North Uist Wind Farm Impact Assessment

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1 Introduction

1.1 Background and aims

The North Uist Development Company, the Customer, is a community development company that intends to build two wind turbines in North Uist. The Ministry of Defence (MOD) has objected [1] to the development on the grounds of interference to the Benbecula (South Clettraval) Air Defence (AD) radar and the Hebrides range control radars (RCRs).

Initial checks by QinetiQ show the potentially affected radar systems are:

- Benbecula AD radar;
- Benbecula secondary surveillance radar (SSR);
- Hebrides Range, St. Kilda RCR;
- Hebrides Range, South Uist RCR; and
- South Uist wind profile radar.

It is possible that the MOD objection does not include any concern over the impact on the SSR and wind profile radar due to the distance of the proposed wind turbines from these systems. Therefore, this assessment will concentrate on the main concerns; the potential impact on the AD and two RCRs.

QinetiQ has undertaken the following assessments:

- Line of sight (LoS) checks. In this task the LoS from the potentially affected radars to the vicinity of the turbines has been checked in order to quantify the potential benefit of micro-siting the turbines to minimise the visibility of the turbines;
- Top level clutter assessment. The likely appearance of the proposed turbines on each of the three potentially affected radars has been predicted, based on the pulse length and beam width of the radars. The cumulative clutter from other known developments has also been shown, using data from the online Renewable Statistics (RESTATS) and RenewableUK databases [2][3], and details of wind farm projects from the Customer [4];
- Top level operational analysis. The potential operational impact of the projects on the local airspace and operations in the region has been assessed.
- Mitigation discussion. Available mitigation options have been discussed, including appropriate technical mitigations and operational mitigations.

1.2 Proposed wind farm

The proposed wind farm comprises two Enercon E44 wind turbines, each having a tower height of 55 metres and a blade length of 22 metres. Turbine dimensions were provided by the Customer [5]. This gives a maximum blade tip height of 77 metres. The turbine locations [5] in grid reference and latitude/longitude format, along with the turbine identification (ID) numbers are given in Table 1-1. The wind farm layout is shown in Figure 1-1.
1.3 Radar systems, DIO objections and potential impacts

1.3.1 DIO objections

The Customer has received an objection from the Defence Infrastructure Organisation (DIO) to the proposed wind farm due to the potential for unacceptable impacts on three MOD radar systems [1]. The radar systems are:

1. Benbecula AD radar. This is part of a network of AD radars used to compile the Recognised Air Picture in UK airspace;

2. St. Kilda RCR. This is a Watchman radar, similar in functionality to Air Traffic Control (ATC) radars, used to maintain situational awareness of all aircraft movements within the MOD Hebrides Practice and Exercise Area (PEXA); and

<table>
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<th>Grid Reference</th>
<th>Latitude (WGS84), degrees</th>
<th>Longitude (WGS84), degrees</th>
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<td>NF 81393 64642</td>
<td>57.559145</td>
<td>-7.329624</td>
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<td>T2</td>
<td>NF 81408 65157</td>
<td>57.563761</td>
<td>-7.330049</td>
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Table 1-1: Turbine ID numbers and locations

Figure 1-1: proposed wind farm showing turbine ID numbers
3. South Uist RCR. This is also a Watchman radar used to maintain situational awareness in the Hebrides PEXA.

The locations of the radars are shown in Figure 1-2 in relation to the proposed wind farm.

Figure 1-2: Locations of radars (white squares) that are potentially affected by the proposed wind farm (blue square, approximate location)

1.3.2 Potential impacts

The DIO concerns are that the turbines could be detected by the radars and potentially degrade the system performance. The most obvious impact is that if they are detectable, and cannot be filtered out using signal processing techniques, then they will appear on the radar display as clutter, i.e. unwanted plots. Wind turbine clutter can be a distraction to radar operators and can conceal real returns from objects of interest (e.g. planes, missiles). Because wind turbine blades move, and the strength of radar echoes vary, wind turbine clutter tends to be intermittent, rather than static.

