Chapter 16

Other Issues (Shadow Flicker, Telecommunications, Aviation and Health & Safety)

CHAPTER 16

16 OTHER ISSUES (SHADOW FLICKER, TELECOMMUNICATIONS, AVIATION AND HEALTH AND SAFETY)

This chapter of the Environmental Impact Assessment Report (EIA Report) evaluates any remaining topics that are within the scope of the Environmental Impact Assessment (EIA), due to potential environmental effects arising from the Troston Loch Wind Farm (the Development) but do not require a full assessment, these topics include:

- Shadow Flicker;
- Telecommunications and other Utilities;
- Aviation; and
- Health and Safety, including Accidents.

16.1 SHADOW FLICKER

16.1.1 Introduction

This section evaluates the effects of shadow flicker from the Development on nearby neighbouring properties. Under certain combinations of geographical position and time of day, the sun may pass behind the rotors of a wind turbine and cast a shadow over neighbouring properties. Shadow flicker is an effect that can occur when the shadow of a blade passes over a small opening (such as window), briefly reducing the intensity of light within the room, and causing a flickering to be perceived. Shadow flicker effects can only occur inside buildings where the blade casts a shadow across an entire window opening.

16.1.2 Legislation, Policy and Guidance

The following guidance, legislation and information sources have been considered in carrying out this assessment:

- Online Planning Guidance for Renewables and Low Carbon Energy[1];
- Dumfries and Galloway Council Local Development Plant Supplementary Guidance Part 1 Wind Energy Development: Development Management Considerations[2]; and
- Review of Light and Shadow Effects from Wind Turbines in Scotland[3].

16.1.2.1 Online Planning Guidance for Renewable and Low Carbon Energy

Online planning guidance for onshore wind provides information for consideration surrounding shadow flicker. This is the most current guidance available in terms of shadow flicker; therefore, this guidance has been used to inform the assessment methodology and study area for this assessment. It states:

> *"…where separation is provided between wind turbines and nearby dwellings (as a general rule 10 rotor diameters), "shadow flicker" should not be a problem"*

[1] Scottish Government (2014) Onshore Wind Turbines: planning advice – online at: https://beta.gov.scot/publications/onshore-wind-turbines-planning-advice/ [Accessed on 30/11/2018]
[2] Dumfries and Galloway Council Local Development Plan: Supplementary Guidance Part 1 Wind Energy Development: Development Management Considerations June 2017. Online at: https://www.dumgal.gov.uk/media/17607/Part-1-Wind-Energy-Development-Development-Management-Considerations-Screening-Determination/pdf/0892-16_Wind_Energy_Guidance_Part_1.pdf [Accessed on 30/11/2018]
[3] Review of Light and Shadow Flicker Effects from Wind Turbines in Scotland, LUC, March 2017 https://www.climatexchange.org.uk/research/projects/review-of-light-and-shadow-effects-from-wind-turbines-in-scotland/ [accessed 29/01/2019]

16.1.2.2 Dumfries and Galloway Council Local Development Plan Supplementary Guidance Part 1 Wind Energy Development: Development Management Considerations

Dumfries and Galloway Council (the Council) have produced supplementary Planning Guidance for Wind Developments (June 2017). It states:

"The potential effects of shadow flicker are considered to be site specific, and depend on prevailing wind patterns among other factors. As a general rule, a minimum separation distance of 10 times the turbine rotor blade diameter from sensitive users/receptors should be maintained, however this will depend on specific locational circumstances, such as topography, and further information may be requested in this respect."

16.1.2.3 Review of Light and Shadow Flicker Effects from Wind Turbines in Scotland

A review of light and shadow effects from wind turbines was commissioned by ClimateXChange to review how light and shadow flicker effects are considered in the development planning process in Scotland.

This document includes a review of current UK guidance, along with a review of how the current guidance is applied through the selection and review of case studies.

The review provides a number of recommendations regarding the content of guidance on shadow flicker. These include:

- Guidance should not include reference to the occurrence of shadow flicker throw 'within 130 degrees of north';
- Guidance should exclude reference to the 10 rotor diameter distance; and
- There is a need for guidance on the thresholds of exposure to shadow flicker in Scotland.

It should be noted that since the publication of this review (2017), shadow flicker guidance in Scotland has not changed, and as such, the guidance in the Online Planning Guidance for Renewables and Low Carbon Energy remains extant.

16.1.3 Assessment Methodology and Significance Criteria

16.1.3.1 Scoping Responses and Consultations

Consultation for this EIA Report topic was undertaken with the organisations shown in Table 16.1.

Table 16.1 Consultation Responses

Consultee	Type and Date	Summary of Consultation Response	Response to Consultee
Dumfries and Galloway Council Environmental Health Department	Scoping Report	No comment provided	This assessment has been undertaken in line with the details provided in the Scoping Report.

16.1.3.2 Study Area / Survey Area

Properties with the potential to be affected by shadow flicker as a result of the Development have been identified using Geographical Information Systems (GIS).

