct path between transmitter and receiver and a method for accounting for multiple wind turbines is not provided.

The ITU-R BT805 paper is quite useful and applies to a single wind turbine. It suggests:

- A CIR in excess of 28-34 dB is required to attain an analogue picture quality having impairment grade 4 or above.
- Interference levels directly behind the turbine are 10dB higher than interference levels to the side of the turbine.
- Interference levels in flat terrain are unlikely at distances of more than 500m from the wind turbine site.
- Investigation of interference levels is not required at distances of more than 5km from the site.
- The paper refers to the ratio of the wanted signal to the unwanted signal which the Dabis papers refer to as CI Ratio. This document uses the term CI Ratio or CIR.

Radar studies have shown that reflected or scattered signals are much stronger immediately beyond the turbine. This is normally accounted for by using a higher RCS for scenarios where the turbine lies between transmitter and receiver.

The RES document describes a similar approach but includes a method for accounting for the effects of multiple wind turbines by summing the unwanted reflected signals (absolute not decibel). The RES document also suggests:

- a study area of 20km x 20km centred on the wind farm
- allowing for a standard antenna characteristic
- summing unwanted signals directly
- a CIR threshold of 10db – Interference being likely when CIR is less than 10dB

Pager Power Approach

A number of the above approaches have been modelled together with some additional factors such as:

- Triplicate calculations accounting for tip, hub and rotor bottom.
- Increasing turbine Radar Cross Section when receiver falls directly beyond wind turbine and adjusting according to the degree by which the radio path is broken.
- Accounting for actual field strength
- Calculating interference in accordance with the Dabis Method
- Calculating interference in accordance with the ITU method

Following assessment by these various methods the following conclusions have been drawn:

- Although it is true that wind farm interference appears more likely when the received signal is weak there is no direct relationship between signal strength and observed picture interference.
- Observed picture interference is directly related to the CI Ratio.
- The ITU-R BT805 method appears to be significantly more accurate than the Dabis method for assessing observed interference.
- Summing of unwanted signals from each turbine to determine a total unwanted signal level appears to be reasonably accurate.
- The CIR threshold of 10dB cited by RES appears to be reasonable – it is certainly true that the threshold of 28-34 cited by BT805 is too high when

using this method. Observations on a 32 wind turbine development suggest that a threshold of 15 may be more reasonable in this case.

- Carrying out assessment at hub height appears to be fairly representative – however there can be significant differences in CI Ratio. In an example with no direct line of sight between transmitter and receiver the CI Ratio varies by 31dB between the top and bottom of the rotor. This is a large variation and should be considered or accounted for.

It was concluded therefore that triplicate calculations at tip, hub and rotor base should be considered. The principals of this calculation are as follows:

- The interference signal calculation should be carried out three times for each turbine – at tip, hub and rotor base.
- A weighted average of the three unwanted interference signal levels is made (of absolute levels not decibel levels).
- A signal passing through the turbine at hub height is clearly going to be affected much more than one passing through the tip or rotor base so an increased weighting should be applied to the hub signal.
- The weighting applied to rotor tip and rotor base should be identical as the proportion of the signal passing through the rotor is identical at both heights.
- A geometric calculation suggested the following weightings be used for averaging:

Turbine Part	Weighting (%)
Tip	19.55
Hub	60.9
Rotor Bottom	19.55

- The following rounded values have therefore been used for calculation purposes.

Turbine Part	Weighting (%)
Tip	20
Hub	60
Rotor Bottom	20

Pager Power Assessment Methodology

Having considered the various published works, exploring knowledge of real interference caused by wind farms, and modelling interference in various ways Pager Power has developed an effective modelling method for mapping likely television interference from wind farms. The process involves the following stages:

1. Acquire terrain data in digital format
2. Determine the following for modelling
    a. Transmitter location and height
    b. Turbine locations and hub height
    c. Single Blade Area
    d. Blade Width for modelling purposes
    e. Television signal wavelength for modelling purposes
    f. Area of interest for interference modelling – this will be a rectangular area defined by top-right and bottom-left coordinate pair
    g. Determine sample point spacing for modelling purposes – this is currently a fixed value for the entire area
    h. Determine receiver aerial height for modelling purposes
3. Calculating coordinates of each Receiver Sample Point in the area of interest
4. Calculating Free Space Path Losses for the following paths:
    - Transmitter to each Wind Turbine FSPL_TW
    - Transmitter to each Receiver Sample Point FSPL_TR
    - Each Wind Turbine to each Receiver Sample Point FSPL_WR
5. Building electronic terrain profile for each of the above paths. The number of points in the profile is determined dynamically based on the source terrain data resolution and the particular path length.
6. Determining additional diffraction losses for each of the above paths using ITU-R 526 method. These losses are DL_TW, DL_TR and DL_WR respectively. These calculations are carried out for the turbine tip, turbine hub and turbine rotor.
7. Calculating a Wind Turbine Reflection Factor (RF) in accordance with ITU-R BT805
8. Calculating an adjustment factor (ADJ) to compensate for the 1km free space path loss built into the Relative Amplitude (RA) calculation defined in ITU-R BT805. This is 88.662dB.
9. Determining the following for each wind turbine – sample point pair.
    1. Horizontal Angle (alpha) at Turbine between extended path from transmitter and path to Sample Point
    2. Horizontal Angle (beta) at Sample Point between Turbine and Transmitter
    3. Calculating Relative Amplitude (RA) based in accordance with ITU-R BT805. If RA is calculated to be smaller than -10 it is changed to -10 (as described in BT805).
    4. Calculating Loss due to Antenna Directivity (AL) based on angle beta and the curves in ITU-R BT419.

10. Calculating Interference Signal Magnitude for each Turbine Receiver Sample Point Pair at turbine tip, hub and rotor base by summing the following:
    a. - FSPL_TW
    b. - DL_TW
    c. - FSPL_WR
    d. - DL_WR
    e. RF
    f. RA
    g. ADJ
    h. -AL
11. The above absolute values are summed for each turbine sample point and converted back into decibel values and saved as Summed Interference Values (I). Summing occurs with a 20/60/20 respective weighting split for tip, hub and rotor base.
12. Carrier Signal Magnitude (C) is then determined for each Receiver Sample Point by summing:
    a. – FSPL_TR
    b. – DL_TR
13. CI Ratio is then calculated for each point by subtracting I from C.
14. Receiver Sample Points where CI<15 are then recorded on interference maps.

Formulae

Terms

Term	Unit	Description
A	m^2	Blade Area
AL	dB	Antenna Loss due to angle between signal source and antenna direction
C	dB	Carrier signal strength (based on inverse of losses)
CIR	dB	Carrier to Interference Ratio
d	m	Length of signal path
dkm	km	Length of signal path
DL	dB	Diffraction Loss
FSPL	dB	Free Space Path Loss
FSWT	dBV/m	Field Strength at Wind Turbine
I	dB	Interference signal strength
Iabs	-	Interference signal strength (absolute)
Ih	dB	Interference signal strength due to a single turbine calculated at hub height
Ir	dB	Interference signal strength due to a single turbine calculated at bottom of rotor
It	dB	Interference signal strength due to a single turbine calculated at tip height
Iw	dB	Interference due to a single wind turbine
Iwf	dB	Interference due to a wind farm
RA	dB	Relative Amplitude in forward scatter region
RF	dB	Reflection factor for a wind turbine including free space path loss for 1km
TW	suffix	Denotes path from transmitter to Wind Turbine
TR	suffix	Denotes path from transmitter to receiver
TXFIELD	dBV/m	Transmitter field strength at 1 metre
v	-	Diffraction Parameter
W	m	Width of blade
WR	suffix	Denotes path from wind turbine to receiver
α	Radians	Horizontal angle at turbine between extended path from transmitter and path to receiver
β	Degrees	Horizontal angle between path to signal source and direction receiving antenna is pointing
λ	m	Wavelength

1 Antenna Loss

AL = 0 when β<20
AL = (β-20) x 0.4 when β between 20 and 60
AL = 16 when β>60

From Figure 1 of ITU-R BT419 Bands IV and V (UHF)

2 Reflection Factor

RF = 20log(A/λ)-60

From Annex 1 of ITU-R BT805

3 Relative Amplitude

RA=20log sin(π×W/λ×sinα)/(π×W/λ×sinα)

From Annex 1 of ITU-R BT805

4 Carrier to Interference Ratio

CIR = C - I

From first principles by definition when values expressed in dB

5 Free Space Path Loss

FSPL = 20log(4πd/λ)

From Dabis paper and by definition

6 Interference – Single Turbine – Hub Height

Formulae for a single path at hub height.

Ih = FSWT + RF + max(-10,RA) - 20log(dkm) [**a**]

From ITU-R BT805 for an unobscured path from Wind Turbine to transmitter

FSWT = TXFIELD - FSPL_TW - DL_TW [**b**]

From first principles

Ih = TXFIELD - FSPL_TW - DL_TW + RF + max(-10,RA) - 20log(dkm) [**c**]

Combining [**b**] and [**a**]

Ih = TXFIELD-FSPL_TW-DL_TW+RF+max(-10,RA)-20log(dkm)-DL_WR [**d**]

Accounts for additional diffraction losses between Wind Turbine and receiver

20log(dkm) = 20log(d/1000) = 20log(d) - 60 [**e**]

From first principles

FSPL = 20log(4π/λ) + 20log(d)

20log(d) = FSPL - 20log(4π/λ) [**f**]

*From [**e**] and first principles*

20log(dkm) = FSPL - 20log(4π/λ) - 60 [**g**]

Combining [**f**] and [**e**]

Ih = TXFIELD - FSPL_TW - DL_TW + RF + max(-10,RA) - FSPL_WR + 60 + 20log(4π/λ) - DL_WR [**h**]

Combining [**d**] and [**g**]

7 – Interference Single Turbine

Interference for a single turbine is calculated by taking a weighted average of interferences at tip, hub and rotor base.

It, Ih and Ir are all calculated as detailed in 6 above. These values will differ due to diffraction loss differences.

Iw = 20log((0.2*10^(It/20))+(0.6*10^(Ih/20))+(0.2*10^(Ir/20)))

Absolute averaging of signals with a 20/60/20 weighting – Pager Power Methodology

8 – Interference Multiple Turbines

Multiple Turbines based on calculations at hub height.

Interference signals from multiple sources are calculated by summing absolute values. The following formulae apply:

Iw = 20log(Iabs) [**1**]

Iabs =10^(Iw/20) [**2**]

By definition

Iwf=20log(Σ(10^(Iw/20))) [**3**]

Direct summing of absolute values – Pager Power and RES

9 – Diffraction – Single Knife Edge

DL = 6.9 + 20log(sqrt(((v-0.1)^2)+1)+v-0.1 when v > -0.7
DL = 0 when v <= -0.7

Equation 17 of ITU-R P526 (DL ≈ 0 when v<= -0.7 from the graph at Figure 7)

10 – Diffraction – Path over Irregular Terrain

The general method is described in Section 4.5 of ITU-R P526.

Up to three peaks are considered as specified by the method.

An effective Earth Radius (to account for atmospheric refraction) of 8,494,678 metres is used for calculation purposes.

Calculation Method

Pager Power has custom Sightlines software that is used for performing radar line of sight calculations. This has been developed further to carry out television interference calculations in line with the methodology described above. The software and systems have the following features:

1. A national terrain database that has records of terrain elevation at regular intervals – often known as DTM data.
2. Record of transmitter location and height
3. Record of turbine locations and height
4. Record of area to be analysed and required resolution
5. Diffraction losses are calculated in accordance with ITU-R526 based on an iterative process using a terrain profile derived from the terrain database
6. The system calculates Free Space Path Losses and Diffraction Losses for all paths between transmitter, turbines and receiver locations. These results are stored.
7. Various horizontal angles are calculated and interference signals are summed to calculate CI values at all points in the area being analysed.
8. These resulting values are used to plot charts of interference based on selected bandings. Typical bandings are:
    a. <5dB Strong Interference
    b. 5 -15dB Significant Interference
    c. 15 – 25 dB Possible Interference

Television Assessment – Sheephouse Heights Development

Background

The Sheephouse Heights wind development is planned to have 5 turbines and to be located to the North of the West end of Stocksbridge, South Yorkshire.

The Emley Moor transmitter is located 13Km North of Sheephouse Heights, It broadcasts BBC1, BBC2, ITV1, Channel4 and Five.

The Millhouse Green transmitter is located 3km Northeast of Sheephouse Heights, It broadcasts BBC1, BBC2, ITV1 and Channel4.

The Stocksbridge transmitter is located less than 2Km Southeast of Sheephouse Heights, It broadcasts BBC1, BBC2, ITV1 and Channel4.

This assessment has considered the effect of the Sheephouse Heights wind farm on television reception from the Emley Moor, Millhouse Green and Stocksbridge transmitters in the area around the wind farm.

Terrain Data

Ordnance Survey DTM data set has been used to calculate terrain profiles. This data set does not account for ground clutter such as buildings and trees.

Terrain Profiles

An elevation profile of points lying between the ends of the radio path being considered is built from the source terrain data. The number of points in each profile is variable and is dependent on the path length and the source data resolution – longer paths have more profile points. All profiles have at least 10 points.

Receiver Aerial Height

In the UK aerials are meant to be at a height of 10 metres above ground level to receive good coverage. In practice they are between 5 and 9 metres
For modelling purposes a height of 10m has been used.

Wavelength

A wavelength of 0.453 metres (corresponding to 662 MHz) has been used for assessment purposes. This frequency is at the centre of the UHF frequency spectrum used for terrestrial television transmissions.

Aerial Characteristic

The standard aerial characteristic defined in ITU-R BT419 has been used for assessment purposes.

Calculation Structure

For each receiving location 48 path loss calculations have been performed. This consists of six calculations per turbine.

Interference Maps and Charts

Charts show grid coordinates and areas of interference.

Maps show the same information overlaid onto 1:200,000 Ordnance Survey Maps.

Colours for maps and charts are defined as follows:

Colour	CI Ratio	Interference Level
Red	<5	High
Yellow	5 – 15	Medium
Blue	15 – 25	Low
None	>25	Very Low

Number	Chart/Map	Centre Point	Size	Resolution
1	Chart	425000E 400000N	20km x 20km	500m
2	Map	425000E 400000N	20km x 20km	500m

Conclusions

Existing published works have been used to enhance the Sight Lines computer model to predict television interference from wind farms.

Interference maps and charts showing areas of expected interference have been produced.

These maps and charts are a good guide to where interference is likely. They can only ever be used as a guide because of local interference and propagation effects near the receiver and because of the sampling and data resolutions available.

The Interference charts for Millhouse Green and Stocksbridge show large areas of Interference, but is should be noted that they are designed as fill in transmitters to cover only the immediate area around them.

The area of interest for the Millhouse Green transmitter is Penistone, Thurlstone and Millhouse Green. In this key area the Interference map shows little interference.