If the radar has a tracking capability, wind turbine clutter can degrade tracking performance. The tracking performance can be affected when aircraft fly over an area of clutter. In addition, due to the time-varying nature of turbine clutter, areas of clutter can themselves initiate tracks that could be mistaken for real aircraft.

Wind turbine clutter can also cause a desensitisation of a radar in the vicinity of the turbines, as a result of signal processing techniques trying to suppress the clutter. This can result in a reduced likelihood of detecting objects of interest in this area.

There may also be cumulative effects with other wind turbines in the vicinity of the proposed wind farm. In many cases, the impacts from a single turbine or small group of turbines may be acceptable, but when considered cumulatively with other developments the impacts may be unacceptable.
2 Micro-siting Assessments

2.1 Discussion

Radar operators often use radar LoS visibility\(^1\) as a means of estimating whether a wind turbine will be detectable. The assumption is made that if any part of the turbine is in LoS it will be detectable, otherwise it will be undetectable and have no impact. Clearly this is a simplification, since detection performance also depends on a number of other factors in addition to LoS visibility. Nevertheless, LoS calculations are useful for showing how to micro-site turbines to maximise terrain screening, thus reducing radar impacts.

The QinetiQ digital elevation map (DEM\(^2\)) tool was used to calculate the percentage LoS visibility of the proposed turbines with respect to the three radars under study. In each case the amount of a 77 metre structure, the maximum blade tip height of the proposed turbines that is in LoS to a specified antenna location was calculated.

2.2 Benbecula AD radar

The percentage LoS visibility in the vicinity of the proposed wind farm development is shown in Figure 2-1. The colours represent the percentage of the structure predicted to be in LoS, providing an indication of the degree of terrain screening at each location. Dark red (indicating a value of 100\%) means that the whole of the structure, right down to the base, would be in LoS. Conversely, blue (indicating a value of 0\%) would mean that none of the structure would be in LoS. The proposed turbine locations are shown as white squares. For reference, 1.0 km radius circles centred on each turbine are shown in this figure and in subsequent figures in this section. The percentage visibility values for turbines T1 and T2 are 100.0\% and 95.3\% respectively. However, both turbines could be potentially moved out of LoS by moving them to the blue region shown in Figure 2-1. This would require them to both be moved approximately 1 km north-east of their proposed locations.

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\(^1\) Radar waves curve slightly downwards in the atmosphere and so a radar LoS region will cover a slightly wider area than an optical LoS assessment.

\(^2\) The DEM used provides terrain heights on a roughly 90 metre spaced grid.
2.3 St. Kilda RCR

The percentage LoS visibility in the vicinity of the proposed wind farm is shown in Figure 2-2 for the St. Kilda RCR. The percentage visibility values for turbines T1 and T2 are 100.0% and 94.9% respectively. It can be seen from Figure 2-2 that the turbines could be moved out of LoS to the radar by moving them to the north east of the current proposed locations; however, this would require them to be moved by more than 1 km.
Figure 2-2: Percentage LoS from the St. Kilda RCR in the vicinity of the proposed wind farm. For reference, 1 km radius circles are shown centred on the turbines.

2.4 South Uist RCR

The percentage LoS visibility to the South Uist RCR is shown in Figure 2-3, where the percentage visibility values for turbines T1 and T2 are 97.2% and 100.0% respectively. Micro-siting is unlikely to move the turbines completely out of LoS to the radar, however, there is a region approximately 1 km to the north of the current turbine locations (represented by the yellow patch in Figure 2-3) where the LoS visibility could be reduced to between 60% and 70%. Even so, a vertically upright blade would still be in complete LoS to the radar, so it is likely that the blades would still be detectable to the radar and could potentially appear as clutter on the radar display.