Shadow flicker is known to occur beyond 10 rotor diameters, as reflected in the Review of Light and Shadow Effects from Wind Turbines in Scotland; however the intensity of shadows decreases as the distance to the turbines increases. Given the Scottish Government Online Guidance refers to 10 rotor diameters as the distance above which

shadow flicker should not be a problem, any properties within this area are assumed to be most at risk of shadow flicker effects.

Based on the Scottish Government Online Guidance (2014), the study area around each proposed turbine location extending to a distance of 10 rotor diameters has been identified (1,330 m based on the candidate turbine), as shown in Figure 16.1.

Ordinance Survey Address Layer Data 2, site visits and freely available online aerial photography was used to confirm the locations and names of permanent dwellings in the study area.

16.1.3.3 Baseline Survey Methodology

The assessment of shadow flicker is a desk based assessment, and as such, no on-site survey specific to shadow flicker has been undertaken, with the exception of more general site visits verifying the location and nature of surrounding properties.

16.1.3.4 Methodology for the Assessment of Effects

A recognised computer software package[4] was used to calculate theoretical specific times and durations of shadow flicker effects for potentially affected properties.

This software creates a mathematical model of the Development and its surroundings, based on:

- Turbine locations, hub height and rotor diameter;
- Topography (obtained from Ordnance Survey Land-Form Panorama elevation data on a 50 m horizontal grid); and
- Latitude and longitude of the Development (used in calculating the position of the sun in relation to time of day and year).

A maximum distance of 1,330 m for each turbine (e.g. 10 rotor diameters) was employed during the calculation in accordance with the guidance noted earlier.

Certain worst-case assumptions are made in the calculation, including:

- Weather conditions are such that shadows are always cast during each day of the year, i.e. bright sunshine every day;
- The turbine rotor will always be facing directly towards a given window, maximising the size of the shadow and hence the frequency and duration of the effect;
- The turbines will always be rotating (i.e. always sufficiently windy and no downtime for maintenance); and
- There will not be intervening structures or vegetation (other than topography) that may restrict the visibility of a turbine, preventing or reducing the effect.

The following assumptions have been made for all potential receptors in order to identify all potential effects as a worst case:

- All windows have been assumed to measure 1 m by 1 m (for larger windows the intensity of the effect would be reduced), to be situated at a height of 3 m above ground level, to the window's centre (representing an average of ground and first floor levels that may be typically 1.5 m and 4.5 m respectively);
- Each property is located at the grid reference provided in Table 16.2 (as per details from Ordnance Survey Address Layer Data 2); and
- Windows facing towards each of the cardinal compass point directions (North, East, South and West) have been modelled in order to identify effects from all possible directions. In practice, not all of these directions face the Development, and the buildings may not have windows on each façade.

[4] Resoft WindFarm 4.2.1.7.

The above calculations are intended to indicate a theoretical maximum potential duration of effects and to provide an approximation of the times of day and year that these would occur rather than a precise prediction.

For much of a given year, weather conditions will be such that shadows would not be cast, or would be weak and thus would not give rise to shadow flicker effects. In the west of Scotland, bright sunshine typically occurs for around 30% of daylight hours per annum[5], which is not factored into the software. Of this time, some would be in non-windy conditions when the turbine blades would not be rotating, and some would be when the wind direction would not align with the direction of the sun, such that shadows would not be cast as widely as in the worst-case. This means that the computer model calculation overestimates the duration of effects by at least three times.

In practice, other factors such as the potential screening by vegetation or intervening structures, whether the wind is blowing in order to make the turbine rotors move at all, and the varying wind direction causing the angle of the moving shadow to be reduced, will also reduce or prevent flicker incidence even further, as compared to the theoretical maximum period or the likely period of effect suggested by the calculations. The actual potential impact is therefore likely to be only a fraction of the theoretical maximum.

16.1.3.5 Significance of Effect

No formal guidance is available regarding what levels of shadow flicker may be considered acceptable in the UK. However, Wind Energy Development Guidelines published by the Northern Ireland Department of the Environment Heritage and Local Government (2006)[6] states that:

"It is recommended that shadow flicker at neighbouring offices and dwellings within 500 m should not exceed 30 hours per year or 30 minutes per day."

This assessment predicts the potential maximum effects that occur, and a likely maximum duration for effects once prevailing weather conditions are taken into account. The Northern Irish guidance threshold has been adopted for all residential receptors as a measure of assessing the significance of predicted shadow flicker effects. Specifically, if a receptor is predicted to exceed the above thresholds, then the shadow flicker effect would be considered significant as per the EIA Regulations. Any shadow flicker effect on a receptor below the above threshold would not be considered to be significant.

Mitigation is proposed to minimise or remove predicted effects, if levels of shadow flicker are deemed to be significant.

16.1.3.6 Assessment Limitations

The assumptions made in the assessment process, outlined in this Chapter, are considered to be conservative and likely to make the assessment results worst case.

16.1.4 Baseline Conditions

A single property, Fingland, has been identified within 1,330 m of the proposed turbine locations. No further properties are located within 10 rotor diameters / the shadow flicker study area.