The area of interest for the Stocksbridge Transmitter is Stocksbridge and Deepcar. There appears to be little interference in the area immediately around the Stocksbridge transmitter. An aerial survey is recommended to determine the extent to which the Stocksbride transmitter is selected by residents and the effective range of this transmitter.

Interference from the Emley Moor transmitter is concentrated over Stocksbridge, but also affects Midhopestones and a corridor of land around the A616. It is likely that reception issues with Emley Moor transmissions in the Stocksbridge area could resolved by reorienting aerials to face the Stocksbridge transmitter. It is anticipated that a number of isolated homes near the A616 and the village of Midhopestones would be affected.

In the area examined, digital terrestrial television signals and channel five analogue television signals are provided only by Emley Moor. It should be noted that any residents switching transmitter from Emley Moor to either Stocksbridge or Millhouse Green would lose these Services.

Any adverse impacts with regard to television reception interference can be resolved through technical solutions that will be agreed between the Developer and the planning service. Whilst such mitigation measures may be required to alleviate any television interference, these should only be assessed and considered once the entire site has been constructed and is operating as individual turbines can actually improve signal reception to individual aerials as well as degrade received signals. Mitigation measures can include:

- Change in aerial height;
- Replacement of receiving aerials;
- Retuning of television receivers; or
- Provision of satellite or cable services to affected households

Following the grant of a successful planning consent and prior to construction of the windfarm, the developer would carry out a detailed on-site survey where the potential for disruption to television services would be more accurately assessed.

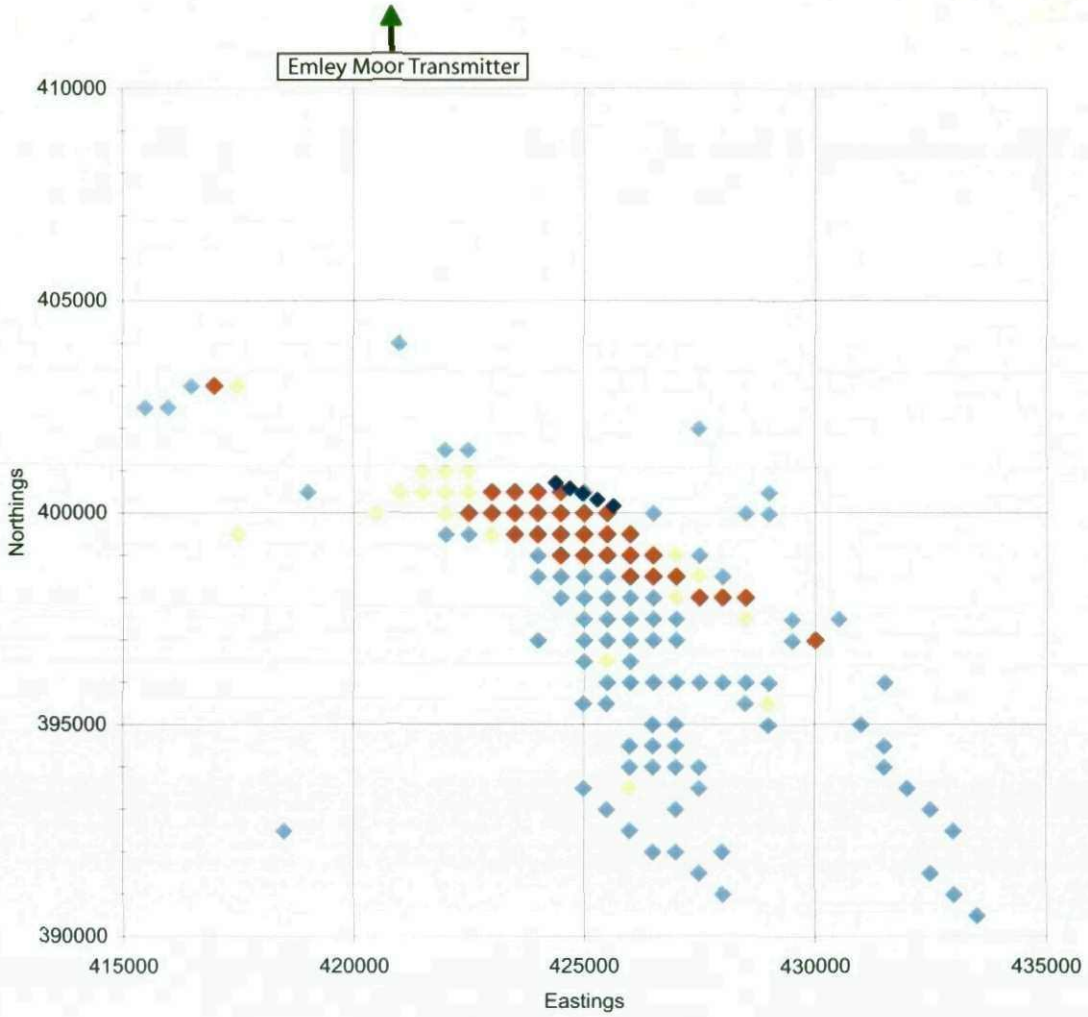
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Appendix 1 – Emley Moor Transmitter Interference Chart

Interference Chart
Emley Moor Television Transmitter
for
Sheephouse Heights Wind Farm
20 x 20km Area

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- CIR <5 High
- CIR 5 - 15 Medium
- CIR 15 - 25 Low
- Turbines



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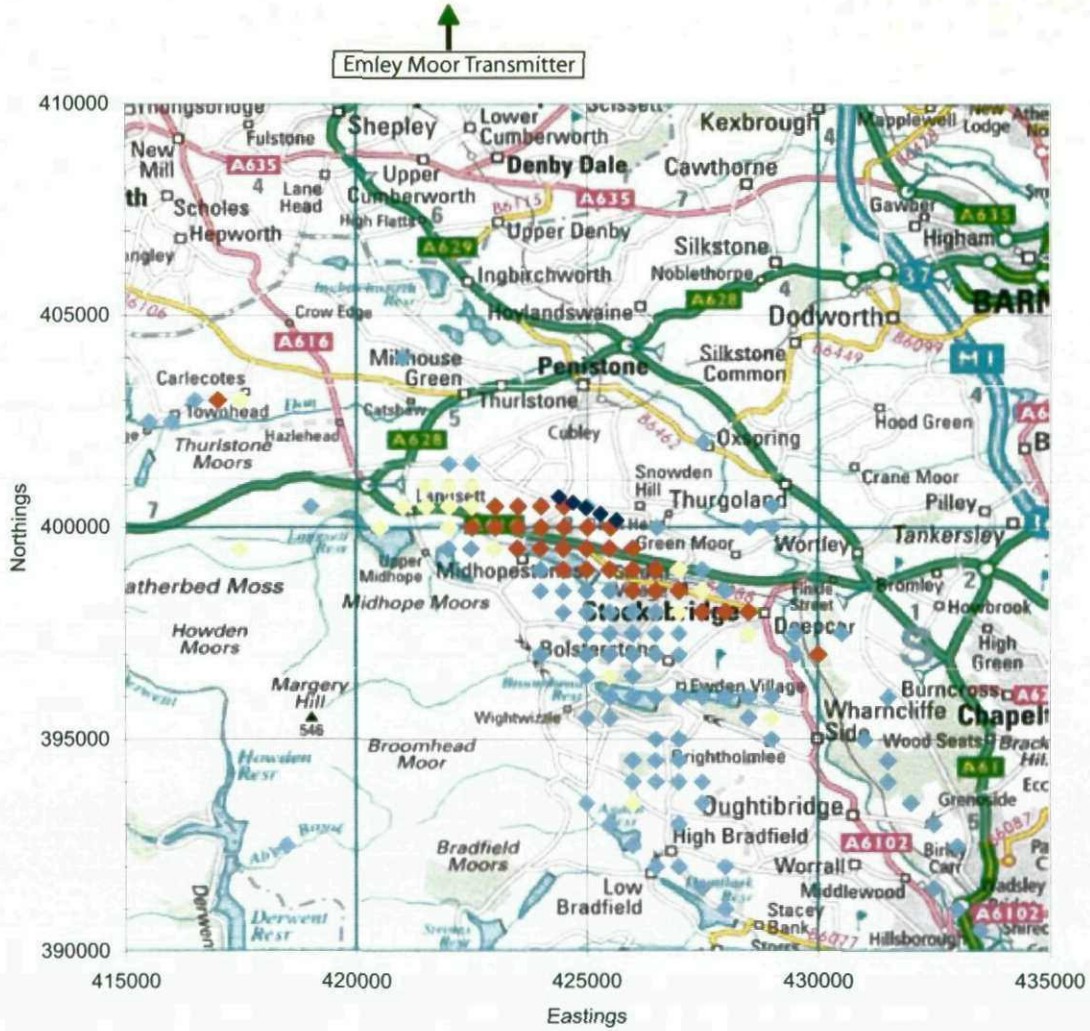
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Appendix 2 – Emley Moor Interference Chart overlaid onto Map

Interference Chart overlaid onto map
Emley Moor Television Transmitter
for
Sheephouse Heights Wind Farm
20 x 20km Area

Copyright © 2007 Pager Power Limited

- CIR <5 High
- CIR 5 - 15 Medium
- CIR 15 - 25 Low
- Turbines



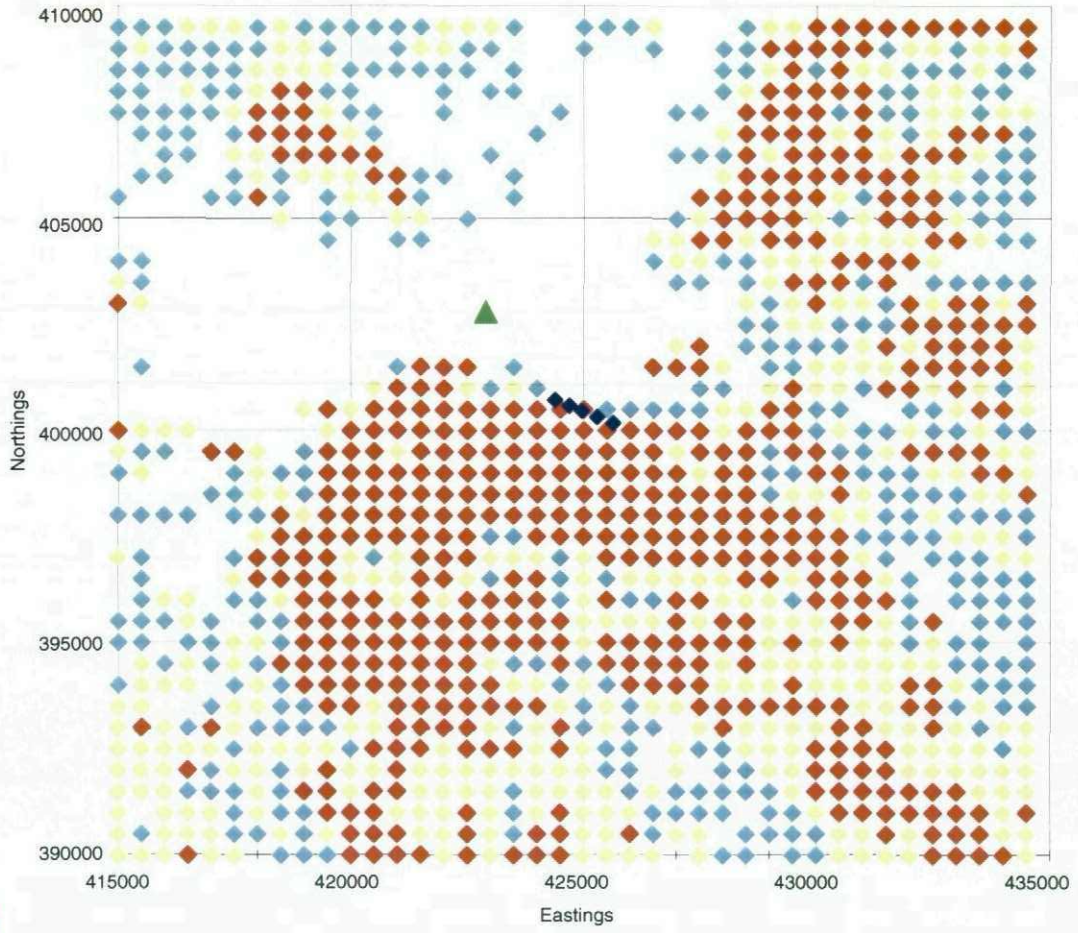
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Appendix 3 – Millhouse Green Transmitter Interference Chart

Interference Chart
Millhouse Green Television Transmitter
for
Sheephouse Heights Wind Farm
20 x 20km Area

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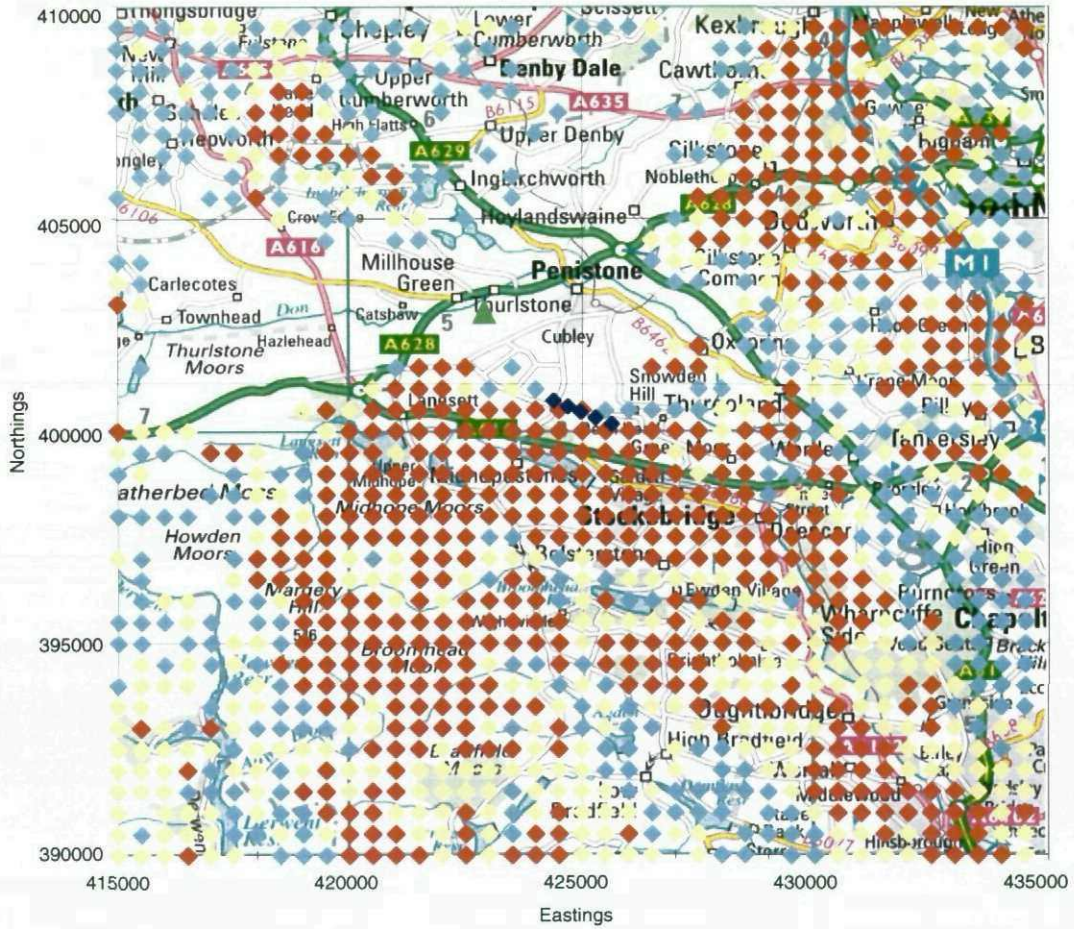
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Appendix 4 – Millhouse Green Interference Chart overlaid onto Map