The inset in Figure 2-3 shows that there is the potential for the turbines to be moved out of LoS, however, this would require them to be moved approximately 4 km from their proposed locations.
Figure 2-3: Percentage LoS from the South Uist RCR in the vicinity of the proposed wind farm. For reference, 1 km radius circles are shown centred on the turbines.
3 Clutter Cell Analysis

3.1 Discussion
As discussed in section 1.3, the cumulative impact of wind farm clutter may be of concern to the DIO. In this section the cumulative appearance of clutter from other wind farm projects is estimated. The locations of all of the known wind farm projects near to the proposed wind farm are shown in Figure 3-1. There are three sources of information:

1. The proposed wind turbines for the North Uist wind farm (two blue squares in Figure 3-1);
2. List of wind turbines supplied by the Customer [4] (88 white squares in Figure 3-1). The turbines are a mixture of makes and models, with tower heights ranging from 4.2 metres to 66 metres above ground level (AGL) and blade lengths ranging from 0.45 metres to 35.5 metres. There is a mixture of live projects and projects that are pending, as pre-agreed with the Customer [6]; and
3. Information from the online RenewableUK and RESTATS online databases [2][3] (green square in Figure 3-1).

It is important to note that the clutter cell analysis in this section assumes the worst case scenario, i.e. all turbines shown in Figure 3-1 are installed and have the potential to appear as clutter on the radar operator’s, provided they are in LoS to the radar.
Not all of the known projects are in LoS from each of the radar systems. To account for this in the cumulative clutter estimation, radar LoS modelling was carried out to determine which of the turbines in Figure 3-1 are in LoS to the radars. A turbine was included in the clutter cell simulation if any part of it is in radar LoS. The turbine dimensions for the other wind farms were provided by the Customer [4] or estimated from the QinetiQ in-house turbine database.

3.2 Benbecula AD radar

A radar display emulation showing the likely appearance of clutter from known wind turbine projects in LoS to the Benbecula AD radar is shown in Figure 3-2. The size of each clutter cell was estimated using the antenna beam-width and down-range resolution assumed for the radar. The colour scheme and annotations on the display are not intended to match the Benbecula radar display. Clutter patches from the study turbines are marked in red, whereas clutter from other turbines is marked in yellow. In terms of the appearance of clutter, this is a worst case picture, where all of the turbines have been detected in a single radar scan. Range rings are shown at 10 km, 25 km and 50 km from the radar.

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3 A real radar would not be able to differentiate between clutter patches from different sources. The distinction is made here to highlight the contribution from the study turbines.
3.3 St. Kilda RCR

Similarly, Figure 3-3 shows a radar display emulation for the St. Kilda RCR, showing the likely appearance of clutter from the proposed wind farm and other known wind farm projects that are in LoS to the radar. Range rings are shown at 50 km, 75 km, 100 km and 125 km ranges from the radar.
3.4 South Uist RCR

A radar display emulation showing the likely appearance of clutter from known wind farm projects in LoS to the South Uist RCR is shown in Figure 3-4. Range rings are shown at distances of 10 km and 25 km from the radar.
Figure 3-4: Representative South Uist RCR screen emulation showing the appearance of clutter from the proposed wind farm (red) and other known turbines (yellow). The radar is shown by a white square.
4 Top Level Operational Assessment

4.1 Benbecula AD radar

Benbecula operates a Type 92 long range surveillance radar, which inputs to the UK Air Surveillance And Control System (ASACS). AD radars are primarily used to survey coastal regions for any perceived threats to the UK shores. However, in recent years, particularly since the September 11th 2001 terrorist attacks, there has been an additional remit to look inland. AD controllers need to be able to see all of the airspace for which they are responsible, detect unknown targets as early, and at as great a range, as possible, and may be required to guide military aircraft through any part of the airspace.

The preceding analysis has shown that the proposed turbine site is in LoS and is likely to appear as clutter on the Benbecula radar display, as illustrated in Figure 3-2. The role of the radar is to detect wanted targets, (e.g. aircraft and missiles) and to discriminate them from unwanted targets (e.g. the ground, buildings and wind turbines), referred to as clutter\(^4\). The radar echoes from wind turbines are typically large and appear as clutter. Because the blades are usually moving, techniques that can be used to remove stationary clutter from the display do not fully suppress wind turbine echoes. The clutter can conceal wanted targets and can be mistaken for a genuine target.