Table 16.2 details the single property within the shadow flicker study area; the location of this property is also shown in Figure 16.1 of this EIA report.

[5] Met Office UK and regional series https://www.metoffice.gov.uk/climate/uk/summaries/datasets [accessed 07/01/19]
[6] Department of the Environment, Best Practice Guidance to Planning Policy Statement 18 'Renewable Energy', 2009

Table 16.2 Shadow Flicker Assessment Locations

Property Name	Easting	Northing	Nearest Turbine	Distance to Nearest Turbine
Fingland	266974	590162	5	1,226

16.1.5 Assessment of Potential Effects

16.1.5.1 Construction Phase

Shadow flicker is a phenomenon that only occurs once the turbines are installed and operational i.e. when blades are rotating, and therefore no shadow flicker effects will occur during the construction or decommissioning phases of the Development.

16.1.5.2 Operational Phase

Table 16.3 details the results of the calculations carried out at the assessment location identified using the shadow flicker modelling software. The table lists the number of days and times of day during which the effects would theoretically occur. It also shows the calculation of the predicted likely number of hours of shadow flicker per annum based on the Site and receptor location in west Scotland (assuming 30 % per annum bright sunshine).

A conservative approach has been taken whereby the screening effects provided by trees or other buildings have not been taken into account, nor has any account been taken of which buildings actually do have windows (for the purpose of this assessment it is assumed that all façades have windows). It is unlikely that all façades will have windows, and there is currently a degree of intervening vegetation screening between the Development and the receptor which is likely to remain in situ and which will reduce or eliminate flicker from occurring in practice. The degree of effects will depend on the precise location of screening, which itself may change over time as vegetation grows or is removed. In addition, the atmospheric conditions will further reduce the actual effects arising, as described in the Assessment Methodology section in Section 16.1.3. As a result, the production of exact predictions of shadow flicker is not practicable, and this assessment considers a worst-case approach.

Table 16.3 Potential Shadow Flicker Effects at the Assessed Location

Property Name	Days per Year	Maximum Minutes per Day	Theoretical Maximum Hours per Annum	Likely Hours per Annum*
Fingland	65	28	20	6

*assuming 30% bright sunshine

The modelling indicates that the eastern and southern façades will experience shadow flicker.

The theoretical maximum number of hours per annum, as shown in Table 16.3, account for any overlap where effects may be experienced at different windows or from different turbines simultaneously. As such, shadow flicker effects are calculated as being possible for up to a theoretical maximum of 20 hours per annum.

Based upon weather conditions required to facilitate shadow flicker occurring for only 30% of the time, the likely number of hours per year where shadow flicker could potentially occur is reduced to 6 hours per annum.

Even this is likely to comprise an over-estimate of actual effects, given the other conservative aspects of this assessment as set out in the assessment methodology.

Table 16.3 shows that no property within the study area exceeds the 30 hours per year or 30 minutes per day identified within the Northern Ireland guidance. Therefore shadow flicker due to the Development is not significant as per the EIA Regulations.

Whilst the effect is not significant, it is likely to be further reduced in practice. Through study of aerial imagery, and confirmed through site visits, there is a barn / farm building attached to the eastern side of the habitable area of the Fingland property, as well as broadleaved trees surrounding the receptor. As shadow flicker effects were predicted to occur on the eastern façade of the property, should this façade not contain habitable rooms, the effect of shadow flicker will be reduced. It is therefore considered that shadow flicker impact will be reduced or eliminated from occurring in practice.

16.1.6 Mitigation and Residual Effects

It has been demonstrated that shadow flicker effects may occur at one receptor within the shadow flicker study area. A conservative approach has been taken, whereby the screening effects provided by trees or other buildings have not been taken in account, and is has been assumed that there are windows on all sides of the receptor. Screening, or the absence of windows may reduce or eliminate flicker from occurring in practice.

Several forms of shadow flicker mitigation are available, including;

- Control at Property: the provision of blinds, shutters or curtains to affected properties;
- Control on Pathway: for example screening via planting close to an affected property; and
- Control at Source: for example shutdown of turbines at times when effects occur.

In practice, Control at Property and Control on Pathway is only possible with the cooperation of the residents, which cannot be assumed to be forthcoming. In addition, screening via planting may take some time before it is effective.

Control at source is likely to be the preferable method for mitigating shadow flicker. This involves shutting the turbine down at times that flicker is likely to occur. These times can be pre-calculated and programmed into the Development's SCADA system (shutdown calendar), although this does not take account of weather conditions occurring at specific times, resulting in excessive shutdowns. Photocells can be installed that determine whether ambient light levels are sufficient for distinct shadows (and therefore shadow flicker) to be generated to prevent unnecessary shutdowns.

Alternatively, a shadow flicker protection system can be incorporated into the SCADA system. This calculates the locations of shadows in real time, determines whether these coincide the pre-programmed locations and takes into account ambient lighting before triggering shutdowns. These systems provide greater flexibility than shutdown calendars as it allows for new locations to be programmed.

