ELECTRICITY ACT 1989 (SECTION 36 AND SCHEDULE 8)
TOWN AND COUNTRY PLANNING ACT 1990 (SECTION 90)
THE ELECTRICITY GENERATION STATIONS AND OVERHEAD LINES (INQUIRIES PROCEDURE)(ENGLAND AND WALES) RULES 2007

PUBLIC INQUIRY TO CONSIDER SECTION 36 ELECTRICITY ACT 1989 APPLICATIONS BY:

(1) STEADINGS WINDFARM LIMITED FOR CONSENT AND DEEMED PLANNING PERMISSION TO CONSTRUCT AND OPERATE A WINDFARM AT KIRKWHELPINGTON, NORTHUMBERLAND (KNOWN AS STEADINGS)

(2) AMEC PROJECT INVESTMENTS LIMITED FOR CONSENT AND DEEMED PLANNING PERMISSION TO CONSTRUCT AND OPERATE A WINDFARM AT RAY ESTATE, NORTHUMBERLAND (KNOWN AS RAY WINDFARM)

(3) WIND PROSPECTS DEVELOPMENT LIMITED FOR CONSENT AND DEEMED PLANNING PERMISSION TO CONSTRUCT AND OPERATE A WINDFARM AT GREEN RIGG FELL, BIRTLEY, NORTHUMBERLAND (KNOWN AS GREEN RIGG WINDFARM)

MARK SPENCER
REBUTTAL PROOF OF EVIDENCE IN SUPPORT OF OBJECTION BY MINISTRY OF DEFENCE

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Rebuttal proof

1. This proof addresses the technical evidence given in the proofs of evidence submitted by Alan Collinson [WPD/6/1 and 6/2] and John Taylor [WPD/5/2 and WPD/5/3] on behalf of Wind Prospects Development Limited and Kenneth Gwynne James [SWFL 8/2] and Malcolm Spaven [SWFL/10/2 and SWFL 10/3] on behalf of Steadings Windfarm Limited.

2. The operational radar issues covered in the proofs of evidence provided by the developers' witnesses are dealt with in the rebuttal proof of Colin Deane, a draft of which I have read.

AMEC

3. AMEC's witnesses chose not to set out their technical case in relation to the MoD (Turner §(40) pg 11; Warren-King [AMEC/9/1] §8.18 pg 26). Both witnesses, however, undertook to provide supplementary information or documentation setting out their case. Having told this Inquiry by letter on 14 December 2007 (and again at a special meeting on 20 December 2007) that it could not properly deal with the aviation issue and so did not intend to try, on 6 February 2007 AMEC informed the Inquiry that it now intended to "play a full part in the analysis of" the aviation issue (AMEC/0/58 §2). The MoD had expected that such a change of stance would be accompanied by, or at least followed immediately by, the provision of the promised information, as this information lies at the heart of "playing a full part" in the aviation issues. But it was not forthcoming. And so, on 14 February, the MoD wrote to AMEC reminding it that the MoD needed the promised supplementary information and documentation.

4. As the Inquiry is aware, that information was only provided on Tuesday 19 February 2008, in the supplementary proof of evidence of Vic Warren-King [AMEC/9/4] and the QinetiQ report "Radar Impact Modelling for the Proposed Ray Wind Farm". The provision of this information some 19 hours before the original deadline for submission of rebuttal proofs made it entirely impossible for me to submit my rebuttal proof.It will be appreciated that this is a highly technical area and a proper consideration and response is not an overnight task.

5. I have tried as best I can in the time available to give a clear initial response to AMEC's analysis and proposed mitigations. It is plain, however, that considerable further work is required. I will therefore have to provide supplementary evidence at a later date in order to give my full response.

Technical Issues

6. Before looking at the specific mitigations proposed by the developers, I will examine some of the general technical issues raised in the proofs of evidence.

Report CD301

7. Collinson raises concerns about the limitations of CD301, the 2005 AWC report “The Effects of Wind Turbines on ATC Radars” (§4.1-4.5 pgs 5-6). In doing this, he tries to cast doubt on the significance that report places on wind turbines being within LOS of an ATC radar (§4.5 and Appendix B to this Proof).

8. This in turn reflects on the MoD’s policy of using LOS as an initial indicator of possible confliction with an ATC radar. I will address below the developments in the MoD’s understanding of the effects of wind turbines on ATC radars. But first it should be pointed out that LOS remains a technically acceptable and practically useful initial indicator of possible confliction with an ATC radar. Once LOS has been established, this triggers another level of operational analysis which will feed into the initial conclusion that a proposed windfarm may conflict with an ATC radar.

9. In lay terms, this is the beginning, rather than the end of the story. But, despite Collinson’s attempts to undermine it, the MoD’s methodology based on LOS as an initial indicator is sound.

10. It is obviously the case that the MoD‘s (and indeed industry’s) understanding of the effect of wind turbines on ATC radars has developed significantly since the 2004 trial that formed the basis for CD301. The MoD is well aware that LOS is not the only issue in predicting the effect a proposed windfarm will have on an ATC radar. The predicted signal strength of the turbines is also recognised to be an important indicator.