The proposed wind turbines will produce radar clutter on the Benbecula radar just to the north and adjacent to a north-south line of existing clutter. Individual small patches of clutter do not necessarily create a significant impact on the detection and continued tracking of unknown targets, since the surrounding airspace remains largely unobstructed. However, AD operators often provide surveillance over a long range picture and thus several patches of nearby clutter will appear in a concentrated area and merge into a more solid area of clutter. This could provide difficulties for detection and tracking, one of the most crucial AD tasks. The site is less than 10 km from the radar head, so it could be argued that an AD operator would not be utilising the Benbecula radar for any formal control of aircraft without already limiting the radar service. However, it would extend the distance by which a low-level contact could remain undetected (or less able to be detected) by the UK’s AD organisation. Depending on the range to which the radar is set, it could already be difficult for controllers to differentiate between individual developments, or to vector aircraft between them. The range selected will be specifically dependent upon the task being carried out. So, from an aviation point of view, the operational effect would need to be considered cumulatively alongside existing clutter and whilst the additional impact is likely to be minimal, there is likely to be a point where the cumulative impacts become unacceptable to the MOD.

Nevertheless, when discussing the existence of clutter on operational systems, it must be stressed that an assessment of the impact of clutter on operations conducted by the users of the affected system can only be undertaken by those users. This study has not approached the users for comment and it must be

\(^4\) Radars such as the Type 92 based at Royal Air Force (RAF) Benbecula are capable of determining the height of targets as well as their range and bearing, transmitting and receiving using multiple beams at different elevations. This enables a three dimensional (3D) picture of the surveillance volume. Consequently, it is possible that wind turbines can be distinguished from aircraft flying above them. However, the large reflectivity of the turbines means that wind turbines can sometimes be detected in the AD radar’s higher elevation beams, leading to a confusing picture.
acknowledged that regardless of the conclusions of technical analysis, the MOD could always object based purely on their specialist experience and assessment of the operational requirement.

4.2 St. Kilda RCR

The proposed wind turbines are located approximately 80 km from St. Kilda RCR radar head, and are located just inside the MOD Hebrides PEXA. Air Traffic Control Officers (ATCOs) utilise the St. Kilda RCR to maintain situational awareness of all aircraft movements within the MOD Hebrides PEXA.

ATCOs are not permanently based at the MOD Hebrides Range. Instead they travel up from Aberporth when needed to cover exercises in the danger area complex. ATCOs only provide services to aircraft inside the complex but need to be able to see for a distance beyond it to be able to discharge their duty for range clearance. In this assessment, based on previous exchanges with Aberporth controllers in 2010, this distance is assumed to be approximately 8 NM and is referred to as a ‘buffer zone’, however, this is not a formal term or an agreed dimension. Any additional clutter within the buffer zone would need to be assessed by MOD as it could have a detrimental effect on the ability of the ATCOs to perform their duties.

The relative locations of the PEXA complex, an 8 NM buffer around the complex, the proposed wind turbine clutter patch as well as existing areas of wind farm clutter are shown in Figure 4-1.

![Figure 4-1: Location of proposed turbine clutter (red) in relation to the Hebrides Range areas and approximate 8 NM buffer zone (light blue line), as it would appear on the St. Kilda RCR display; the proposed turbines are in danger area EGD701E](image-url)
The clutter patch actually lies within the boundary of danger area EGD701E, so there would be no impact on buffer zone effectiveness with regard to detecting intruders from outside the range. However, the cumulative effect of radar clutter could have implications for range safety and ATC operations, since ATCOs are routinely required to provide highly accurate and/or precise instructions to maintain safe and effective air operations – additional radar clutter will degrade their ability to do this.