In the event of a complaint received by the site operator or the Council, and an appropriate investigation confirms occurrence as a result of the Development, than measures such as those outlined above will be used to prevent re-occurrence and protect residential amenity.

All shadow flicker effects are assessed as not significant, however application of the above measures will ensure that effects are minimised or removed entirely.

16.1.7 Cumulative Effect Assessment

Beyond the Development, the next nearest potential wind farm to Fingland is Glenshimmeroch, a ten turbine, 117 m rotor diameter development currently in planning, located to the south of Fingland. The nearest turbine to Fingland is T7, which is located approximately 1,920 m to the south. As this distance exceeds the 10 rotor diameter distance for likely shadow flicker effects (1,170 m), it is considered that shadow flicker impacts from Glenshimmeroch at this property are unlikely to occur in practice. There are no other wind farm developments within 10 rotor diameters of Fingland. Cumulative shadow flicker effects have therefore not been considered further.

16.1.8 Summary of Effects

An assessment of the potential for shadow flicker effects has been carried out as per the guidance notes in Scottish Government Online Guidance. The theoretical maximum and likely hours of shadow flicker occurrence per year have been calculated for the sole property located within 10 rotor diameters of the Development. The flicker effects are expected to be further reduced in practice at all properties due to local screening from intervening buildings and trees, and mitigation measures proposed, if required.

The potential for shadow flicker effects at distances greater than to rotor diameters is predicted to be minimal.

16.1.9 Statement of Significance

No shadow flicker effects will occur during construction or decommissioning.

The effect of shadow flicker has been assessed using appropriate guidance in respect of the operational period, and effects are considered to be not significant in terms of the EIA Regulations.

In practice, if residential amenity at any property is found to be affected by shadow flicker as a result of the Development, mitigation measures will be implemented to reduce the effects or remove flicker effects entirely.

16.2 TELECOMMUNICATIONS AND UTILITIES

16.2.1 Introduction

Due to the size and nature of wind turbines, they have the potential to interfere with electromagnetic signals passing above ground during operation. Infrastructure affected can include telecommunication links, microwave links and television reception. Aviation can also be affected by turbines and is addressed separately in Section 16.3 of this Chapter.

In particular, the tower and rotating blades of wind turbines have the most potential for interference with electromagnetic signals. The degree and nature of the interference will depend on:

- The location of the wind turbines with respect to the receiver and the transmitter;
- Characteristics of the rotor blades;
- Signal frequency; and
- The radio wave propagation in the local atmosphere.

In addition, other infrastructure such as buried utilities may be affected by the construction of the Development.

This section of the EIA Report details the relevant guidance, consultation that has been undertaken with infrastructure operators, the existing baseline for these elements as relevant to the Development and an assessment of the likely effects as a result of the Development.

16.2.2 Guidance

There are a number of documents which provide guidance on telecommunications considerations for wind energy developments. The guidance considered in this assessment are:

- British Wind Energy Association (BWEA), (1994) Best Practice Guidelines of Wind Energy Developments;
- Ofcom (2009) Tall Structures and Their Impact on Broadcast and Other Wireless Service;
- Ofcom (2003) Guidelines for Improving Digital Television and Radio Reception; and
- The Scottish Government (2014) Onshore Wind Turbines.

The potential effects as a result of the Development have been assessed with reference to the above documents.

16.2.3 Consultation

In December 2016, prior to the scoping exercise, telecommunication operators were consulted and information requested for any telecommunication links within the 3 km of the centre of the Site, which covers the entire Site plus approximately 1 km from the boundary of the Site. Table 16.4 provides a summary of the consultation undertaken.

Table 16.4: Consultation Responses from Telecommunication Consultees

Consultee	Type and Date	Summary of Response
Ofcom – Spectrum Licencing	Email - Pre-Scoping Response, 5th January 2017	Initial consultation concluded that there are no links are within the vicinity of the Site.
Arqiva	Email - Pre-Scoping Response, 14th December 2016	No objection, nearest Aqiva link is 28 km to the southwest of the Site.
Atkins	Email - Pre-Scoping Response, 15th December 2016	No objection, in relation to UHF Radio Scanning Telemetry communications.
Joint Radio Company (JRC)	Email - Pre-Scoping Response, 14th December 2016	No objection, does not foresee any potential problems.

16.2.4 Baseline and Assessment of Effects

16.2.4.1 Telecommunications

Should the construction and operation of the Development materially affect the operation of telecommunication links, such as through degradation of signal quality to the extent that it warrants an objection from the link operator, this would be considered a significant effect. Mitigation is generally available either through rerouting of any affected links or upgrades to the transmitting and / or receiving apparatus.

Consultation with the relevant organisations was initiated during the initial stages of the EIA to identify any potential microwave or telecommunication links that could be affected by the Development. Ofcom monitors the fixed microwave links throughout the UK, whereas JRC manages the radio spectrum used by the UK Fuel and Power Industry. Atkins undertakes a similar role for the water industry. Arqiva operates the Freeview terrestrial transmission network including BBC and ITV.