11. I observed some of the 2004 trial and am well versed in the findings in CD301. I have also had access to the results of the second ATC trial, conducted at Clatter, South Wales in 2006, which for now remain classified. Also, I am well aware of, and follow, the methodology set out in the CAA’s Policy and Guidelines on Wind Turbines (CAP 764). This should be obvious from the analyses conducted in relation to the current proposed developments

12. It cannot be disputed that the proposed developments are in LOS of the Spadeadam Watchman radars. It also cannot be disputed that the predicted signal

strength of the proposed developments is such that they will undoubtedly be above the receiver detection threshold of the two radars servicing RAF Spadeadam (i.e. the amplitude of the signals returned by the turbines is consistently above the level at which, unless special filtering or other signal processing measures are taken, the radar system causes an object to be shown on a radar operator's display).

13. Collinson also questions CD301's indication that there should be "particular concern if a radar is within 30nm of the wind turbine" (§4.4 pg 6). The proposed location of Green Rigg is 16 nm from Berry Hill and 18 nm from Deadwater Fell. The proposed location of Steadings is 18 nm from Berry Hill and 21 nm from Deadwater Fell. The proposed location of Ray Estates is 17 nm from Berry Hill and [19 nm from Deadwater Fell.

14. The use of 30nm is, believed to be no more than a useful rule of thumb. The curvature of the earth is such that, crudely calculated, an object **x** feet high is visible **y** miles away according to the formula: $\mathbf{y = \sqrt{1.5x}}$ Thus, for example, if the tip of a turbine is 400ft above the turbine base, the tip will be visible to a viewer at base level approximately 24½ miles away, assuming that both the turbine base and the viewer are at the same amsl (and there are no intervening obstructions). In fact, because a radar is raised above base, in the above example the tip of the turbine would be visible at a distance greater than 24½ miles.

Shadowing

15. Taylor comments that, in his experience, the shadow effect caused by wind turbines has been "greatly overstated" (§3.5 pg 8). The discussion of shadowing by Collinson, Taylor's technical colleague, is more careful and acknowledges that shadowing does occur (§8.1-2 pgs 20-21). His point is that the size of the shadow caused by a wind turbine is "likely to be of the order of one to two hundred meters".

16. It is not known how this figure was produced. Collinson makes reference to a trial conducted by Taylor, but Taylor does not provide the details of this trial (or even refer to it) in his Proof of Evidence. I have not seen any documentation of how trial was conducted and what was found, so it is not known:

a. What type of aircraft was used to test the size of the shadow[1]
b. What height the aircraft was flying
c. What class of airspace was tested

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[1] Bearing in mind that a Hawk fighter jet presents a $1m^2$ target, a trial in which a large aircraft was used would not be particularly elucidating from the MoD's point of view.

d. What range the aircraft was flying

Any results are meaningless without this data.

17. It is certainly the case that, as levels of knowledge about the effects of wind farms on ATC radars have increased, obscuration rather than shadowing has become the main problem. But this is not to say that shadowing is not still an issue. The shadow from the combined number of wind turbines for the three proposed developments could be significant.

Great Orton and other windfarms in LOS of Spadeadam

18. In his Summary of Proof of Evidence, Collinson raises a question concerning the windfarm a Great Orton:

> "Mr Taylor and I were able to identify an existing wind turbine site (Great Orton) that is notionally in the coverage of the Spadeadam radar. The range and elevation of Great Orton from Spadeadam is similar to that of the proposed wind turbine site at Green Rigg. Mr Taylor saw no evidence of an impact on the ATC displays from Great Orton". (§1.4 pg 3).

This is elaborated in Appendix B to his main Proof (§B1-4).

19. It is the case that the Great Orton windfarm is in LOS of Spadeadam.[2] While I appreciate that the word "similar" is fairly elastic, it is stretching it somewhat to say that the range and elevation of Great Orton from Spadeadam is similar to that of the proposed wind turbine site at Green Rigg. Great Orton is 29 miles from the radar at Deadwater Fell and 21 miles from the radar at Berry Hill. Green Rigg is approximately 18 miles from the radar at Deadwater Fell and approximately 16 miles from the radar at Berry Hill. Great Orton is 70 m amsl, Green Rigg is 287m amsl. The wind turbines at Great Orton are 68.5 m from base to turbine tip. The wind turbines at Green Rigg are 100 m from base to turbine tip. Great Orton has 6 turbines. Green Rigg has 18 turbines. The resultant turbine radar cross-section presented by the turbines at Great Orton to the radar at Berry Hill is considerably smaller than that which would be presented by the turbines at Green Rigg.

20. It needs to be remembered that at distance, the cross-section presented by a turbine will be related to the circular segment area described by the chord (created by the horizon) and the visible arc of the turbine blade. The area of this cross-section (which strongly influences the signal strength) is not linearly related to the length of the blade tip that is in LOS to the radar. For example, a 100m

[2] Unfortunately, incorrect information about the positioning of windfarm was provided on its website, and it was accordingly omitted from Annex D to my Proof of Evidence.

diameter turbine of which only the top 4m of blade is within LOS of a radar presents a circular segment of 107.5m², but a 100m turbine of which only the top 8.1m of blade is within LOS of the radar presents a circular segment of 300m². Nevertheless, because of Taylor and Collinson's thesis, I investigated whether the windfarm was displayed on the radars. The results of this investigation are included in my Technical Assessment of the existing windfarms in LOS of Spadeadam, which appears as **Appendix 1** to this Rebuttal Proof.