4.3 South Uist RCR

As stated in section 4.2, the proposed wind turbines are located within the MOD Hebrides PEXA boundary and are approximately 25 km from the South Uist RCR radar head. The relative locations of the PEXA complex, an 8 NM buffer around the complex, the proposed turbine clutter patch as well as existing areas of wind farm clutter are shown in Figure 4-2 and show that the proposed wind farm is not located within the buffer zone. Like the St. Kilda RCR, the South Uist RCR is used to maintain situational awareness in the Hebrides PEXA. The same operational impacts discussed in section 4.2 for the St. Kilda RCR apply to the operational impacts on the South Uist RCR: an increase in radar clutter within the range is likely to have an effect on range safety and ATC operations.

Figure 4-2: Location of proposed turbine clutter in relation to the Hebrides Range areas and approximate 8 NM buffer zone, as it would appear on the South Uist RCR display (South Uist radar is shown as a white square)
5 Mitigation Options

5.1 Discussion

There are three types of potential mitigation approaches available. The first is to modify the turbines in some way to minimise or remove the impact. These are referred to as turbine-based mitigations. The second approach is to modify the radar set-up in some way, to ensure signals do not reach the turbines or to remove the unwanted clutter once the turbine echoes are received. These are referred to as radar-based mitigations. The third approach is to accept the impact and to modify the way in which the radar data is used or the way certain activities are undertaken. These are referred to as operational mitigations.

Any mitigation route must be feasible, i.e. achievable, and acceptable to both the wind farm developer and any affected stakeholder.

5.2 Turbine based mitigations

5.2.1 Micro-siting

The results in section 2 have shown that there are several sites in the vicinity of the current proposed turbine locations where the turbines would be out of LoS to the Benbecula, St. Kilda and South Uist radars. However, it is important to note that micro-siting is unlikely to move the turbines out of LoS to all three radars at the same time, i.e. it is possible to move the turbines to a specific location where they are out of LoS to one or two of the radars, but not all three. As an example, Figure 5-1 shows a region to the north of the proposed turbine locations (represented by the green area in Figure 5-1) where the turbines are out of LoS to the St. Kilda and Benbecula radars, but would be at least partially in LoS to the South Uist radar (percentage LoS values between around 60% and 100%).

Note that in Figure 5-1 there are two boundaries depicted as white lines. Each of these represents an area where the turbines could be relocated to move them out of LoS to either the Benbecula or the St. Kilda radars. The overlapping area (the green area in the figure) is the region where the turbines would be out of LoS to both the Benbecula and St. Kilda radars.
Turbines can be moved out of LoS of the Benbecula and St. Kilda radars by siting them in the green area.

Figure 5-1: Example region (green) where the proposed turbines could be located to move them out of LoS of the Benbecula and St. Kilda radars (top image), overlaid on a LoS visibility plot for the South Uist radar (bottom image).

Turbines would still be in partial LoS to the South Uist radar, however, depending on the location of the turbines, the percentage LoS visibility could be reduced to around 60%.
5.2.2 Reduction in turbine size

Reducing the size of the turbines is likely to reduce the impact on each of the radar systems considered in this study. In general, smaller turbines reflect less radar signal and may have a lower detectability. Similarly, lowering the maximum blade tip height will potentially increase terrain screening, which may again lead to a reduction in detectability.

Coupled with micro-siting, this could potentially remove the clutter impacts\(^5\). As an example, it has been shown in section 5.2.1 that if the turbines are relocated to the green area in Figure 5-1, they would be out of LoS to two of the radars (Benbecula and St. Kilda) but would still be in at least partial LoS to the South Uist radar. However, if, in addition to micro-siting, the blade tip height is reduced from 77 metres to less than approximately 30 metres, there is the potential for the turbines to be moved out of LoS to South Uist as well. This is illustrated in Figure 5-2.

\(^5\) Even if the turbines are out of LoS to a radar, they could still be detected by the radar and appear as clutter on the radar display. This is because radar signals can bend round obstacles as they propagate over the terrain. Nevertheless, LoS calculations can provide an indication of whether or not a turbine is likely to be detected.
5.2.3 Radar absorbent materials

It is possible to reduce the size of reflections from turbines using radar absorbent materials (RAM) [7].