The search for existing telecommunication and microwave links was undertaken within a 3 km radius of the approximate centre of the Site, which covers all turbine locations,

and approximately 1 km beyond the boundary of the Site. This ensures all telecommunication and microwave links potentially affected are identified.

Ofcom, JRC, Atkins and Arqiva identified no links within the telecoms study area and have raised no objection to the Development.

Digital television signals are rarely affected by the operation of wind turbines; however in some cases interference can be caused by blocking or reflections. A minimum signal strength is required for digital television to operate effectively, if a property already receiving a weak digital signal experiences additional blocking or reflections from wind turbines, the signal level may drop, causing the television to pixelate or cut out intermittently. Reflections and blocking from other objects (such as trees) close to a receptor can cause similar effects. Simple measures to boost the signal through an improved receiver are usually sufficient to correct the issue.

The area surrounding the Site receives television signals that were made exclusively digital, after the digital switchover was completed, and hence no analogue TV signals are broadcast in the area[7]. As a result, it is considered that the television reception received by the properties close to the Site will not be affected, and no significant effects will occur. However, in the event that interference which is directly attributable to the Development is experienced, the Applicant will endeavour to implement a suitable mitigation solution. Examples of technical solutions include: changing the receptor height, re-orientating the receptor to receive signals from an alternative transmitter, upgrading the receptor system or installation of satellite television. The requirement for a corrective action would be most appropriately identified after the onsite survey is complete, and the Development is operational.

Broadcast radio (FM, AM and DAB digital radio) are transmitted on lower frequencies than those used by analogue TV signals. Lower frequency signals tend to pass through obstructions more easily than the higher frequency TV signals, and diffraction effects also become more pronounced at lower frequencies. Both of these factors will tend to lessen the impact of wind turbines on radio reception. Should interference to radio signals be experienced as a result of the Development, the technical solutions described in the above paragraph are considered as suitable mitigation measures.

16.2.4.2 Utilities

Other infrastructure, such as above or below ground utilities, could be affected during construction; however, implementation of best practice would ensure that these are not adversely affected.

One, two phase overhead wooden pole electricity line is located within the Site, originating at the forestry cabins in the centre of the Site and running northwards beyond the Site towards the U1415 minor road.

A linesearch[8] utility search was undertaken during the EIA process, which identified no further utilities within the Site, while Scottish Water identified no assets within the Site when consulted during the scoping process.

Prior to construction, a further line search for undergrounded utilities would take place to identify any new or updated services. Adverse effects would be avoided through the implementation of safe systems of work, which would include consideration of the identified two phase electricity line.

During construction, there may be construction traffic passing beneath electricity lines along the transportation route. Although it is very unlikely that any damage to this

[7] Digital UK http://www.digitaluk.co.uk/__data/assets/pdf_file/0019/35083/National_Switchover_leaflet.pdf [access 07/01/19]
[8] Linesearch Online Tool. Online at: http://www.linesearchbeforeudig.co.uk/# [Search undertaken 18/01/2016]

infrastructure will occur, appropriate management measures will be put in place to ensure that electricity lines are not affected by the Development, and that the Development is constructed in accordance with relevant health and safety legislation as appropriate. Following the implementation of such measures, if necessary, there will be no effect on utility infrastructure as a result of the Development, and it is not considered further.

16.2.5 Statement of Significance

Consultation undertaken with the telecommunications consultees has confirmed no fixed communication links operating across the Site and that therefore the Development will not interfere with telecommunications and electromagnetic signals. Effects on television reception are unlikely, and technical solutions are readily available as suitable mitigation measures should adverse effects be present. Adverse effects on infrastructure such as utilities would be avoided through safe systems of work. Therefore, there are no significant effects predicted upon telecommunications and utilities as a result of the Development.

16.3 AVIATION

16.3.1 Introduction

Wind turbines have the ability to reflect radio waves and therefore have the potential to interfere with radar systems. In addition wind turbines can present a physical obstruction at, or close to, an aerodrome or other aviation activity site, such as areas of low flying.

16.3.2 Baseline Conditions and Consultation

The primary sources of information for the technical assessments were:

- Pager Power's database of installations – continuously updated based on stakeholder consultation, field surveys and official publications;
- NATS (formerly National Air Traffic Services) Aeronautical Information Package – which includes coordinate information for navigation aids at licensed aerodromes;
- The Developer's information pertaining to the development including consultation responses; and
- Relevant aviation charts.

The nearest licenced aerodrome is Glasgow Prestwick International Airport, 48 km northwest of the Site, the nearest unlicensed airfield is located 15 km southwest at Glenswinton, with a single grass/gravel runway.

The nearest known Ministry of Defence (MoD) facility is the Kirkcudbright Training Area, located approximately 37 km south of the Site. Given the nature of the facility, which is used for a variety of field fire and dry training exercises, this would not conflict with the Development.

The Site is located within an area of high priority for military low flying which according to the MoD is '*likely to raise considerable and significant concerns*', this high priority area extends across much of Southern Scotland in which there are a large number of operational and consented wind developments.