Interference Chart overlaid onto map
Millhouse Green Television Transmitter
for
Sheephouse Heights Wind Farm
20 x 20km Area

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- CIR <5 High
- CIR 5 - 15 Medium
- CIR 15 - 25 Low
- Turbines
- Millhouse Green Transmittter



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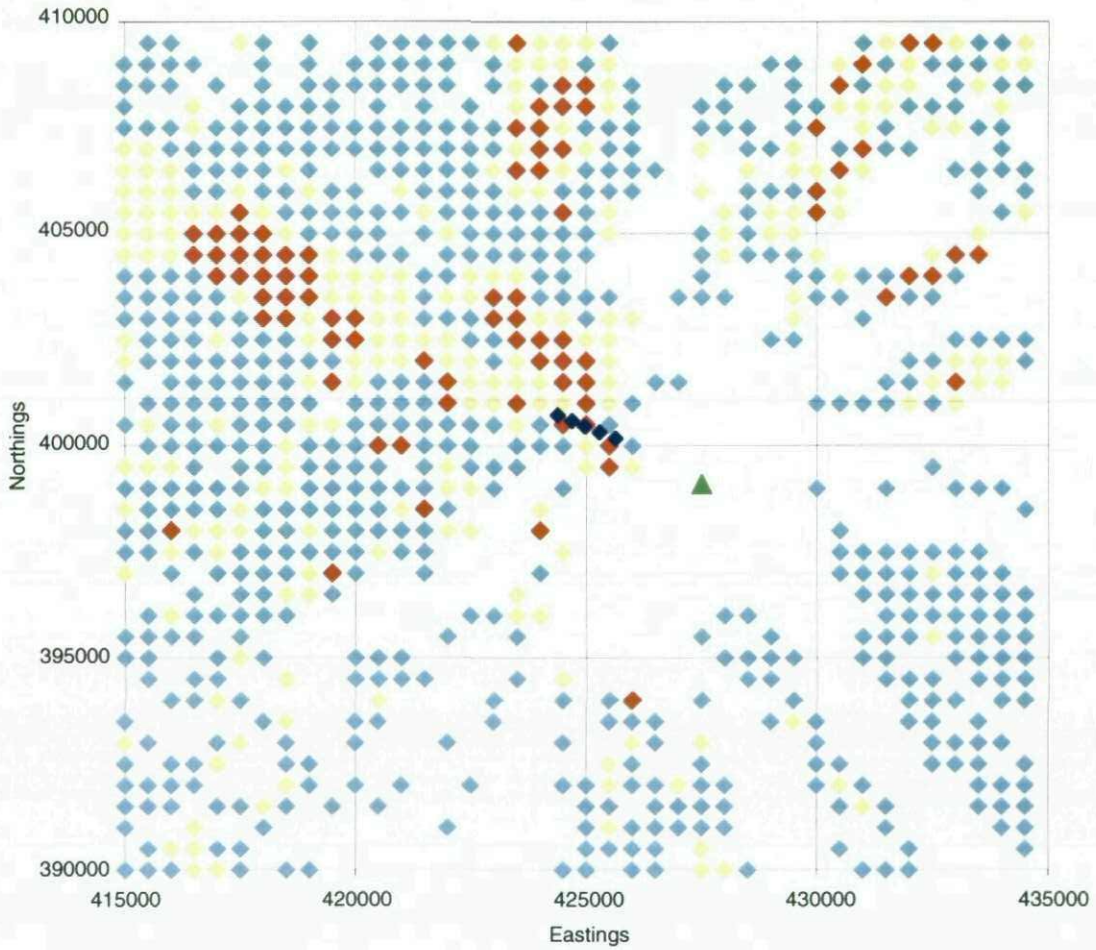
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Appendix 5 – Stocksbridge Transmitter Interference Chart

Interference Chart
Stocksbridge *Television Transmitter*
for
Sheephouse Heights Wind Farm
20 x 20km Area

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- CIR <5 High
- CIR 5 - 15 Medium
- CIR 15 - 25 Low
- Turbines
- Stocksbridge Transmitter



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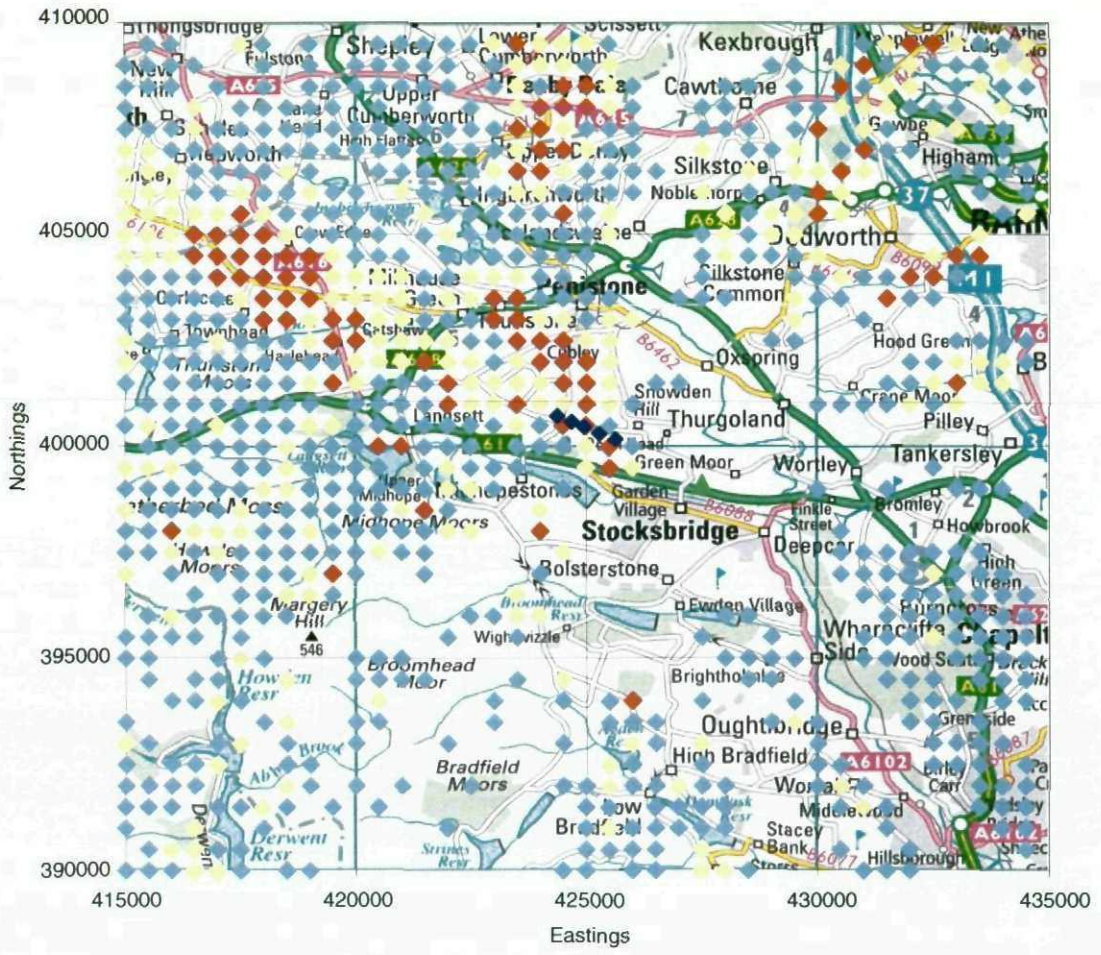
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Appendix 6 – Stocksbridge Transmitter Interference Chart overlaid onto Map

Interference Chart overlaid onto map
Stocksbridge Television Transmitter
for
Sheephouse Heights Wind Farm
20 x 20km Area

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- CIR <5 High
- CIR 5 - 15 Medium
- CIR 15 - 25 Low
- Turbines
- Stocksbridge Transmitter



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12.2 MICROWAVE LINK SURVEY AND ANALYSIS

The following pages contain the Microwave Link Survey and Analysis Report, conducted by Pager Power in August 2007.

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Arcus Renewable Energy Consulting Ltd.

Proposed Sheephouse Heights Wind Farm Development

Microwave Link Survey and Analysis

Grahame Stuteley BSc (Hons)
2nd August 2007

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Microwave Link Survey and Analysis
Proposed Sheephouse Heights Wind Farm Development

Job Ref:	5654A
Date	2nd August 2007
Prepared for:	Arcus Renewable Energy Consulting Ltd.
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Tel:	01787 319001
Email:	jean@pagerpower.co.uk

Record of Changes

Issue:	Date:	Detail of changes:
1	6 Aug 07	First issue

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Introduction

Arcus Renewable Energy Consulting Ltd. is proposing the development of a wind farm 2km north-west of Stocksbridge, South Yorkshire. The proposed wind farm is due to have 5 wind turbines, with a hub height of 80m and a rotor diameter of 90m and a maximum blade tip height of 125m.

A number of microwave communications links have been identified from consultations with Ofcom and the JRC, which either cross or constrain the wind farm site.

Pager Power was invited to survey the link ends and determine exclusion zones using Ofcom guidelines. Three links were identified and surveyed, and an exclusion chart of the findings has been produced.

Proposed Wind Farm

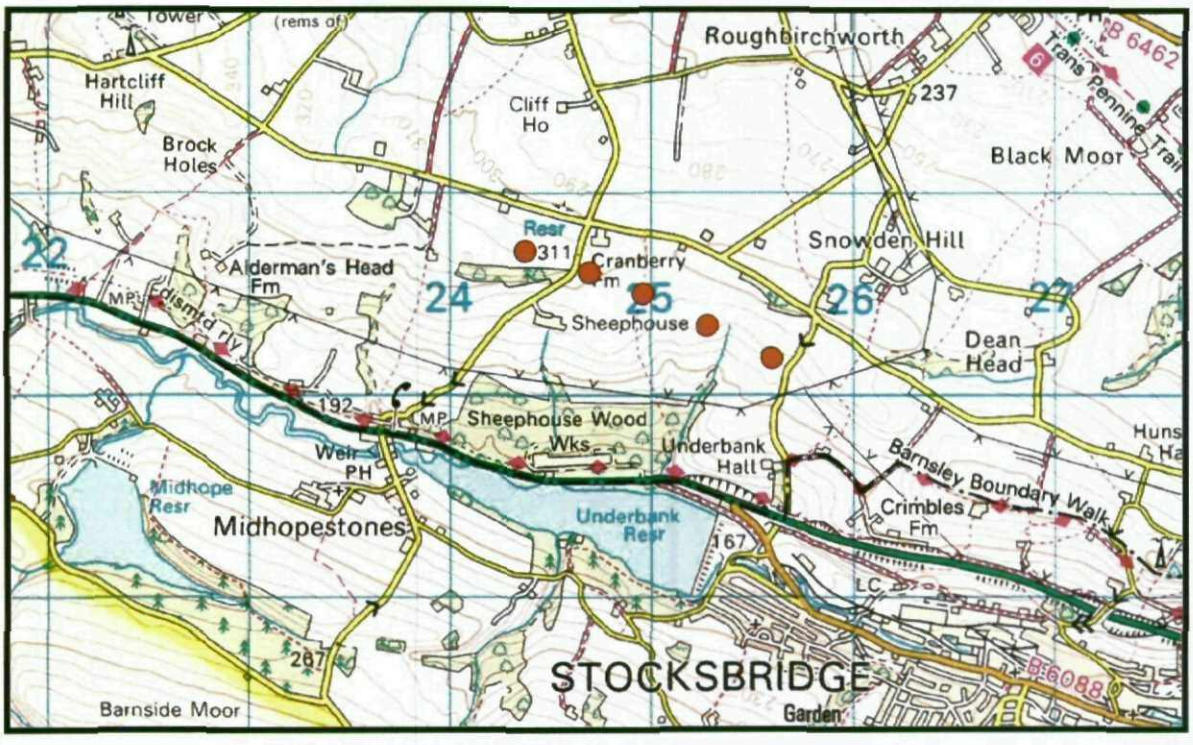
Background

Arcus Renewable Energy Consulting Ltd. is proposing the development of a wind farm 2km north-west of Stocksbridge, South Yorkshire. The proposed wind farm is due to have 5 wind turbines, with a hub height of 80m and a rotor diameter of 90m and a maximum blade tip height of 125m.

The proposed wind turbines have the following grid co-ordinates:

Turbine 1	424385E 400721N
Turbine 2	424693E 400585N
Turbine 3	424965E 400461N
Turbine 4	425287E 400318N
Turbine 5	425634E 400170N

The map below illustrates the proposed wind farm to the north-west of Stocksbridge:



Note: Not to scale, for illustrative purposes only.

Communication Links

A number of links have been identified by Ofcom and the JRC which exist in the area around the proposed development site. These are listed in the table below:

WINDFARM CO-ORDINATION REQUESTS FOR MIDHOPESTONES SHEEPHOUSE HEIGHTS

Links	*Company*	*Contact*	*Telephone*
995819	BT	Mike Redwin	01749 345514
105429	BT	Mike Redwin	01749 345514
991315	BT	Mike Redwin	01749 345514
83089	Orange PCS	windfarms@orange.co.uk	0
8582	Crown Castle Telecoms	Ian Gordon	01926 416131
8583	Crown Castle Telecoms	Ian Gordon	01926 416131
45202	MLL Telecom Ltd	Ed Bell	01628 474737

Note: Some of these link paths pass outside of the proposed site boundary and are therefore considered at minimal risk to disruption. Only the critical links which pass within or very near to the site have been considered at high risk of disruption and included in this report.

Two **JRC links** cross the proposed site and have been highlighted as being potentially disrupted by the proposed wind turbine development.