5.3 Radar based mitigations

5.3.1 Artificial horizon (clutter fence)

In certain circumstances, and where low-level radar coverage in the area of the wind turbine development is not required, it may be possible to use a manmade object, such as a clutter fence, to prevent a radar from detecting the wind turbines. Clutter fences are often used on RCS measurement ranges, to reduce background interference. Typically constructed of RAM, the fence is placed at some location between the radar and the turbines to create an artificial radar horizon.

However, with this mitigation, low level radar performance in the sector containing the clutter fence will be affected. This may be acceptable to the MOD, depending on whether a suitable location could be found for the fence, and the operational significance of the affected airspace.

5.3.2 Alterations to the current radar

The following radar alterations can reduce the signal strength reaching the turbines, reducing the likelihood of them appearing as clutter:

- Tilting the antenna beam;
- Reducing the transmitted power; and
- Modifying the sensitivity time control (STC\(^6\)) law used in the direction of the turbines.

However, all three of these methods could potentially degrade the existing radar coverage for aircraft, and are, therefore, unlikely to be acceptable to the MOD. Radar alterations are likely to be relatively expensive and radar downtime may be incurred while the new system is installed and tested.

5.3.3 Radar upgrade or replacement

Some radars are more robust to wind farm clutter interference than others. A radar’s resilience to wind farm impacts depends on factors such as whether single or multiple elevation beams are used, resolution capability, adaptive clutter mapping, and the use of tracking algorithms.

For example, the Lockheed Martin AN/TPS-77 AD radar has been trialled against wind farms, and it is claimed to largely mitigate the impact of wind farm clutter. This was cited as one reason for the UK procuring an AN/TPS-77 radar for use in an area where wind farms are to be built [8][9]. Objections from the MOD to several large offshore wind farms in the Greater Wash were dropped when the AN/TPS-77 was purchased to replace the existing system at RAF Trimingham. The MOD has since purchased two further systems to replace existing systems at RAF Brizlee

\(^6\) STC is often used in radar systems to cope with a wide range of received signal strengths. Radars need to be extremely sensitive to be able to detect weak signals from distant aircraft but also cope with much stronger reflections from nearby objects such as large aircraft and the surrounding terrain. At close ranges to the radar, the reflected power levels can increase significantly, sending the receiver into saturation. STC effectively reduces the gain of the receiver at close ranges to reduce these effects.
Wood and RAF Staxton Wold, removing objections to wind farms in those areas [10]. Any future upgrade of the current Benbecula radar to an AN/TPS-77 could potentially acceptably mitigate the impact of wind turbine clutter.

Regarding ATC radars, such as the St. Kilda and South Uist RCRs, both the Thales STAR2000 [11] and the upgraded BAE Watchman [12] claim to be wind farm resilient. Any future upgrade of the current Watchman radars at St. Kilda and South Uist could potentially acceptably mitigate the impact of wind turbine clutter.

5.3.4 Infill radar

Radar clutter can be mitigated using infill radar, where the area of the radar picture affected by clutter is replaced by data from another radar that cannot detect the turbines but has adequate low level cover. Infill systems can be distant systems relying on fortuitous terrain screening, or bespoke systems local to the turbines. While the MOD accepts the method is a credible approach for both ATC and AD radar systems, there are some constraints on the use of infill radars, such as data integrity, reliability, cost, and engineering limitations. There are no current proven instances of infill methods being used to mitigate wind turbine clutter on AD radars.

5.4 Operational mitigations

5.4.1 Benbecula AD radar

Operational mitigation is not always readily available regarding the presence of clutter on AD radars. From a surveillance aspect, the AD environment requires adequate coverage of the airspace within its area of responsibility in order to detect intruder aircraft and/or guide fighter aircraft through. Consequently, it may not be possible to provide full surveillance services of an area of interest or to avoid an area of clutter operationally. Quite simply, they want the maximum range possible from any surveillance source. Given that the MOD have objected to the proposed wind farms, it is clear that that have already judged the impacts to be operationally unacceptable.