The Site is located approximately 55 km west southwest of the Eskdalemuir Seismological Recording Station, and therefore outwith the 50 km consultation zone.

The NATS radar at Lowther Hill is located approximately 29.5 km northeast of the Site. The NATS radar at Great Dun Fell is located approximately 117 km southeast of the Site. Other NATS radar in the area that have been assessed include Glasgow Airport

and Orchardton (Cumbernauld). The NATS online self-assessment maps and independent analysis indicate that the Site will be within an area where turbines are likely to interfere with the primary surveillance radar of NATS En-Route Ltd (NERL). This has been confirmed in further discussions with NATS.

Consultation has been undertaken with aviation stakeholders as summarised in Table 16.6.

Table 16.6: Consultation Responses from Aviation Consultees

Consultee	Type and Date	Summary of Response
Defence Infrastructure Organisation - Ministry of Defence	Scoping Response 26/09/2017	No Objection. MOD request that the perimeter turbines are fitted with MOD accredited 25cd omni-directional or infrared lighting with an optimised flash pattern of 60 flashes per minute of 200ms to 500ms duration at the highest practicable point. The cardinal turbines should be fitted with 25 candela and infrared combination lighting.
Defence Infrastructure Organisation - Ministry of Defence	Further engagement regarding lighting (emails on 07/01/2019 and 08/01/2019)	Agreement that the current scheme does not require visible lighting (infra-red only).
Glasgow Prestwick Airport	Pre-application advice 09/01/2018	Consulted outwith of the formal scoping process. Confirmed that the Development would not present a safeguarding issue and no objection would be forthcoming.
NATS	Scoping Response 17/08/2017	Objects the proposal, due to predicted unacceptable impacts on radar at Lowther Hill and Great Dun Fell and therefore conflicts with safeguarding criteria.
NATS	31/07/2018	Initial discussions between Pager Power and NATS were undertaken, use of local in-fill as a mitigation option was considered.
Civil Aviation Authority	N/A	No response to scoping request.

16.3.3 Assessment of Potential Effects

Where consultation has highlighted potential impacts, technical assessment has been undertaken to quantify the predicted effects and assess the resulting significance. Where impacts are significant, mitigation will be applied.

The technical analysis has been informed by:

- A digital terrain database – based on OSGB 36 datum that is interpolated by a sophisticated weighted algorithm;
- Radar line of sight analysis that includes earth curvature and atmospheric refraction; and
- Safeguarding criteria specified within CAA and ICAO publications (see References at the end of this chapter and the technical appendices).

The process for determining impact significance is by:

- Determining the receptor sensitivity;
- Determining the magnitude of effect; and
- Combining the above to determine the Significance of Impact.

16.3.3.1 MoD

There are no military radar that are predicted to be affected by the Development. Therefore, the magnitude of effect for radar would be 'no effect' and the resulting impact significance would be 'not significant' by definition.

The Eskdalemuir seismic array is considered to have a sensitivity of 'Very High' because it is of international scale and has very limited potential for substitution. The Development is outside the safeguarding range for the Eskdalemuir seismic array. Consequently, the magnitude of effect is 'No Change' and the resulting impact significance is 'not significant'.

The Development is within a 'high priority' military low flying area. Military low flying areas are of regional scale. The level of acceptable development within a zone is variable and complicated to determine, however the overall sensitivity is considered 'medium'.

The Development will present an obstruction within a military low flying area. The MoD has not objected to the Development and consultation has been undertaken to establish the associated aviation lighting requirements. The magnitude of effect is 'minor' and the resulting impact significance is 'not significant' subject to the provision of adequate lighting (discussed in the 'Mitigation' section of this chapter).

16.3.3.2 Glasgow Prestwick Airport

Wind developments can affect airports predominantly by presenting a collision risk to aircraft approaching/departing the airport or by interfering with radar/other navigation aids.

The potential for collision risk is safeguarded via Obstacle Limitation Surfaces (OLS) – defined in accordance with the Civil Aviation Authority (CAA) Civil Aviation Publication (CAP) 168 'Licensing of Aerodromes'.

An OLS is considered a receptor of 'Medium' sensitivity. None of the OLS at Glasgow Prestwick Airport extend over the Development, therefore the magnitude of effect is 'no change' and the impact significance is 'not significant'.

Based on the range to the Development, only the Primary Surveillance Radar (PSR) at Glasgow Prestwick Airport requires assessment – the other navigation aids would not typically be assessed at this distance.

The PSR is a receptor of 'medium' sensitivity. All of the turbines within the Development are below radar line of sight, which means they will not cause interference. The magnitude of effect is 'no change' and the impact significance is 'not significant'.

Glasgow Prestwick Airport confirmed during pre-application advice that they would not lodge any objection because their procedures and radar would not be affected. The turbine layout has been modified since this initial response, however the general Site location is the same and, the number of turbines has reduced by one, and all turbines remain below radar line of sight, as during the initial consultation, so no change is expected.