21. In order to complete this Technical Assessment, I spent two days at Spadeadam (31 Jan – 1 Feb 08) and assessed all the known windfarms whose predicted signal strength was above the receiver threshold of the Watchman radar to determine if they were displayed on the operators' display.

22. I was able to take screen shots of the returns being displayed from several windfarms in the vicinity of the Range. Great Orton was one of the windfarms causing clutter during my visit, and the screen shots of this display can be seen at Figure 3 of my Report (Appendix 1 §14 pg 5).

23. It is well known that windfarms do not produce consistent amounts of clutter and that in the case of some turbines (especially those further away from the radar) there are times that those turbines, despite being within LOS of a radar, produce no signal above the threshold of the radar (despite doing so at other times). It is this very phenomenon that contributes to the difficulties for radar operators in distinguishing the signals produced from a wind turbine from that produced by an aircraft. It is therefore not surprising that some of the existing windfarms in LOS of Spadeadam (which are both further away from RAF Spadeadam and have fewer and smaller turbines than any of the proposed wind farms) were not producing returns on the day of the developers' site visit to the Range.

24. I also took the opportunity of my visit to Spadeadam to validate the predictions that were made in Annex D to my Proof of Evidence. This work can be seen in §5-10 (pgs 2-4) and §15-17 (5-6) of my Report (Appendix 1).

25. The predictions were validated for all the windfarms except Tow Law and Lowca. As with the wind farm at Great Orton, it is possible that the Tow Law turbines were simply not producing returns on the days of my visit, but will do so intermittently at other times (§10 pg 4). It is to be noted that the wind farm at Tow Law has 3 turbines; that these are 76.4 km from the radar at Deadwater Fell (it is not in LOS of Berry Hill); that the turbines are at 292 m amsl; and that they have a

base to turbine tip height of 75 m. In relation to Lowca, the predicted signal strength is very close to the minimum discernible returns that can be picked up by the Spadeadam radars (§6 Table 1 pg 2). It was thus not surprising that Lowca was not showing returns during my visit.

Technical Mitigations

26. The MoD's continuing position is that workable technical mitigations for the clutter produced by wind turbines do not currently exist. There is significant and ongoing involvement of the MoD in assisting the development and trailing of such mitigations, both on a technical and an operational level. I have not seen anything credible to suggest that these efforts have any chance of coming to fruition in the next five years. Given the technical obstacles that need to be overcome and given that radar technology is now quite mature, based on my experience in radar it is my professional opinion that there is no real chance that these efforts will come to fruition in the next five years.

27. Warren-King is therefore mistaken when he asserts that technical solutions such as ADT or SENSIS, or Non Auto Initiation Zones (also referred to as Non-Acquisition Areas), may be granted regulatory approval by 2011 (AMEC/9/1 §9.4 pg 27). It is particularly unlikely that mitigations such as stealth technology, which he also mentions, will be available in anything like that timescale.

Tilting the Radar

28. The witnesses for Wind Prospects Development Limited suggest that tilting one of the Spadeadam radars may provide a technical solution to the clutter created by the proposed developments ("**the tilting mitigation**").[3] Taylor puts the suggestion as follows:

> "An alternate mitigation would be to combine the two Spadeadam radars into a composite picture. Any clutter from the windfarm could be removed using range and azimuth gating (RAG) (a system in the radar for removing clutter) from one of the radars. The second radar could be very slightly tilted so that the main beam passed over the windfarm. Data from the tilted radar could then be used to 'fill in' the gap in coverage created by the RAG circuit in the vicinity of Green Rigg" (§6.10.2 pg 31).

[3] Collinson §10.4 (pg 26) and Taylor §6.10.2 (pg 31).

29. Collinson separates out tilting (§10.4 pg 26) and producing a composite picture (§10.5 pg 27), but it is understood that, in order to be workable, the tilting mitigation would require these two aspects to function together.[4]

30. This type of tilting mitigation is proposed for the Whitelees windfarm, which is in LOS of Glasgow airport. James relates that a mitigation using the supplementary radar at Kincardine is being implemented (§9.3.1 pg 13). Having spoken to NATS, this system is currently being installed however the supplementary radar has been positioned such that there is believed to be sufficient terrain screening between the radar and the Whitelees windfarm (i.e. no line-of-sight exists). There is, therefore, no requirement to provide any mechanical tilt to mitigate from windfarms and the antenna tilt is set to 0°.

31. I have carried out an initial technical study of the tilting mitigation proposed by James and Collinson. The possible tilting of either the Berry Hill radar or the Deadwater Fell radar was examined.[5] While this is a valuable beginning to the work required to pursue the tilting mitigation as a full solution to windfarm clutter, it should be remembered that significant further study and trailing would be required before this mitigation could be implemented.