These are:

JEYANS1 WHARNCLIFFE YE (S YORKS) 431125 396881 JEYANO8 HAZLEHEAD SS (S YORKS) 417718 404855 15599m
JEYNS1 WHARNCLIFFE YE (S YORKS) 431125 396881 JEYNO8 HAZLEHEAD SS (S YORKS) 417718 404855 15599m

Link Details

The following links have been identified from the Ofcom and JRC lists as those adjacent to the proposed development which may potentially be at risk of interference from the proposed wind farm development:

Link	Link Ref	Band (GHz)	Operator	End A	End B
1	Unknown	18	BT	422400E 401700N	427540E 399190N
2	JRC	0.46	YEDL	431125E 396881N	417718E 404855N
3	JRC	0.46	YEDL	431125E 396881N	417718E 404855N

Note: Two separate JRC links exist along the same link path.

Survey Results

Detailed survey results are shown on the Antenna Location Check Sheets shown in Appendix 1.

Link	Link Ref	Band (GHz)	Operator	End A	End B
1	Unknown	18	BT	**Hartcliff Hill, Penistone 422384E 401684N**	**Hunshelf Bank, Stocksbridge 427538E 399180N**
2	JRC	0.46	YEDL	**Wharncliffe Chase 431119E 396898N**	**Crow Edge Works 417723E 404864N**
3	JRC	0.46	YEDL	**Wharncliffe Chase 431119E 396898N**	**Crow Edge Works 417723E 404864N**

Calculation Basis

The Exclusion Zone is calculated, based on the second Fresnel Zone, as described in the Radio Communications Agency paper "Fixed-link wind-turbine exclusion zone method".

It should be noted that:

- This is the approach recommended by the Radio Communications Agency when the exact antenna locations are known.
- Page 4 of the above paper states that this is a conservative approach.

Calculations use the lower of the two link frequencies, resulting in a wider exclusion zone.

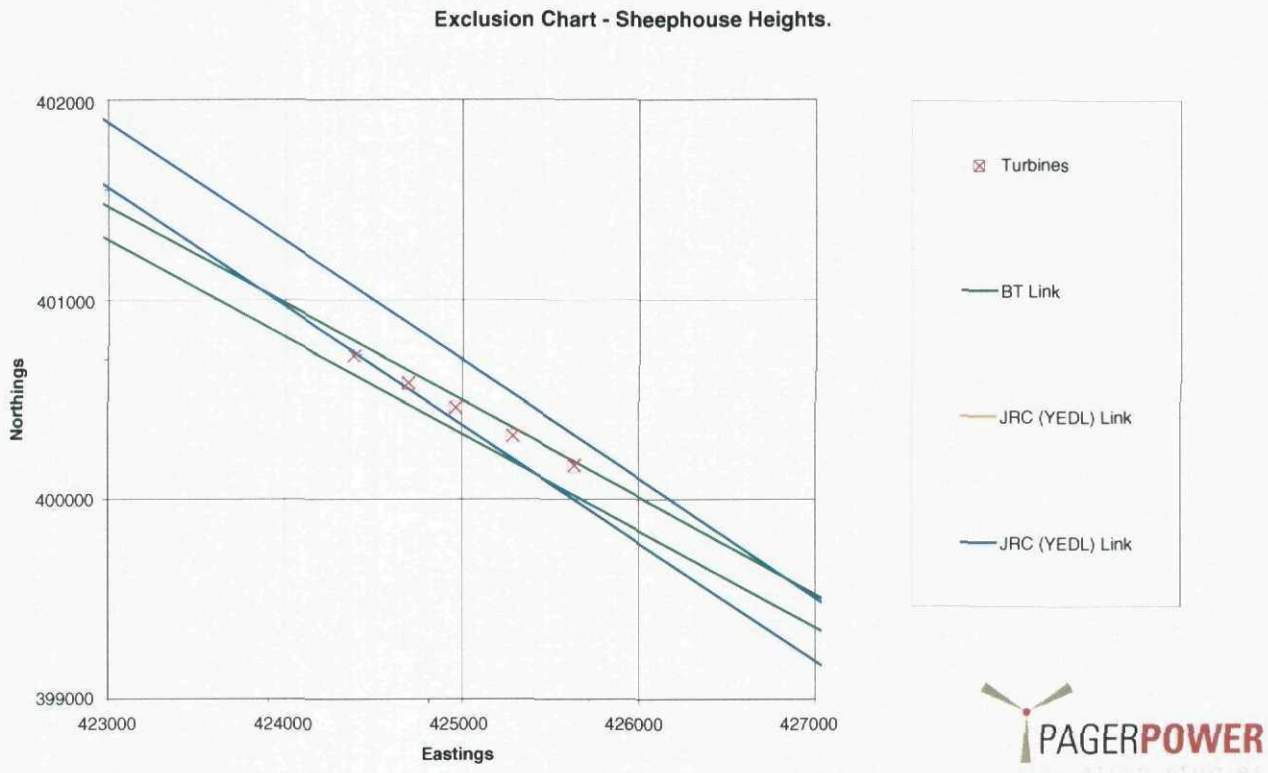
The above method does not specifically account for GPS errors which occur when measuring the antenna locations, or when siting the turbines. To allow for this Pager Power suggest developers apply an additional fixed exclusion width of 25 metres, beyond the second Fresnel Zone.

A 2-dimensional exclusion zone has been plotted. This includes the second Fresnel Zone and the additional recommended 25 metres, or the clearance zone as defined by individual link operators – e.g. 100m clearance required by Cable & Wireless

Pager Power generally recommends that wind turbines are constructed 250 metres beyond large communications masts to minimize multipath and other effects.

Exclusion Zone Chart

The full size chart is shown in Appendix 2.



Analysis

The chart shows that there are potential conflicts between the following turbines and links.

Turbine	Turbine Coordinates	Link	Horizontal Distance from turbine to link centre (m)	Calculation Number	Second Fresnel Radius (m)	Distance turbine has to be moved (m)
1	424385E 400721N	1	8.2	1	6.7	68.5m
2	424693E 400585N	1	20.5	2	6.9	56.4m
3	424965E 400461N	1	27.8	3	6.9	49.1m
4	425287E 400318N	1	39.9	4	6.9	36.9m
5	425634E 400170N	1	58.4	5	6.7	18.2m
1	424385E 400721N	2	155.9	6	71.3	N/A Clearance of 14.7m
2	424693E 400585N	2	115.4	7	71.2	25.8m
3	424965E 400461N	2	82.9	8	71.0	58.0m
4	425287E 400318N	2	41.3	9	70.6	99.4m
5	425634E 400170N	2	8.9	10	70.1	131.2m
1	424385E 400721N	3	155.9	11	71.3	N/A Clearance of 14.7m
2	424693E 400585N	3	115.4	12	71.2	25.8m
3	424965E 400461N	3	82.9	13	71.0	58.0m
4	425287E 400318N	3	41.3	14	70.6	99.4m
5	425634E 400170N	3	8.9	15	70.1	131.2m

All distances are in metres. The final column shows the distance the turbine would have to be moved so that the turbine and its blades lie 25 metres beyond the second Fresnel zone.

The individual clearance calculations are shown in Appendix 4.

Conclusions

One microwave link and two UHF Telemetry links in the vicinity of the proposed Sheephouse Heights wind development have been surveyed.

An exclusion chart has been constructed in accordance with Ofcom recommendations, referring to the link details provided to us by the link operators, Ofcom and The JRC. The exclusion zones account for the 2nd Fresnel zone and include a further 25m buffer zone to allow for GPS variations.

It can be seen from the exclusion chart that all 5 proposed turbine locations are heavily constrained by the 3 links surveyed in this report. Clearance calculation analysis has shown that proposed wind turbine 1 is clear of links 2 and 3 by 14.7m. Apart from this, all of the proposed turbines are likely to cause interference with all 3 of the link services.

Pager Power advises that either the proposed layout is revised, or that mitigation with both BT and The JRC is initiated at an early stage.

Appendix 1 – Location Check Sheets

Pager Power Limited
Microwave Link Antenna Location Check

Customer	**Arcus Renewables**
Customer Reference	**Link 1**
Pager Power Reference	**5654A**

RCA Link Reference	**Unknown**
Link Operator	**BT**
Link Frequency Low (GHz)	**18**
Link Frequency High (GHz)	**18**
Service	**Microwave**
Survey Date	**27th July 2007**
Surveyor	**Grahame Stuteley**

	A End	**B End**
Location Name	Hartcliff Hill, Penistone	Hunshelf Bank, Stocksbridge
RCA Specified NGR	422400E 401700N	427540E 399190N
Measured NGR	**422384E 401684N**	**427538E 399180N**
Measurement Accuracy	<5m	<5m
Specific Antenna Identified	Yes	Yes
Measurement Method	GPS adjacent to mast	GPS1 adjacent to mast
Crosscheck Method	Map	Map

	GPS Unit 1	**GPS Unit 2**
GPS Manufacturer	Thales	Garmin
GPS Model	Mobile Mapper	GPS 12
GPS Serial Number	*00011799668*	36152368

Distance Meter Type	Laser
Manufacturer	Leica
Model	Disto Classic
Serial Number	30503229

Additional Information	

Pager Power Limited
Microwave Link Antenna Location Check



Customer	**Arcus Renewables**
Customer Reference	**Link 2**
Pager Power Reference	**5654A**

RCA Link Reference	**JRC**
Link Operator	**YEDL**
Link Frequency Low (GHz)	**0.46**
Link Frequency High (GHz)	**0.46**
Service	**UHF Telemetry**
Survey Date	**27th July 2007**
Surveyor	**Grahame Stuteley**

	A End	**B End**
Location Name	Wharncliffe Chase	Crow Edge Works
RCA Specified NGR	431125E 396881N	417718E 404855N
Measured NGR	**431119E 396898N**	**417723E 404864N**
Measurement Accuracy	<5m	<5m
Specific Antenna Identified	Yes	Yes
Measurement Method	GPS adjacent to mast	GPS1 adjacent to mast
Crosscheck Method	Map	Map

	GPS Unit 1	**GPS Unit 2**
GPS Manufacturer	Thales	Garmin
GPS Model	Mobile Mapper	GPS 12
GPS Serial Number	*00011799668*	36152368

Distance Meter Type	Laser
Manufacturer	Leica
Model	Disto Classic
Serial Number	30503229

Additional Information	

Pager Power Limited
Microwave Link Antenna Location Check



Customer	**Arcus Renewables**
Customer Reference	**Link 3**
Pager Power Reference	**5654A**

RCA Link Reference	**JRC**
Link Operator	**YEDL**
Link Frequency Low (GHz)	**0.46**
Link Frequency High (GHz)	**0.46**
Service	**UHF Telemetry**
Survey Date	**27th July 2007**
Surveyor	**Grahame Stuteley**

	A End	**B End**
Location Name	Wharncliffe Chase	Crow Edge Works
RCA Specified NGR	431125E 396881N	417718E 404855N
Measured NGR	**431119E 396898N**	**417723E 404864N**
Measurement Accuracy	<5m	<5m
Specific Antenna Identified	Yes	Yes
Measurement Method	GPS adjacent to mast	GPS1 adjacent to mast
Crosscheck Method	Map	Map

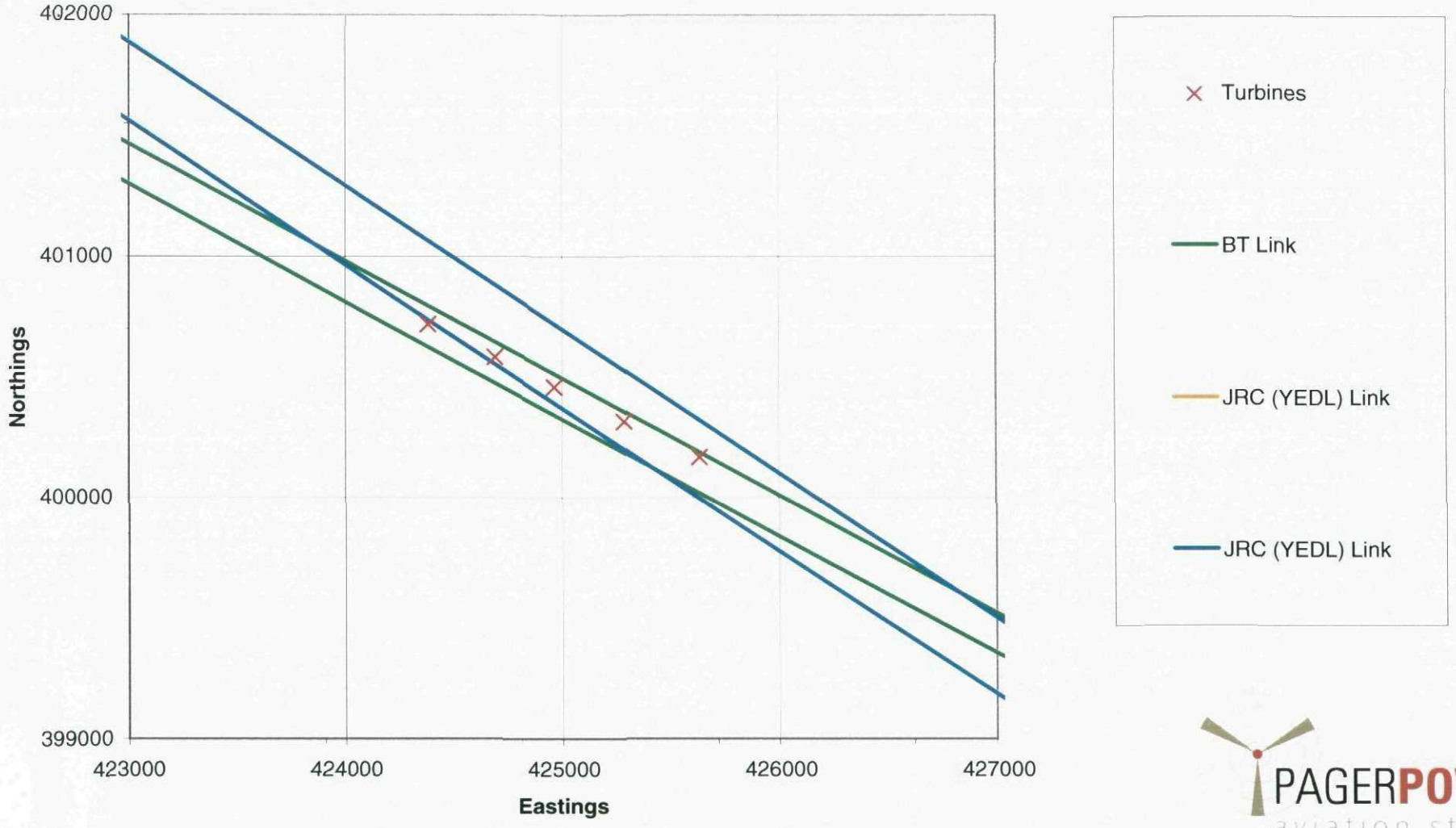
	GPS Unit 1	**GPS Unit 2**
GPS Manufacturer	Thales	Garmin
GPS Model	Mobile Mapper	GPS 12
GPS Serial Number	*00011799668*	36152368