5.4.2 St. Kilda and South Uist RCRs

Due to the potential impact on the St. Kilda and South Uist RCRs, the DIO has objected to the proposed wind farm. The analysis in sections 2 and 3 of this study have shown that in all cases the turbines are in radar LoS and likely to appear as radar clutter located within the boundary of an established danger area (EGD701E), as shown in Figure 4-1 and Figure 4-2. There are also other wind turbines within the danger area, which may increase the cumulative effect of interference of the ATCOs’ displays.

Viable operational mitigations are available and generally fall into the following categories:

- Management of aircraft services outside the range complex; and
- Management of control within the range complex.

The proposed location is not outside the range complex and even if the location was to change (via micro-siting) it would be unlikely to be repositioned to be within the buffer zone. There is unlikely to be any impact to aircraft services outside the range complex, therefore, only the latter mitigation option (management of control within the range complex) will be considered in this report.
Management of control within the range complex:

The controllers' tasks within the complex are:

- To assist the activities of aircraft operating within the complex;
- To ensure the safety of aircraft within the complex; and
- To ensure the safety of aircraft wishing to cross the complex.

The above tasks are currently conducted in a safe and effective manner by means of extant processes and procedures approved for the purpose. Any detrimental effects caused by the proposed wind turbines are likely to be along the lines of increased radar clutter reducing the ability of ATCOs and range staff to detect and maintain track identity of aircraft within the range boundary. However, radar services may be offered with specific limitations to aircraft as they transit areas of clutter or they may be offered a re-route around the clutter. This may be acceptable to aircraft simply wishing to transit the complex. Such aircraft may also be provided approval to cross the complex under a procedural service (i.e. without the use of surveillance radar).

Aircraft operating on the range, involved in core range activity and/or trials flying may require to be flown in a specified areas in order to achieve the task in hand. In this instance a re-route or reduction in radar service to avoid an extended area of radar clutter may not be acceptable. However, it may be acceptable for range safety personnel to plan for an activity to take place outside an area of clutter or reduced radar cover, so that safety would not be compromised. This would inevitably deny a portion of the range complex to specific trials activity, which would probably not be acceptable to the MOD authority.
6 Summary

The North Uist Development Company intends to build the two-turbine North Uist wind farm. The MOD has objected to the development on the grounds of interference to the Benbecula (South Clettraval) Air Defence (AD) radar and the Hebrides range control radars (St. Kilda and South Uist).

Radar LoS calculations have shown that both turbines are in LoS to the Benbecula, St. Kilda and South Uist radars, and are likely to be detected as clutter on the radar display.

An operational analysis has shown that the operational effect on the Benbecula AD radar would need to be considered cumulatively alongside existing clutter and whilst the additional impact may be minimal, there is likely to be a point where the cumulative impacts become unacceptable to the MOD. Regarding the St. Kilda and South Uist radars, the proposed turbines are inside the danger area complex, and, therefore, there would be no impact on buffer zone effectiveness with regard to detecting intruders from outside the range; however, the cumulative effect of radar clutter could have implications for range safety and ATC operations within the danger area complex.

It has been shown that micro-siting can potentially move the turbines out of LoS to one or two of the radars, however, micro-siting alone is not likely to move the turbines out of LoS to all three radars.

In terms of radar mitigations, alterations to the radar set-up, radar upgrades or using an infill solution have the potential to mitigate any impacts, although these solutions may be relatively expensive or unacceptable to the MOD. It has been shown that a combination of micro-siting and reducing the blade tip height (to less than around 30 metres) could potentially move both turbines out of LoS to all three radars, which could remove the clutter impacts.

In terms of operational mitigation, there is no operational mitigation for the impact on the Benbecula AD radar, other than accepting the small impact on performance. The DIO objections show that the MOD have already judged the impacts to be operationally unacceptable. For the RCRs at St. Kilda and South Uist, a potential operational mitigation is to develop formal arrangements for the management of control of aircraft inside the PEXA. The acceptability of this approach to the MOD in this case is not known.
References