32. The technical report of the study I conducted is attached to my proof as **Appendix 2**. I conclude that the degree of tilt necessary to remove each of the proposed windfarms from the radar consoles at Spadeadam differs from development to development:

a. In relation to Green Rigg, Berry Hill would have to be tilted 2° and Deadwater Fell 2.5°;
b. In relation to Steadings, Berry Hill would have to be tilted greater than 4° and Deadwater Fell 3°;
c. In relation to Ray Estates, Berry Hill would have to be tilted greater than 3° and Deadwater Fell 2.5°

33. The paragraphs below seek to explain my methodology and distil my findings in simple language. I will also go on to address the practical implications of implementing the tilting mitigation, which are not covered in the technical report.

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[4] The composite picture mitigation is also proposed independently of tilting, with Lowther Hill as the proposed fill-in radar.

[5] Operationally it would be undesirable to tilt Deadwater Fell, as its current tilt of -1° was chosen specifically so that coverage of low flying aircraft could be achieved. Nevertheless, it was thought prudent to examine both the radars.

34. I note that Qinetiq, contracted by AMEC, have also analysed the possibility of tilting the radar antennae (§7.1 pgs 37-40). Due to the lateness of receipt of Qinetiq's report, I have not been able to examine their methodology or conclusions in any great detail. I observe, however, that their conclusions are similar *to my own,*and that they dismiss the mitigation as being "severely detrimental to the detection performance of the reference aircraft" (§7.4 pg 45).

35. My technical report focuses on two areas:

a. Determining the current predicted coverage of the proposed developments, and comparing this to the predicted coverage if tilting is introduced; and
b. Determining the amount of mechanical tilt required to ensure that the signal strength of the proposed windfarms would be sufficiently diminished for the clutter not to appear on the ATCOs consoles.

36. Usually, Watchman radars are tilted by half or one degree (Report Table 2 §7 pg 3). This tilt can either be positive or negative – in lay terms, either up away from the ground or down towards the ground.

37. The strength of a signal picked up by a radar is measured in decibels per milliwatt ["dBm"]. A signal has to be above a certain dBm in order for the radar to detect that signal. This is termed the "minimum discernible signal". The minimum discernible signal for the Spadeadam Watchman radars is –121dBm. Therefore, any signal greater than that (ie any negative number closer to 0) will, unless the subject of filtering or other processing, display on the radar console.

38. In order to prevent the proposed developments from displaying on the radar console, it is necessary to lift the radar beam so that the returns being produced by the wind turbines are –121dBm or below. In very lay terms, tilting the radar achieves this because it shifts the part of the beam that is particularly good at picking up signals (known as the "gain") away from the returns being produced by the turbines. In effect, it makes the signals appear weaker to the radar.

39. The relationship between the strength of a radar signal and the angle of the gain above the horizon can be expressed mathematically. Using this, I was able to determine, for both Berry Hill and Deadwater Fell, how much a half degree tilt up from the horizon would reduce the predicted strength of the signals from the

proposed windfarms. These figures, in half degree increments, are contained in my Report: Berry Hill in Table 3 (§8 pg 3) and Deadwater Fell in Table 6 (§14 pg 7).

40. As this table shows, in order for the radar to be tilted over just one of the proposed windfarms, a tilt of 2° is necessary. In order to tilt over all the proposed developments, a tilt of 4° is necessary. On any normal view this is not, as James suggested, a "very slight" tilt (§6.10.2 pg 31).

41. I am not aware of any Watchman radar antennae used in the United Kingdom for ATC that operate with a 4° tilt. I have discussed with my colleagues whether it would actually be feasible to tilt a Watchman antenna to that degree. Lee Ashton, a contractor with the MoD, mentioned that he had once commissioned a Watchman radar for use as an engineering training rig at RAF Locking and had tilted it to 5° in order to overcome interference issues with other radars in the vicinity. He confirmed that the radar did function. This is the only indication I have had that such a degree of tilting is physically possible in a training environment. It is therefore not known whether such a degree of tilt can be achieved in an ATC environment.

42. Even a 2° tilt is double the normal capacity of the Watchman radar. It is to be remembered that a radar includes a large heavy metal dish rotating at approximately 16rpm for extended periods. It is a precise scientific instrument. Tilting the radar beyond 1º may affect the balance of the unit, the power needed to rotate the dish and the wear on the bearings. I know of nothing from the manufacturers of the Watchman radar that countenances such a practice. More testing is required before it can safely be said that the radar will operate within specification (including meeting its anticipated lifespan and periods between servicing) if tilted beyond 1º.

43. The operational impact of tilting the radar antenna between 2° and 4° is discussed in Colin Deane's rebuttal proof at §100-103.

The practical implications of implementing the tilting mitigation

44. In order to tilt a radar antenna, the antenna has to be removed from its mount, and shims have to be inserted to physically lift the system. Shims can be made in either 1° or ½° segments, a 2° tilt will therefore require that two shims be inserted under the Watchman antenna.

45. The tilting mitigation would therefore require that the radar to be tilted be taken off-line. In relation to the Deadwater Fell Antenna, the radome will have to be removed (a radome is physical structure which is used to reduce weather damage to a radar system). For both Deadwater Fell and Berry Hill, the antenna will have to be removed, the shims inserted and the antenna bolted back on. It is estimated that this would take up to two weeks and is dependant upon weather conditions.