Distance Meter Type	Laser
Manufacturer	Leica
Model	Disto Classic
Serial Number	30503229

Additional Information	

Appendix 2 – Exclusion Zone Chart

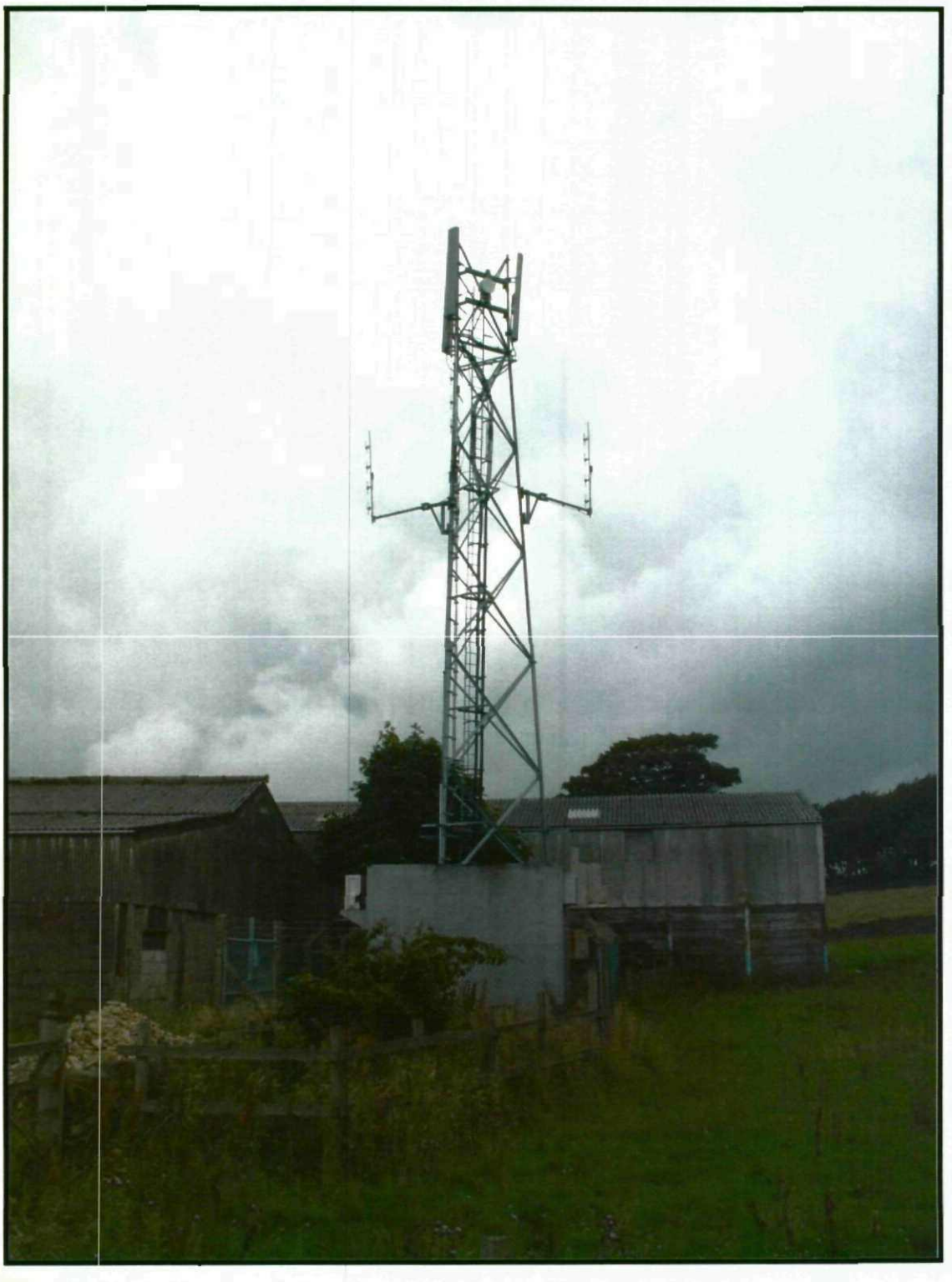
Exclusion Chart - Sheephouse Heights.



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Appendix 3 – Photographs

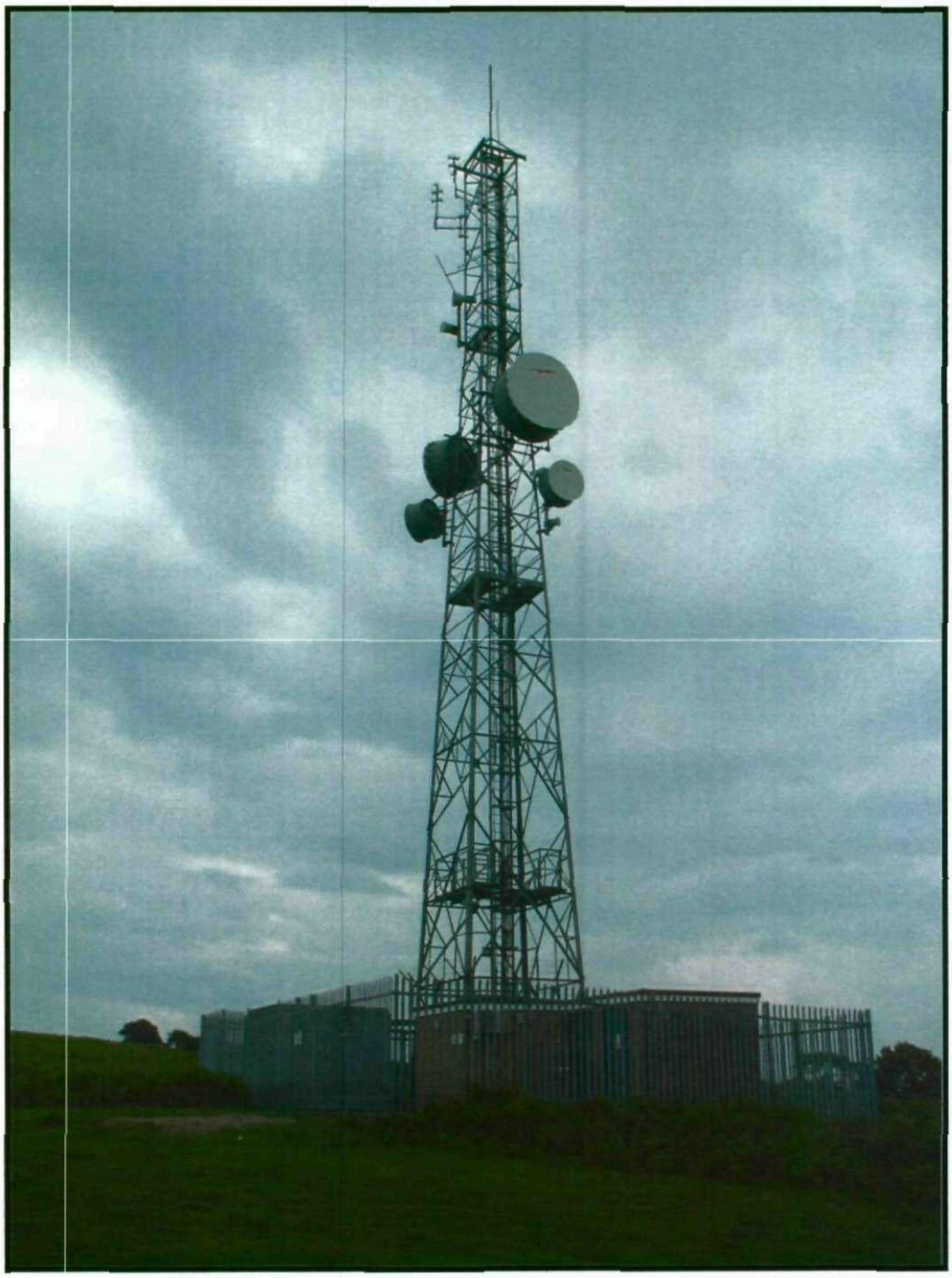
Below: Hartcliff Hill.



Below: Hunshelf Bank.



Below: Wharncliffe Chase.



Below: Crow Edge Works.





Appendix 4 – Calculation Sheets

Exclusion Distance Calculation 2D [ClearanceFresnel2D01]

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	A End	Z End
Link Description	Link 1	Link 1
Easting	422384	427538
Northing	401684	399180
Frequency GHz (e.g. 13)		18

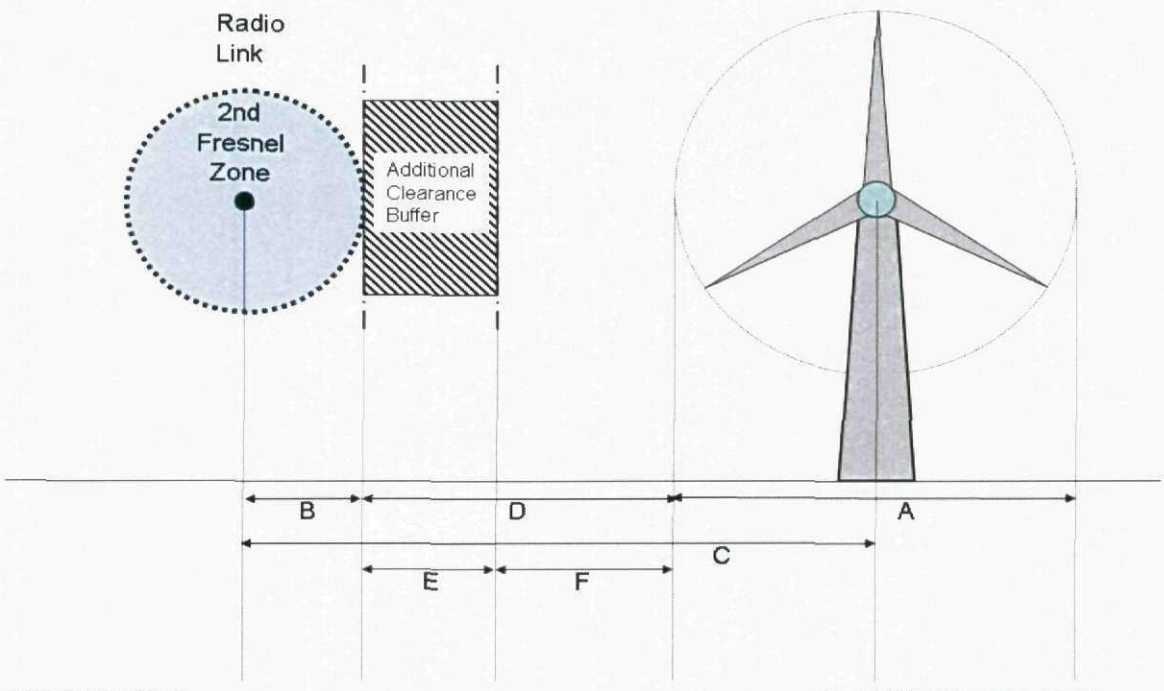
Turbine	T1	T1
Turbine Easting		424385
Turbine Northing		400721
Turbine Rotor Diameter [A]		90

Calculation Reference	1

Turbine Distance from A End (km)	2.2
Turbine Distance from Z End (km)	3.5
Link Length (km)	5.7

Second Fresnel Zone Radius [B] (m)	6.7
Turbine Distance from Link Path [C] (m)	8.2
Clearance between Tip and Zone [D] (m)	-43.5

Additional Clearance [E] (m)	25
Remaining Clearance Tip - Zone [F] (m)	-68.5



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Exclusion Distance Calculation 2D [ClearanceFresnel2D01]

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	A End	Z End
Link Description	Link 1	Link 1
Easting	422384	427538
Northing	401684	399180
Frequency GHz (e.g. 13)		18

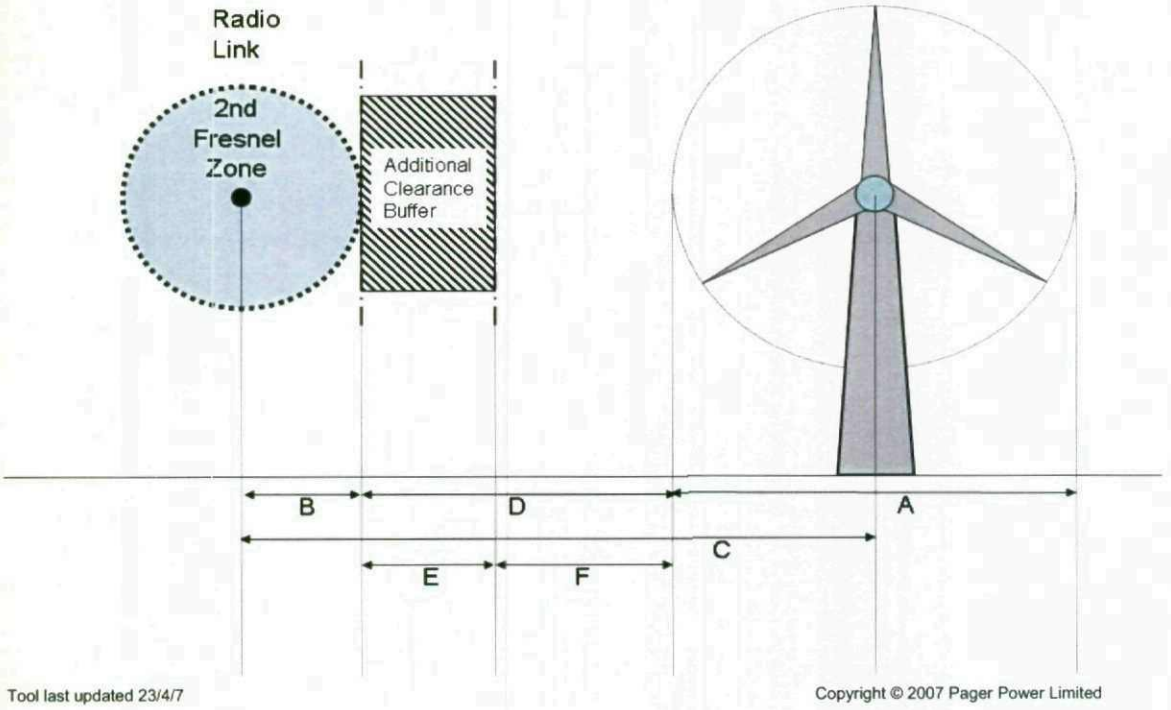
Turbine	T2	T2
Turbine Easting		424693
Turbine Northing		400585
Turbine Rotor Diameter [A]		90

Calculation Reference	2

Turbine Distance from A End (km)	2.6
Turbine Distance from Z End (km)	3.2
Link Length (km)	5.7

Second Fresnel Zone Radius [B] (m)	6.9
Turbine Distance from Link Path [C] (m)	20.5
Clearance between Tip and Zone [D] (m)	-31.4

Additional Clearance [E] (m)	25
Remaining Clearance Tip - Zone [F] (m)	-56.4



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Exclusion Distance Calculation 2D [ClearanceFresnel2D01]