16.3.3.3 NATS

NATS operates en-route radar and navigation aids throughout the UK, which are safeguarded against wind developments. The most significant concern for PSR is the potential for false returns, or 'radar clutter' caused by the spinning rotor. Secondary Surveillance Radar (SSR) can also be affected by reflection issues, however these are safeguarded to shorter distances. No SSR concerns are applicable for the Development.

The NATS safeguarded PSR that have been assessed are:

- Lowther Hill;
- Great Dun Fell;
- Glasgow Airport; and
- Orchardton (Cumbernauld).

Each radar has a receptor sensitivity of 'medium'.

The radar at Glasgow Airport and Orchardton (Cumbernauld) will not have radar line of sight to the Development. The magnitude of effect is therefore 'no change' and the overall impact is 'not significant'.

Technical assessment has shown that the radar at Lowther Hill is highly likely to detect each of the wind turbines and that the Development is predicted to cause radar clutter. The average distance between the turbines and the radar is 29 km. The magnitude of effect is 'moderate' and the significance of impact is 'moderate – significant'. Mitigation is a requirement for the Lowther Hill radar, discussed in the 'Mitigation' section of this section.

Technical assessment has shown that the radar at Great Dun Fell is highly likely to detect all but one of the turbines and that the Development is predicted to cause radar clutter. The average distance between the turbines within the Development and the radar is 117 km. The magnitude of effect is 'moderate' and the significance of impact is 'moderate – significant'. Mitigation is a requirement for the Lowther Hill radar, discussed in the 'Mitigation' section of this chapter.

16.3.4 Mitigation

16.3.4.1 MoD

The MoD requires aviation lighting due to the presence of the military low flying zone. Consultation with the MoD has confirmed that their requirement is for infra-red lighting only, specifically:

- The cardinal turbines should be fitted with infra-red lighting;
- The lighting should have an optimised flash pattern of 60 flashes per minute of 200ms to 500ms at the highest practicable point.

It has been confirmed with the MoD that visible lighting is not a requirement. The highest practicable point for a wind turbine in the context of aviation lighting is the turbine hub.

The precise lighting scheme has not been finalised, this will be designed in accordance with the MoD requirements above.

16.3.4.2 NATS

The predicted impact on the NATS radar will require technical mitigation. Technical solutions have been explored in order to develop a mitigation strategy for the Development. The optimal solution would comprise two elements, namely:

- Radar blanking; and
- In-fill coverage.

Radar blanking is a solution whereby radar returns are suppressed within a defined area, in this case the airspace over the Development. By itself, this solution results in a 'hole' in the radar's coverage, which is not considered operationally acceptable in this case. Therefore, a radar blanking solution must be accompanied by 'in-fill' coverage from one or more alternative radar that have adequate coverage within the blanked area but are not affected by the Development.

The result of radar blanking in combination with an in-fill solution is seamless coverage over the Development, without the presence of radar clutter.

Technical assessment has shown that the NATS radar at Glasgow Airport and Orchardton are unlikely to be affected and could be incorporated as part of a technical solution by providing coverage over the Development location.

Initial discussion with NATS has also indicated that utilisation of the Prestwick Terma radar can be considered – this type of radar is specifically designed to mitigate the effects of wind turbine radar clutter.

Additionally, provision of a new in-fill radar at Lowther Hill could also technically mitigate the effects of the Development. In-fill radar are designed to detect aircraft without being affected by wind turbine clutter. This means the adversely affected radar can be blanked, removing the clutter, and in-fill coverage for the airspace over the Development would be provided by the new local in-fill radar.

The mitigation strategy, which will be developed further in close collaboration with NATS, will be to provide in-fill radar coverage at the affected area to allow blanking of the affected radar. Specifically, the two options that will comprise the mitigation strategy are:

1. Provision of a new local in-fill radar at Lowther Hill. The Lowther Hill PSR itself could be blanked, with coverage provided by the new radar and the Glasgow Airport PSR. Impacts on the Great Dun Fell PSR could be blanked or operationally accommodated.
2. Blanking the Lowther Hill PSR and Great Dun Fell PSR, utilising in-fill coverage from:
    - The Prestwick Terma radar; or
    - NATS radar at Glasgow Airport and/or Orchardton.

16.3.5 Residual Effects

Any mitigation strategies will be designed to ensure that adverse impacts are remedied such that any residual effects will be non-existent or insignificant. Specifically, the lighting scheme will be designed in accordance with the MoD requirements such that safety is maintained in the area. The NATS radar mitigation will ensure that coverage in the Site area is maintained to the required standard.

16.3.6 Statement of Significance

The potential effects of the Development on aviation activity has been assessed technically and operationally. Consultation has been undertaken with the relevant stakeholders including the MoD and NATS. Significant effects are not predicted for any MoD infrastructure, a lighting scheme is required, for which the requirements have been agreed via consultation with the MoD. Significant impacts, in the absence of mitigation, are predicted for the NATS radar at Lowther Hill and Great Dun Fell. A mitigation strategy based on radar blanking and infill coverage has been identified as the optimal solution and is to be progressed in collaboration with NATS.