46. Once the physical lifting had occurred, the radar system would have to be recommissioned. It is estimated that it would take at least a further three weeks to get radar up to specification.

47. After recommissioning, flight trials would have to be completed in order to verify that the radar was fully functional. The MoD cannot rely on a radar to provide ATS unless that radar has been fully flight checked. A new flight trial for the tilted radar would have to be designed, as no such trial currently exists. The flight trial would last a week, with up to 8 hrs a day of flying. This kind of flight checking costs an average of £3000 an hour.

48. If the radar passed the flight check, it would be ready for use. Accordingly, in order to implement the tilting mitigation, the chosen radar would have to be out of service for at least six weeks. It is notable that neither of the two radars in question have, since their original commissioning (Deadwater Fell in 1990 and Berry Hill in 2005) , had their tilt increased or decreased or otherwise been interfered with in the way now being suggested by the developers.

Producing a composite picture

49. The radar consoles at Spadeadam cannot at present show a composite picture of the feeds from Deadwater Fell and Berry Hill. The radar feeds are currently selectable (one at a time) on each of the four displays. Accordingly, for the tilting mitigation to work the radar consoles would have to be upgraded.

50. I have not had an opportunity to conduct a detailed technical analysis of this upgrading. I have, however, discussed it with Flight Refuelling Limited, the manufacturers of the consoles used at Spadeadam. They believe that it is possible for a composite or “mosaiced” picture of two radar feeds to be produced on a single screen, such that the predominant image is from one radar, with a small mosaic of image from the second radar superimposed in a specific area of the screen. Cost and implementation timescales are yet to be determined

51. It should be noted, however, that it would have to be demonstrated that this technology is reliable before the upgrading of the radar consoles could occur. Also, the upgraded system would have to undergo the same specification and flight checking as described above.

Fill-in Radar (Lowther Hill)/Composite picture

52. The witnesses for Steadings Wind Farm Limited mention a variation of the composite picture scenario that forms part of the tilting mitigation, using the terrain shielded Lowther Hill as the patch or mosaic radar (James §9.3-9.33 pg 13; Spaven §7.14 pg 10 and the draft Spaven report §5.19 pg 32, §6.43 pg 46).

53. Strangely, the witnesses claim that their composite picture mitigation is “not required” for the proposed developments. It is not clear why they go into detail about a possible mitigation which is “not required”, or why it is not required.

54. In any event, it suffers from the following difficulties:

a. the Lowther Hill radar is plot extracted and would need to be “mosaiced” with the video from one of the Spadeadam radar systems

b. The Lowther Hill radar rotates at a lower speed so the console update rate over the Windfarm region will be less

c. Radar systems use slant range to display the position of targets, the location of Lowther Hill is such that the two “mosaicing” radar system will present positional inaccuracies (known as slant rang errors) and the target is likely to jump in position when the display changes from one radar feed to the other

55. So, while it is believed possible to produce a composite picture, it is not currently feasible on the Spadeadam radars, and it is not know how long the technology would take to develop and implement.

56. Also, the Lowther Hill radar does not have sufficient radar coverage of the area of the proposed wind farms at the requisite flight levels for the mitigation to work. Unfortunately, it suffers from the opposite problem to the Spadeadam radars in the tilting mitigation – at 3000ft agl the terrain shields too much of the area from the radar. In order for the composite picture to be reliable enough to be used for ATC, the patching radar has to be able to see for 10 nm around the wind farms. This is so that an aircraft can maintain separation of 5nm from the wind farms and be sure that it is also 5nm away from any other traffic or hazards near the wind

farms. Lowther Hill does not have a clear 10 nm view around the proposed wind farms.

57. Figure 1 shows Lowther Hill radar predicted coverage for a Hawk aircraft flying at an altitude of 2500ft above ground level, the blue shaded areas represent the areas in which the aircraft would be seen, it is important to note the coverage north and north east of the proposed windfarms is intermittent at best.