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aviation studies

	A End	Z End
Link Description	Link 1	Link 1
Easting	422384	427538
Northing	401684	399180
Frequency GHz (e.g. 13)		18

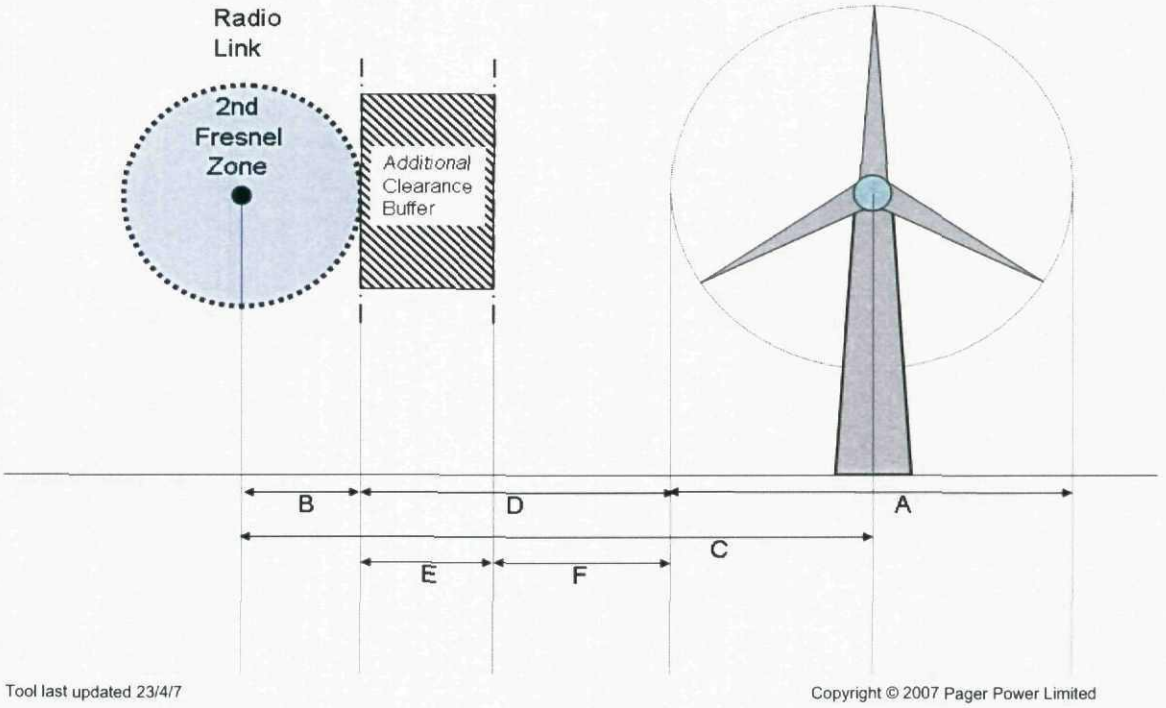
Turbine	T3	T3
Turbine Easting		424965
Turbine Northing		400461
Turbine Rotor Diameter [A]		90

Calculation Reference	3

Turbine Distance from A End (km)	2.9
Turbine Distance from Z End (km)	2.9
Link Length (km)	5.7

Second Fresnel Zone Radius [B] (m)	6.9
Turbine Distance from Link Path [C] (m)	27.8
Clearance between Tip and Zone [D] (m)	-24.1

Additional Clearance [E] (m)	25
Remaining Clearance Tip - Zone [F] (m)	-49.1



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Exclusion Distance Calculation 2D [ClearanceFresnel2D01]

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	A End	Z End
Link Description	Link 1	Link 1
Easting	422384	427538
Northing	401684	399180
Frequency GHz (e.g. 13)		18

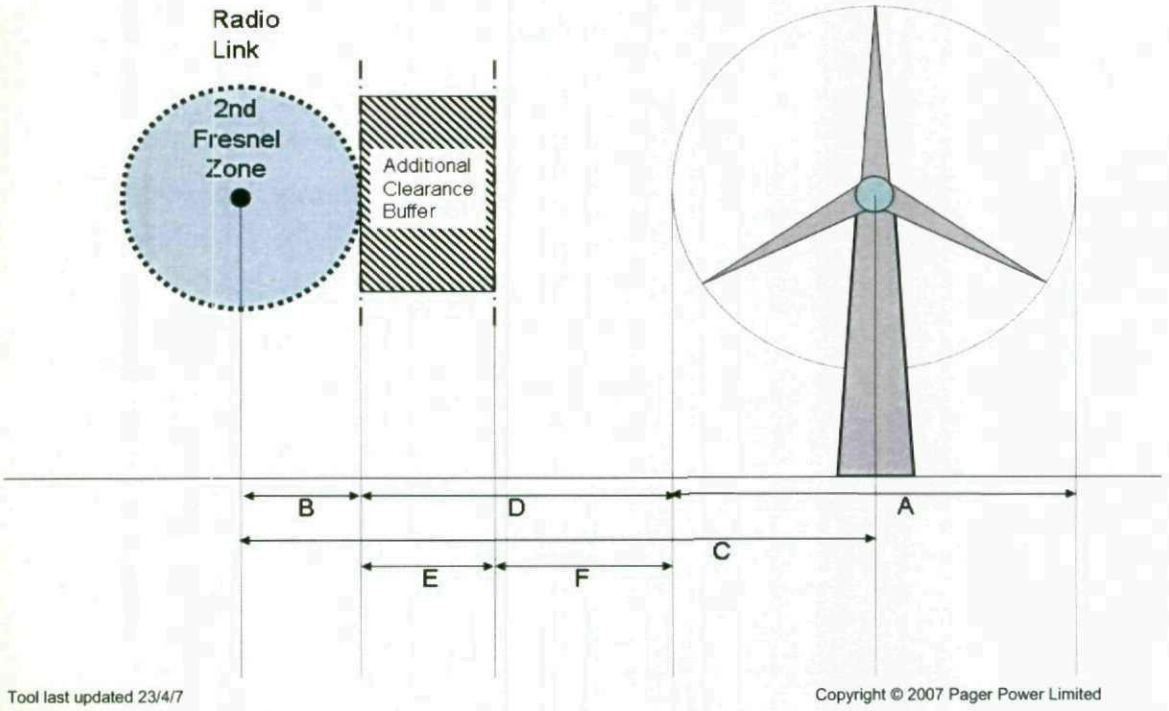
Turbine	T4	T4
Turbine Easting		425287
Turbine Northing		400318
Turbine Rotor Diameter [A]		90

Calculation Reference	4

Turbine Distance from A End (km)	3.2
Turbine Distance from Z End (km)	2.5
Link Length (km)	5.7

Second Fresnel Zone Radius [B] (m)	6.9
Turbine Distance from Link Path [C] (m)	39.9
Clearance between Tip and Zone [D] (m)	-11.9

Additional Clearance [E] (m)	25
Remaining Clearance Tip - Zone [F] (m)	-36.9



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Exclusion Distance Calculation 2D [ClearanceFresnel2D01]

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	A End	Z End
Link Description	Link 1	Link 1
Easting	422384	427538
Northing	401684	399180
Frequency GHz (e.g. 13)		18

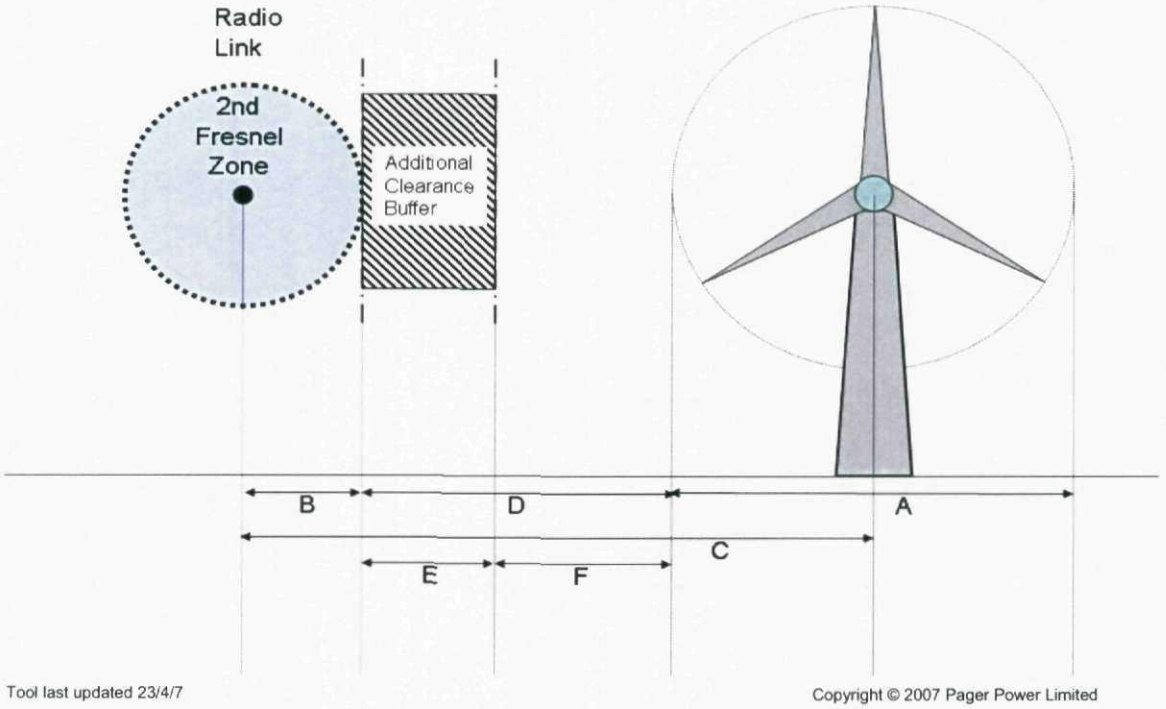
Turbine	T5	T5
Turbine Easting		425634
Turbine Northing		400170
Turbine Rotor Diameter [A]		90

Calculation Reference	5

Turbine Distance from A End (km)	3.6
Turbine Distance from Z End (km)	2.1
Link Length (km)	5.7

Second Fresnel Zone Radius [B] (m)	6.7
Turbine Distance from Link Path [C] (m)	58.4
Clearance between Tip and Zone [D] (m)	6.8

Additional Clearance [E] (m)	25
Remaining Clearance Tip - Zone [F] (m)	-18.2



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Exclusion Distance Calculation 2D [ClearanceFresnel2D01]

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	A End	Z End
Link Description	Link 2	Link2
Easting	431119	417723
Northing	396898	404864
Frequency GHz (e.g. 13)		0.46

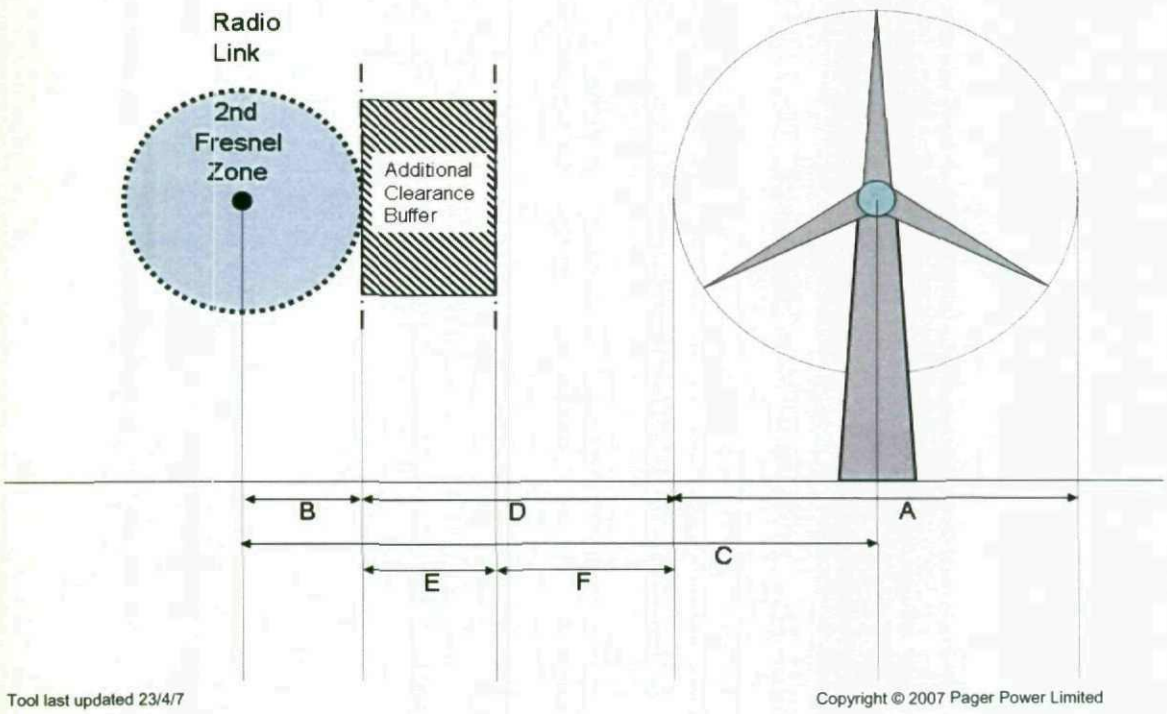
Turbine	T1	T1
Turbine Easting		424385
Turbine Northing		400721
Turbine Rotor Diameter [A]		90

Calculation Reference	6

Turbine Distance from A End (km)	7.7
Turbine Distance from Z End (km)	7.8
Link Length (km)	15.6

Second Fresnel Zone Radius [B] (m)	71.3
Turbine Distance from Link Path [C] (m)	155.9
Clearance between Tip and Zone [D] (m)	39.7

Additional Clearance [E] (m)	25
Remaining Clearance Tip - Zone [F] (m)	14.7



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Exclusion Distance Calculation 2D [ClearanceFresnel2D01]

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aviation studies

	A End	Z End
Link Description	Link 2	Link2
Easting	431119	417723
Northing	396898	404864
Frequency GHz (e.g. 13)		0.46