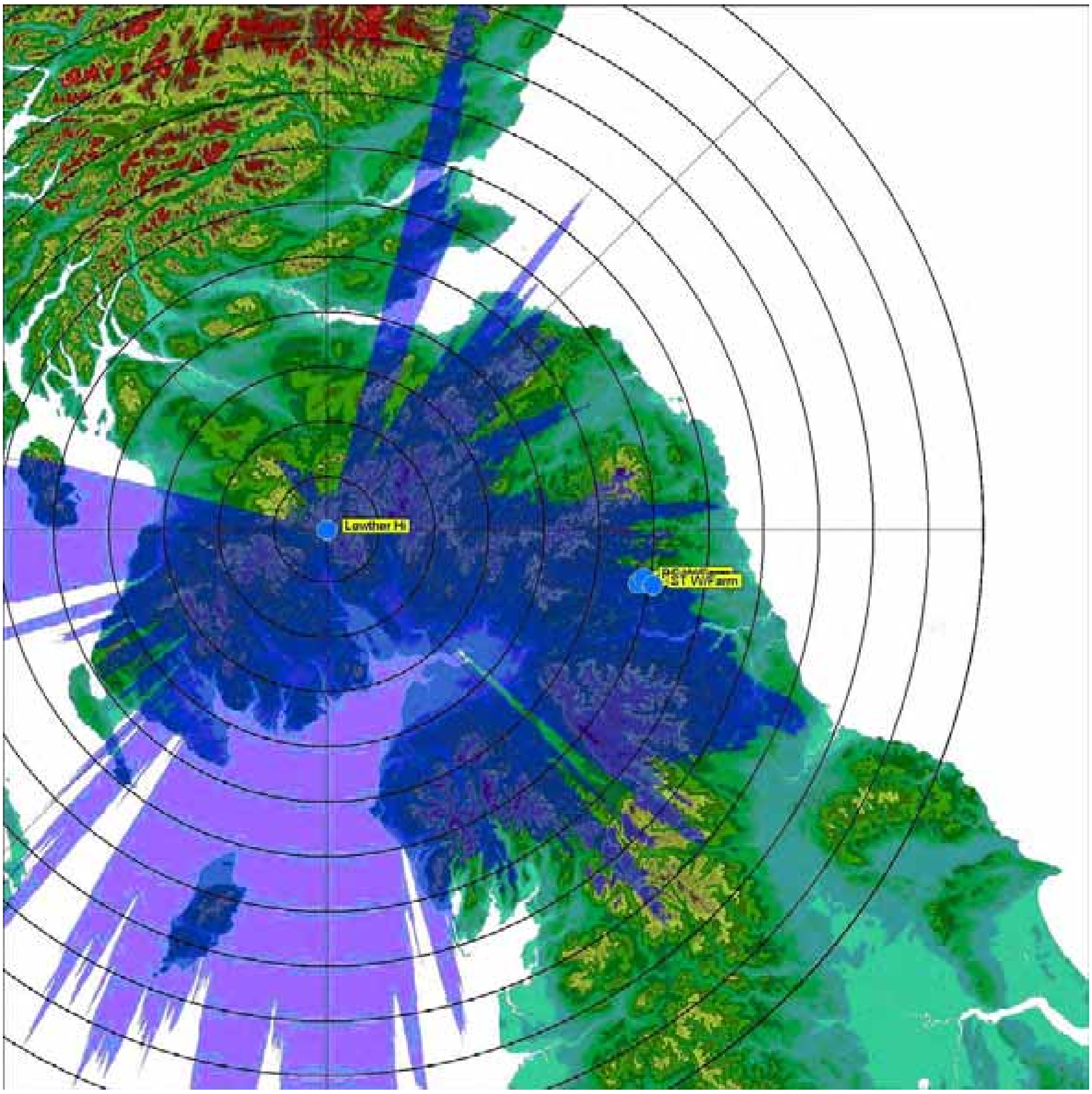

Figure 1 – Lowther Hill predicted radar coverage for a hawk target flying at an altitude of 2500ft above ground level
Scale: Radar Range rings at 10nm intervals

58. The operational use made of the Lowther Hill feed is discussed at of Colin Deane's Rebuttal Proof (§76-77).

59. I note that Qinetiq have also analysed the possibility of a patch-in solution from Lowther Hill (§7.2 pgs 42-43). Again, due to the lateness of receipt of Qinetiq's report, I have not been able to examine their methodology or conclusions in any great detail. I observe that they conclude that the mitigation "may be possible" (§7.4 pg 45), but go no further than that.

Fill-in radar – Berry Hill radar and AMEC's mitigation

60. Warren-King states in his supplementary statement that the Qinetiq modelling of Berry Hill radar shows that "the majority of the Ray turbines have less than a single blade in LoS" of the radar (AMEC/9/1 § 8.18.4 pg 26). The results from the Qinetiq modelling differ significantly to those of my analysis, I believe the reasons for this are:

a. Differences in modelling techniques - at Paragraph 20 of Mr Turner's rebuttal proof he describes the terrain data used in the QinetiQ modelling is from the Shuttle Radar Topography Mission (SRTM) which includes the effects of man-made structures. The MoD have purposely not used this data for the modelling of windfarms as man-made structure are only semi-permanent, therefore to use them as mitigation against windfarms should only be considered if the structures are identified and owned and controlled by either the MoD or the windfarm developers.
b. Incorrect Radar Parameters – Having reviewed the Radar Parameters used by QinetiQ during their Radar Impact Modelling it was discovered the pulse width used is incorrect for both the Berry Hill and Deadwater Fell Watchman radar system QinetiQ used 8.5µsec when in fact the actual figure is 20µsec. The radar pulse-width is vital in calculating the radar performance and therefore this error is expected to have resulted in the effects of the wind turbines being significantly understated and therefore more clutter displayed on the Berry Hill Operators' display than that suggested by Mr King.
c. The Qinetiq Radar Impact Modelling report also states the location of Berry Hill Radar as N53° 03'00.8", W02°33'12.8", the actual location of the Berry Hill Radar is N55° 03'00.8", W02°33'12.8". This may well merely be a typing error, but it will have to be confirmed that the correct location was used in the tests.

61. As §8.18.6 of Warren-King's supplementary proof makes clear, AMEC is proposing a variation of the fill-in mitigation (AMEC/9/4 pg 27). Their proposal relies on a composite picture of Berry Hill and Deadwater fell, which they claim can

be produced, in relation to the Ray windfarm only, without having to tilt Berry Hill. As stated previously the clutter levels presented to Berry Hill radar from the steading windfarm is believed to have been estimated during the QinetiQ Radar Impact Modelling and there this is not believed a feasible mitigation technique.

62. As this mitigation relies on a composite picture of the Deadwater Fell and Berry Hill radars being produced, my comments in §46-48 above are repeated.

63. Although I have been able to provide an initial evaluation of Qinetiq's methodology and results in the short space of time since their report was submitted, it is clear that more analysis is necessary. Accordingly, I will have to provide supplementary evidence at a later date in order to give my full response.

Installing a third radar at Spadeadam

64. AMEC have now offered to finance, "either in full or in part", the installation of a third radar for the use of Spadeadam ATCO, which would be terrain shielded from the proposed Ray windfarm (Warren-King AMEC/9/4 §8.18.8 pg 27). It is highly unlikely that it would be possible to site, build, test and bring a new radar into operation within five years

65. This mitigation is examined in the Qinetiq report at §7.3 (pgs 43-45). Clearly, 44 hours is far from sufficient for a proposal of this complexity properly to be evaluated. Accordingly, supplementary evidence will have to be provided at a later date in order for the MoD to give its full response.

66. My initial reactions are as follows.

a. The methodology used, "inverse LoS map", is sound, however the MoD would require that any potential radar site is sufficiently screened from the effects of the windfarm utilising terrain screening only and not man made obstructions.
b. It is not clear which type of radar system is being proposed: plot extracted or non plot extracted. This makes a difference.
c. Warren-King says in his supplementary proof that the installation of the new radar would be either partially or fully financed by the developer (§8.18.8 pg 27). It is not clear whether this would include financing the specification, maintenance, support, training, optimisation, or acceptance of the radar.

d. The installation of a third Radar at RAF Spadeadam may require complex frequency management to allow all the three RAF Spadeadam radar systems and any Civilian Radar systems to operate in harmony. Frequency management is a complex process and with so many ATC radar systems within the vicinity of RAF Spadeadam, at worst case, it may not be possible to identify suitable operational frequencies for the third radar or it may require one or both of the RAF Spadeadam radar systems to have a change of frequency. Were this to be required, the radar to be changed would have to be taken off-line. The practical implications are similar to those outlined above in relation to taking the radar off-line for the tilting mitigation: :
   i. The radar system would have to be recommissioned. It is estimated that it would take at least three weeks to get radar up to specification.
   ii. After recommissioning, flight trials would have to be completed in order to verify that the radar was fully functional at the new frequencies. The MoD cannot rely on a radar to provide ATS unless that radar has been fully flight checked. The flight trial would last a week, with up to 8 hrs a day of flying. This kind of flight checking costs an average of £3000 an hour.
   iii. If the radar passed the flight check, it would be ready for use. Accordingly, in order to implement the change of frequency, the chosen radar would have to be out of service for at least four weeks.

e. The proposal relies on a composite picture of either Berry Hill or Deadwater fell and the third Radar, accordingly my comments in paragraphs above about producing a composite picture are repeated,

67. Once the windfarm developers have identified potentially suitable sites for the third Radar the MoD would need to confirm any predicted radar coverage is suitable for ATC Spadeadam

Range Azimuth Gating (RAG) mapping

68. RAG mapping is a computerised process by which a defined region of radar coverage is blanked out, effectively editing returns and clutter out of the radar map.

69. Collinson proposes that RAG mapping could be used as a possible mitigation for the proposed windfarms (§10.1 pgs 24-25). Again, the operational feasibility of this is discussed in Colin Deane's Rebuttal Proof (§89-92)

70. The Watchman radar has three processing channels; Normal Radar, Ground Clutter Filter and Moving Clutter Filter. It is possible to optimise a Watchman radar using RAG which allows the outputs from each of the three processing channels to be turned on and off on a range and azimuth basis. The Deadwater Fell currently has RAG, although this is not used on all three of the channels at the same time. To remove the clutter from a windfarm it is likely that all 3 channels would need to be turned off in the windfarm region thereby removing any radar returns in that area.

Plot Extraction - ADT/Sensis

71. Plot extraction relates to the computerised display of the radar returns. The computer program picks up a radar target, plots the centre of the target's return, and, in very lay terms, joins the dots of each return to produce a computerised model of the track. Once the program has extracted where a target's plots are on the screen, it predicts where the next plot is likely to occur, then as long as this plot is within a preset tracking algorithm the aircraft will be displayed on the radar console

72. There are two things to note about plot extraction. First, it is a method of predicting the path of a moving radar return. Generally, plot extraction systems expect aircraft to be travelling in straight lines, and they work best when this is the case. There are algorithms which are used for manoeuvring aircraft, but these are less reliable especially if the aircraft is flying in areas of radar clutter such as windfarms.