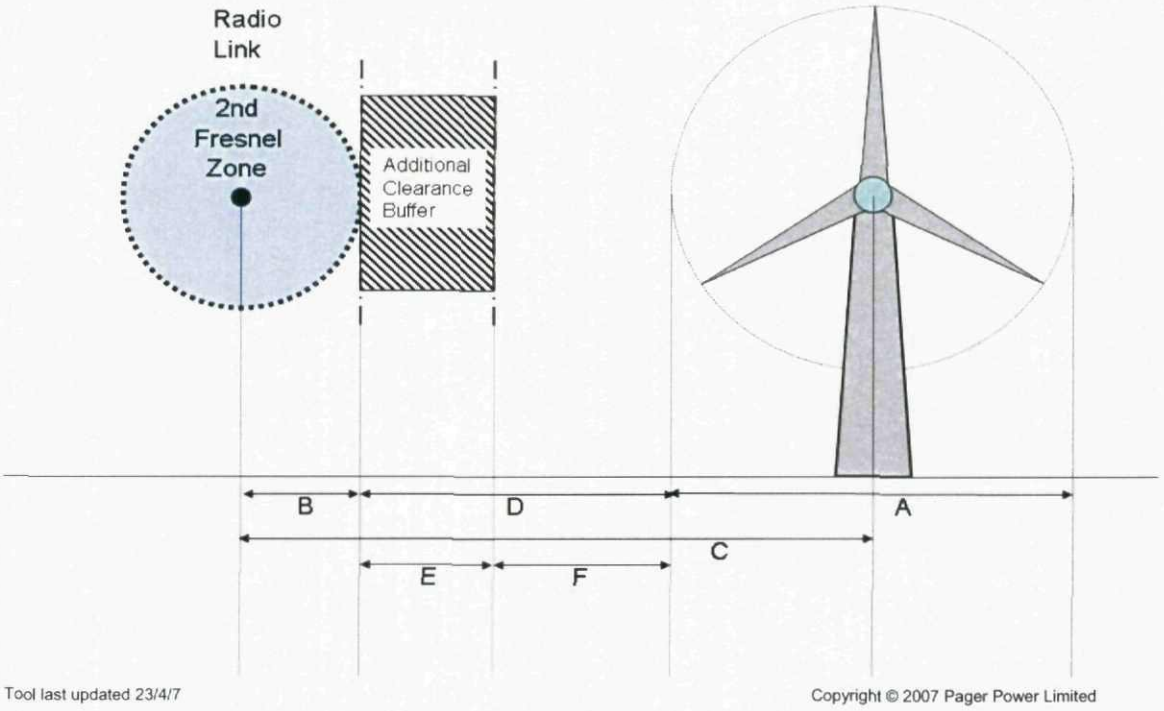
Turbine	T2	T2
Turbine Easting		424693
Turbine Northing		400585
Turbine Rotor Diameter [A]		90

Calculation Reference	7

Turbine Distance from A End (km)	7.4
Turbine Distance from Z End (km)	8.2
Link Length (km)	15.6

Second Fresnel Zone Radius [B] (m)	71.2
Turbine Distance from Link Path [C] (m)	115.4
Clearance between Tip and Zone [D] (m)	-0.8

Additional Clearance [E] (m)	25
Remaining Clearance Tip - Zone [F] (m)	-25.8



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Exclusion Distance Calculation 2D [ClearanceFresnel2D01]

PAGERPOWER aviation studies

	A End	Z End
Link Description	Link 2	Link2
Easting	431119	417723
Northing	396898	404864
Frequency GHz (e.g. 13)		0.46

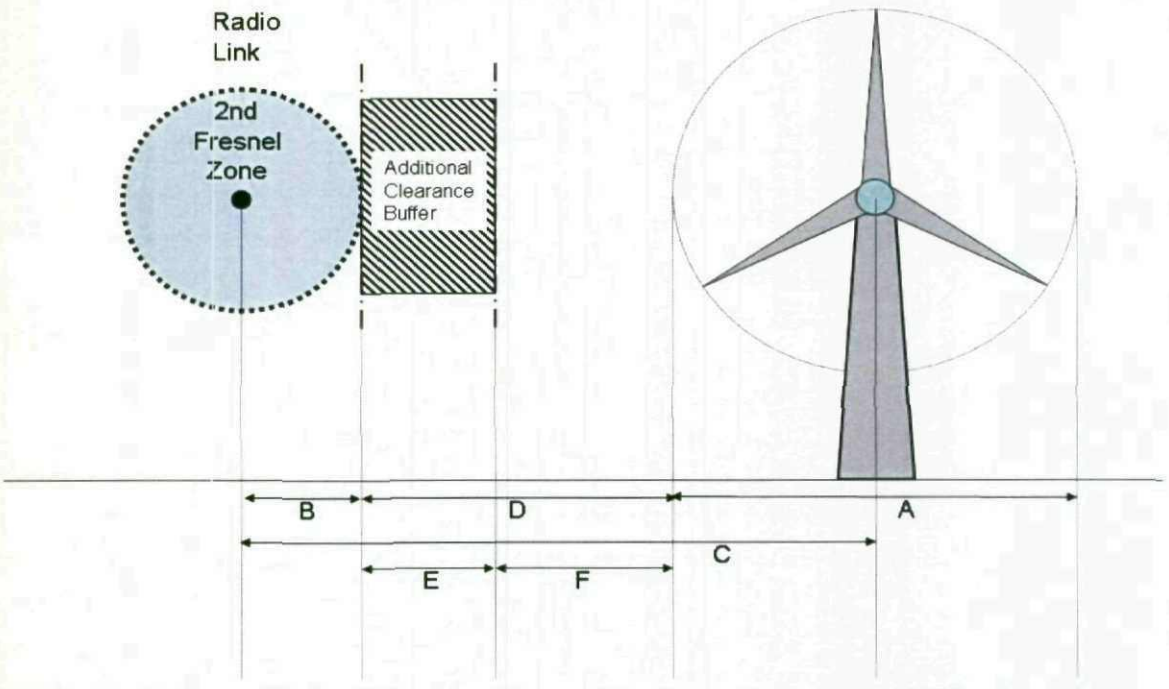
Turbine	T3	T3
Turbine Easting		424965
Turbine Northing		400461
Turbine Rotor Diameter [A]		90

Calculation Reference	8

Turbine Distance from A End (km)	7.1
Turbine Distance from Z End (km)	8.5
Link Length (km)	15.6

Second Fresnel Zone Radius [B] (m)	71.0
Turbine Distance from Link Path [C] (m)	82.9
Clearance between Tip and Zone [D] (m)	-33.0

Additional Clearance [E] (m)	25
Remaining Clearance Tip - Zone [F] (m)	-58.0



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Exclusion Distance Calculation 2D [ClearanceFresnel2D01]

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	A End	Z End
Link Description	Link 2	Link2
Easting	431119	417723
Northing	396898	404864
Frequency GHz (e.g. 13)		0.46

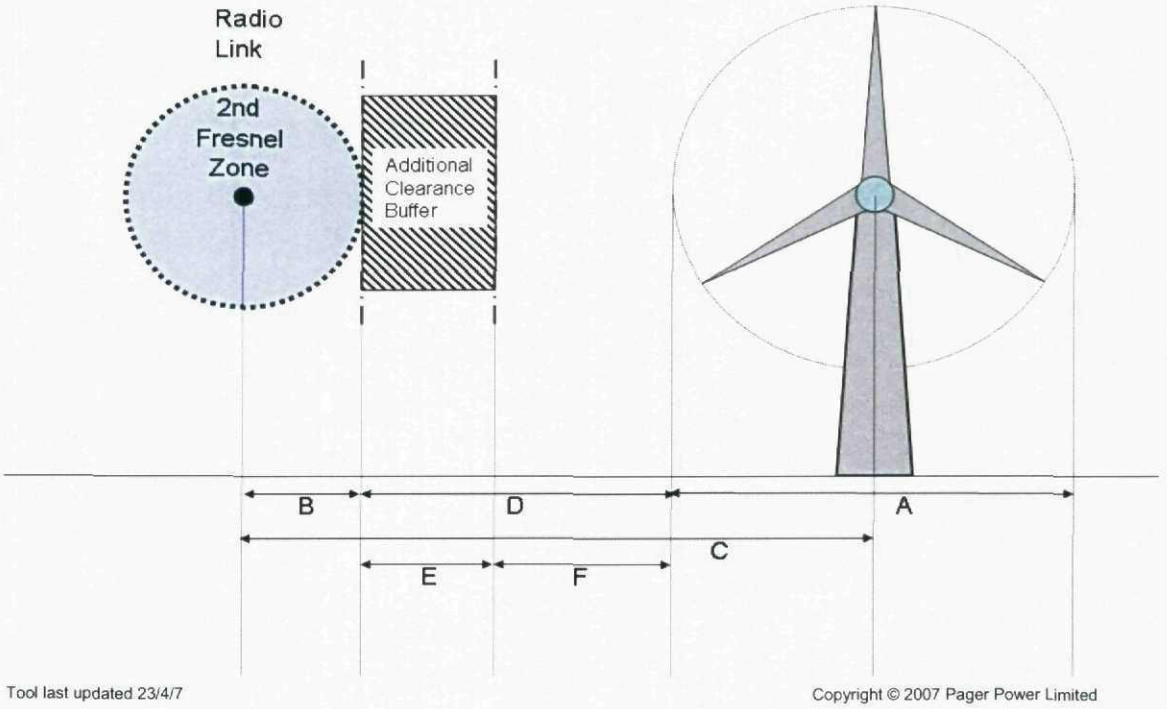
Turbine	T4	T4
Turbine Easting		425287
Turbine Northing		400318
Turbine Rotor Diameter [A]		90

Calculation Reference	9

Turbine Distance from A End (km)	6.8
Turbine Distance from Z End (km)	8.8
Link Length (km)	15.6

Second Fresnel Zone Radius [B] (m)	70.6
Turbine Distance from Link Path [C] (m)	41.3
Clearance between Tip and Zone [D] (m)	-74.4

Additional Clearance [E] (m)	25
Remaining Clearance Tip - Zone [F] (m)	-99.4



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Exclusion Distance Calculation 2D [ClearanceFresnel2D01]

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	A End	Z End
Link Description	Link 2	Link2
Easting	431119	417723
Northing	396898	404864
Frequency GHz (e.g. 13)		0.46

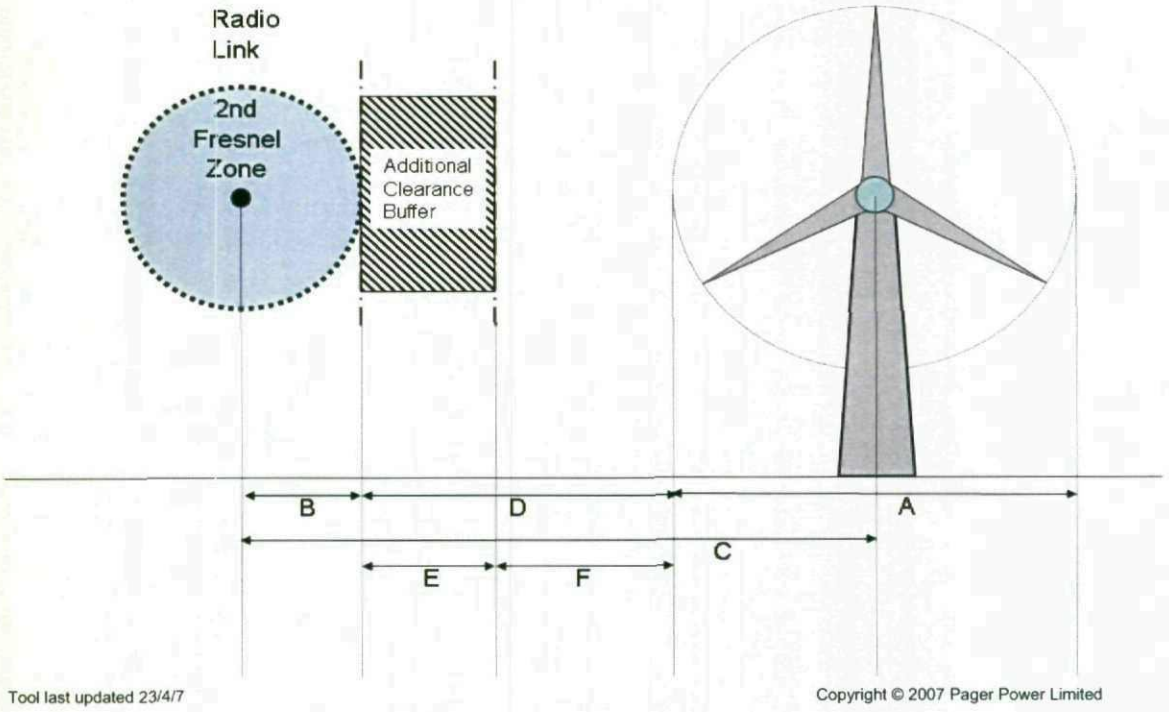
Turbine	T5	T5
Turbine Easting		425634
Turbine Northing		400170
Turbine Rotor Diameter [A]		90

Calculation Reference	10

Turbine Distance from A End (km)	6.4
Turbine Distance from Z End (km)	9.2
Link Length (km)	15.6

Second Fresnel Zone Radius [B] (m)	70.1
Turbine Distance from Link Path [C] (m)	8.9
Clearance between Tip and Zone [D] (m)	-106.2

Additional Clearance [E] (m)	25
Remaining Clearance Tip - Zone [F] (m)	-131.2



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Exclusion Distance Calculation 2D [ClearanceFresnel*2D01*]

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	A End	Z End
Link Description	Link 3	Link 3
Easting	431119	417723
Northing	396898	404864
Frequency GHz (e.g. 13)		0.46

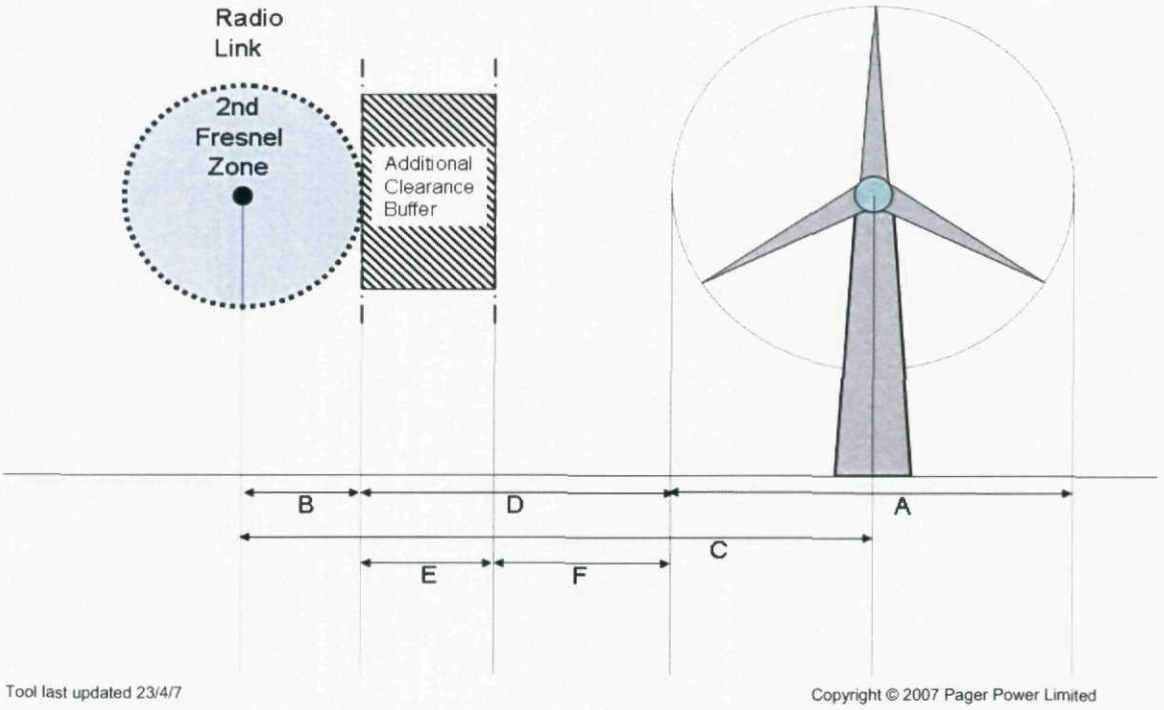
Turbine	T1	T1
Turbine Easting		424385
Turbine Northing		400721
Turbine Rotor Diameter [A]		90