73. Second, plot extraction systems need to scan a prospective target three times in order for it to be designated as a valid target (aircraft) and shown on the radar screen. This means that, until the third sweep of the radar, a moving target will not be depicted because the plot extraction program is acquiring its data. This may be acceptable in controlled airspace for civilian aircraft moving in straight lines. However, where an aircraft is flying in and out of cover, and not in a straight line, it may not be picked up by a plot extraction system for a significant period of time, because it is never visible for three sweeps of the radar.

74. As is mentioned in Colin Deane's Rebuttal Proof (§92), the ATCOs at Spadeadam can only tolerate the loss of an aircraft for a maximum of two sweeps of the radar. If an aircraft if it is lost for three sweeps, it has to be reidentified. Accordingly, a system that operates on the basis of an inbuilt three-sweep deficit will not meet Spadeadam's basic requirements.

75. It is the case that other parts of the military, in particular the navy, have different requirements. Plot extraction is in use on some of the navy's systems. Up until 2007, although the navy radars were flight checked, the plot extraction systems were not. This has changed, and the contractor, Lee Ashton, has produced flight check specifications for each radar using plot extraction to ensure it functions properly.. The ATC requirements of navy craft, usually operating over the sea, are significantly different from those of Spadeadam. These flight checks were completed summer 2007 and the plot extracted radar systems performed as expected however it should be noted the flight trial is conducted with the aircraft flying on a set radial (straight line) to the radar.

76. Two specific types of plot extraction system currently being developed for military ATC are proposed by AMEC (Warren-King AMEC/9/1 §8.15-16 pg 25) and Wind Prospects Development Limited (Taylor §6.10.3 pg 31) as offering a potential mitigation. These are the SENSIS system, produced by Selex Sistemi Integrati (Selex) and the Advanced Digital Tracker (ADT) being developed by British Aerospace Systems (BAeS)

77. SENSIS works by replacing the radar's receiver with a new unit which performs the plot extraction function. ADT works with the radar's own receiver, but adds a plot extraction system in between the receiver and the radar console.

78. Colin Deane's Rebuttal Proof discusses the results of the 2006 trials of the ADT and SENSIS systems at Clatter in Wales, and the timescale for developing either system into a workable technical solution (§93-99). I endorse his analysis.

Stopping the turbines

79. Taylor proposes that the Green Rigg turbines could be "stopped whenever aircraft under a radar service were required to pass close to a wind farm" (§6.10.1 pg 30). He suggests that the turbines could be pre-programmed to stop, and a "stop button" could be installed in the Spadeadam ATC that would allow stopping at short notice.

80. Taylor further states that Collinson will “demonstrate that when the turbines are stationary, the effect on the radar would be minimal and within acceptable limits for radar performance” (§6.10.1 pg 30).

81. Collinson makes it clear that the turbines will not in fact be stopped, but will be stalled, resulting in the turbines slowing to “less than 1 revolution per minute” (§10.6 pg 28). He claims that this will be sufficient to prevent the turbines from being visible on Spadeadam’s radar screens. I do not know of any other windfarm development where this mitigation has been implemented, and therefore cannot comment on the likelihood of its effectiveness beyond saying that it would, of course, have to be tested to ensure that the effect on the radar would be “minimal”.

82. I also do not know for what lengths of time the developer would find it acceptable for turbine to be stopped on account of radar interference, but such is the extent of the use of RAF Spadeadam that it would be likely to be a good proportion of each day.

Secondary Radar

83. Collinson examines SSR radar and concludes that “there is no technical reason for an objection to Green Rigg on the basis of SSR effects”. I will not address this in detail as I am not the MoD’s technical expert for secondary radar. I can confirm that the CAA has identifies 10nm as the minimum safe distance away from a secondary radar that a windfarm can be situated.

84. I can also confirm that Collinson is correct that SSR can be problematic. Tactical SSRs are notoriously unreliable. The MoD has not had formal trials investigating the effects of wind turbines on SSR. It was planned that the ADT/SENSIS trial would provide an opportunity for this to occur, but the SSR did not function properly on the days of the trial.

85. If SSR is to be used as mitigation, particularly if it is possible that it might operate as the only mitigation for the windfarm clutter, then the effects of that mitigation have to be proven. This is not considered by the witnesses for Steadings Wind Farm Limited, who propose reliance on SSR and a method of ensuring track identity (draft Spaven report §6.15 pgs 39-40).

86. The operational aspects of SSR are discussed in §71-75 of Colin Deane’s Rebuttal Proof.

Errata

87. It should be noted that I was mistaken in my Proof of Evidence §11-13 (pg 8) about the towns near which the proposed developments are situated. I stated:

a. Green Rigg windfarm is in Hartside, Bellingham, when in fact it is in Birtley;
b. Ray Estates windfarm is in Humbleton, Haydon Bridge when in fact is lies between Risdale in the west and East Woodburn and Knowesgate in the east.
c. Steadings windfarm is in Great Bavington, Co. Durham, when in fact it is between Kirkwhelpington and Throckrington.

88. The mistakes only extended to the towns named. I have double checked, and the grid locations of the turbines are all correct. Accordingly, all the LOS analyses and the various tables giving locational information about the proposed windfarms are accurate.

M SPENCER
ADATS-IPT-TB3B