Calculation Reference	11

Turbine Distance from A End (km)	7.7
Turbine Distance from Z End (km)	7.8
Link Length (km)	15.6

Second Fresnel Zone Radius [B] (m)	71.3
Turbine Distance from Link Path [C] (m)	155.9
Clearance between Tip and Zone [D] (m)	39.7

Additional Clearance [E] (m)	25
Remaining Clearance Tip - Zone [F] (m)	14.7



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Exclusion Distance Calculation 2D [ClearanceFresnel2D01]

	A End	Z End
Link Description	Link 3	Link 3
Easting	431119	417723
Northing	396898	404864
Frequency GHz (e.g. 13)		0.46

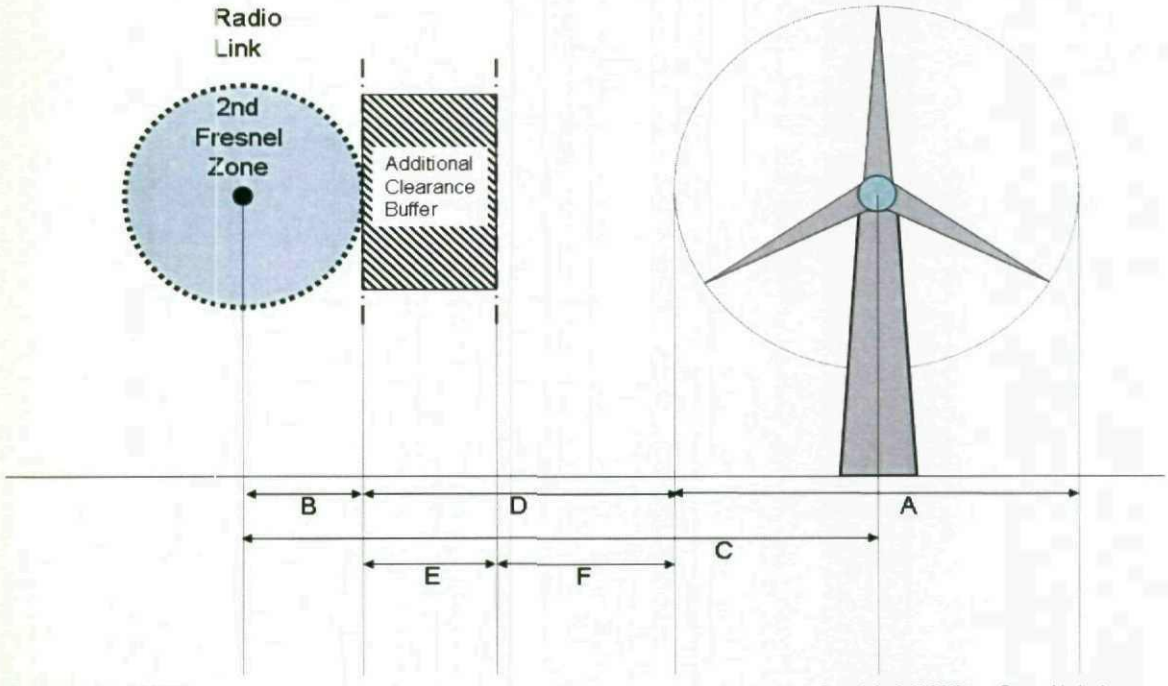
Turbine	T2	T2
Turbine Easting		424693
Turbine Northing		400585
Turbine Rotor Diameter [A]		90

Calculation Reference	12

Turbine Distance from A End (km)	7.4
Turbine Distance from Z End (km)	8.2
Link Length (km)	15.6

Second Fresnel Zone Radius [B] (m)	71.2
Turbine Distance from Link Path [C] (m)	115.4
Clearance between Tip and Zone [D] (m)	-0.8

Additional Clearance [E] (m)	25
Remaining Clearance Tip - Zone [F] (m)	-25.8



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Exclusion Distance Calculation 2D [ClearanceFresnel2D01]

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	A End	Z End
Link Description	Link 3	Link 3
Easting	431119	417723
Northing	396898	404864
Frequency GHz (e.g. 13)		0.46

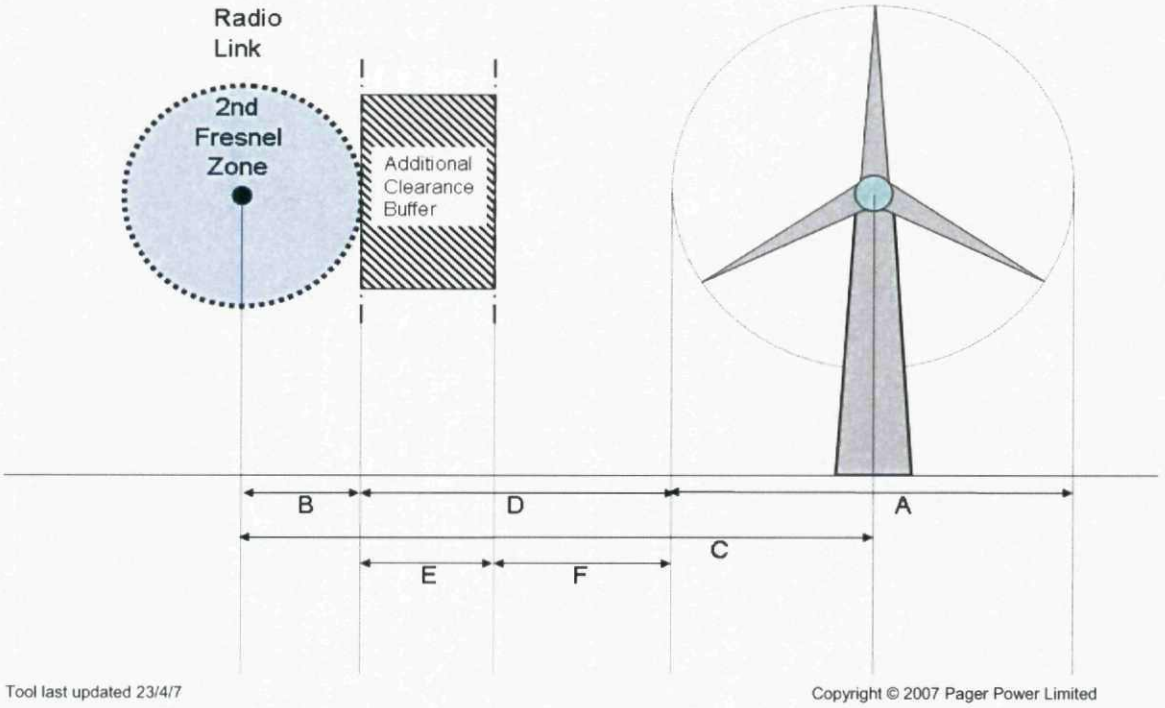
Turbine	T3	T3
Turbine Easting		424965
Turbine Northing		400461
Turbine Rotor Diameter [A]		90

Calculation Reference	13

Turbine Distance from A End (km)	7.1
Turbine Distance from Z End (km)	8.5
Link Length (km)	15.6

Second Fresnel Zone Radius [B] (m)	71.0
Turbine Distance from Link Path [C] (m)	82.9
Clearance between Tip and Zone [D] (m)	-33.0

Additional Clearance [E] (m)	25
Remaining Clearance Tip - Zone [F] (m)	-58.0



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Exclusion Distance Calculation 2D [ClearanceFresnel2D01]

PAGERPOWER aviation studies

	A End	Z End
Link Description	Link 3	Link 3
Easting	431119	417723
Northing	396898	404864
Frequency GHz (e.g. 13)		0.46

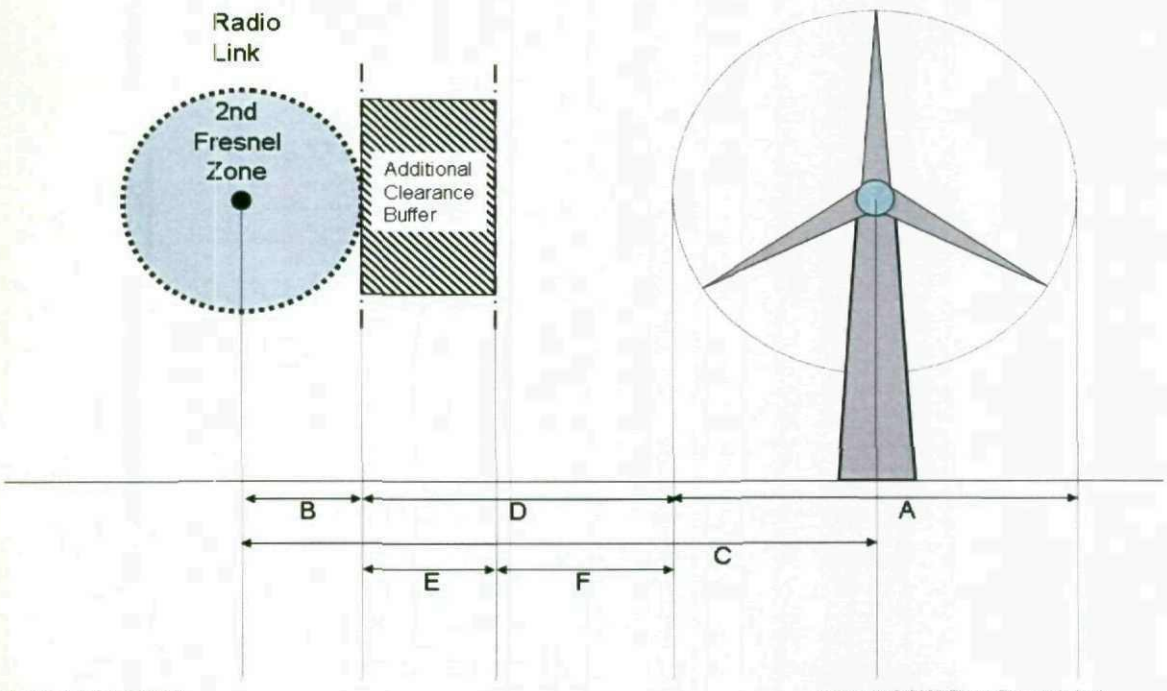
Turbine	T4	T4
Turbine Easting		425287
Turbine Northing		400318
Turbine Rotor Diameter [A]		90

Calculation Reference	14

Turbine Distance from A End (km)	6.8
Turbine Distance from Z End (km)	8.8
Link Length (km)	15.6

Second Fresnel Zone Radius [B] (m)	70.6
Turbine Distance from Link Path [C] (m)	41.3
Clearance between Tip and Zone [D] (m)	-74.4

Additional Clearance [E] (m)	25
Remaining Clearance Tip - Zone [F] (m)	-99.4



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Exclusion Distance Calculation 2D [ClearanceFresnel2D01]

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	A End	Z End
Link Description	Link 3	Link 3
Easting	431119	417723
Northing	396898	404864
Frequency GHz (e.g. 13)		0.46

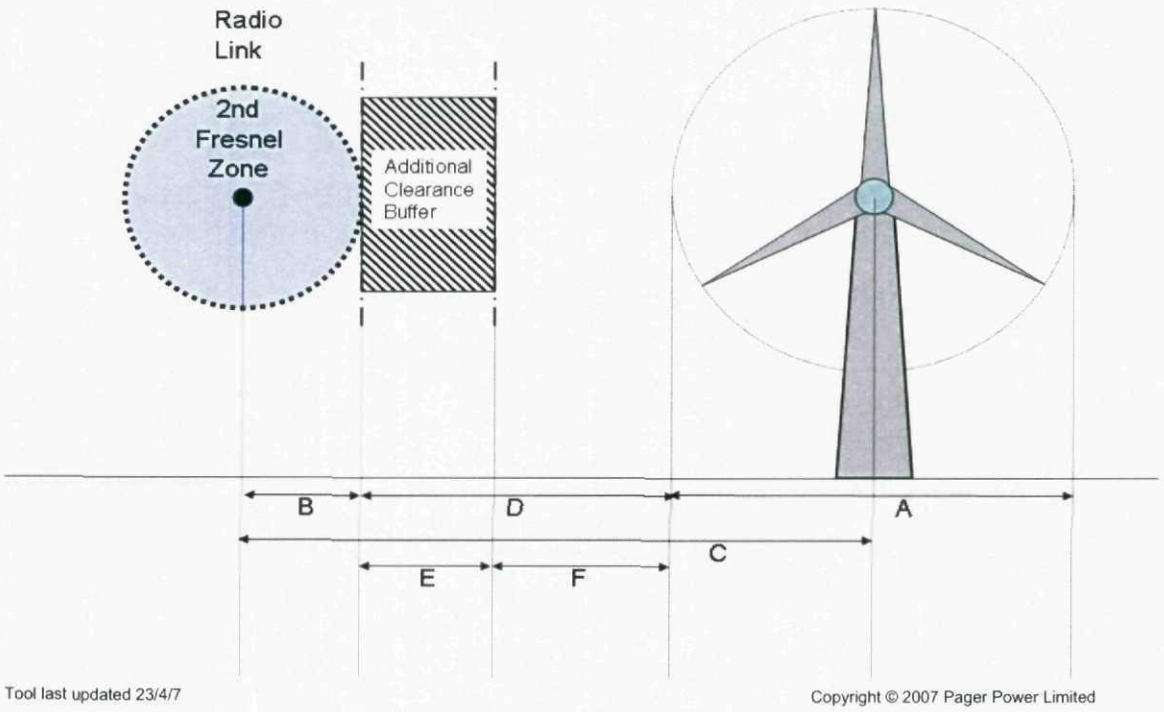
Turbine	T5	T5
Turbine Easting		425634
Turbine Northing		400170
Turbine Rotor Diameter [A]		90

Calculation Reference	15

Turbine Distance from A End (km)	6.4
Turbine Distance from Z End (km)	9.2
Link Length (km)	15.6

Second Fresnel Zone Radius [B] (m)	70.1
Turbine Distance from Link Path [C] (m)	8.9
Clearance between Tip and Zone [D] (m)	-106.2

Additional Clearance [E] (m)	25
Remaining Clearance Tip - Zone [F] (m)	-131.2



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