16.4 HEALTH & SAFETY, INCLUDING ACCIDENTS

16.4.1 Introduction

The EIA Regulations state than an EIA must identify, describe and assess in an appropriate manner, the expected effects deriving from the vulnerability of the Development to risks, so far as relevant to the Development, upon health and safety, including natural disasters and major accidents.

16.4.2 Vulnerability of the Development to Natural Disasters

The Site is not located within an area known for natural disasters such as floods, hurricanes, tornadoes, volcanic eruptions, earthquakes or tsunamis.

As stated in Chapter 15: Climate Change and Carbon Balance of this EIA Report, none of the identified climate change trends listed will affect the Development with the exception of increased high wind speed conditions. Due to the exposed nature of wind farm sites, wind turbines are designed to withstand extreme weather conditions. Brake mechanisms installed on turbines allow them to be operated only under specific wind speeds and, should severe wind speeds be experienced, then the turbines would be shut down. Although an unlikely event for Scotland, the brake mechanism could also apply to a hurricane scenario.

Other natural disasters that could affect the Development include forest fires and floods. Wildfires within forests form a small proportion of "outdoor fires" in Scotland[9] and are uncommon[10], and the risk of a forest fire affecting the Development is therefore low. The Forestry Management Plan within Chapter 13 Forestry contains details of how this would be managed within the surrounding forestry. In the rare event that one does occur, standard operating procedures for emergency operations at wind turbine sites would be followed.

Flooding is the most probable natural disaster that could affect the Development and is assessed within the hydrological assessment, Chapter 9 of this EIA Report. No other natural disasters are considered to have the realistic potential to occur and therefore, natural disasters are not considered further within this chapter.

16.4.3 Potential for the Development to Cause Major Accidents

The risk of environmental accidents is covered, where relevant, in individual technical chapters. For example, the potential for environmental incidents, like flooding, or accidents, like spillages, are considered in Chapter 9: Geology, Hydrology and Hydrogeology of this EIA Report, whilst aviation safety issues are assessed within section 16.3 of this chapter.

No other major accidents are considered likely to occur. On-site accidents during construction and operation are assessed in Sections 16.4.4 and 16.4.5 of this Chapter.

16.4.4 Construction Phase

Effects upon health and safety are managed through risk assessments, pursuant to legislation of the European Union such as Directive 2012/18/EU of the European Parliament[11] on the control of major-accident hazards. The Directive lays down rules for the prevention of major accidents which might result from certain industrial activities and the limitation of their consequences for human health and the environment. Directive 2012/18/EU requires the preparation of emergency plans and response measures which will be covered under equivalent documents relevant to the nature of the Development.

The Construction (Design and Management) Regulations 2015[12] (CDM Regulations) are intended to ensure that health and safety issues are properly considered during

[9] The Scottish Government (2014). Fire and Rescue Statistics, Scotland. [online] Gov.scot. Available at: http://www.gov.scot/Resource/0046/00466202.pdf [Accessed 06/12/18].
[10] Davies, G. and Legg, C. (2016). Regional variation in fire weather controls the reported occurrence of Scottish wildfires. PeerJ, 4, p.e2649.
[11] European Union (2012) Directive 2012/18/EU. Available at: http://eur-lex.europa.eu/legalcontent/EN/TXT/PDF/?uri=CELEX:32012L0018&from=en [Accessed 06/12/18]
[12] Scottish Government (2015) The Construction (Design and Management) Regulations 2015. Available at http://www.legislation.gov.uk/uksi/2015/51/contents/made [Accessed 06/12/18]

development to reduce the risk of harm. In accordance with the CDM Regulations, a Principal Designer and Principal Contractor would be appointed.

The Principal Designer would have responsibility for coordination of health and safety during the pre-construction phase. Guidance published by the Health and Safety Executive in January 2015, defines principal designers as '*…designers appointed by the client in projects involving more than one contractor. They can be an organisation or an individual with sufficient knowledge, experience and ability to carry out the role.*'

Principal contractors are defined in the 2015 CDM Regulations as '*contractors appointed by the client to coordinate the construction phase of a project where it involves more than one contractor …They … must possess the skills, knowledge, and experience, and (if an organisation) the organisational capability necessary to carry out their role effectively given the scale and complexity of the project and the nature of the health and safety risks involved.*'

Throughout all phases of the Development, cognisance would be made of the following guidance documents produced by Renewable UK:

- Wind Turbine Safety Rules Third Edition[13];
- Guidance & Supporting Procedures on the Application of Wind Turbine Safety Rules Third Edition[14]; and
- Onshore Wind Health & Safety Guidelines[15].

The remoteness and the type of the Development will reduce the severity of accidents occurring and major accidents occurring as a result of construction are highly unlikely. An Outline Construction Environmental Management Plan (CEMP) is located in Appendix A9.1 which implements best practice construction practices to minimise the risk of accidents, such as pollution events. In the unlikely event that such an event were to occur during construction, emergency response plans would be available and implemented to deal with any occurrences.

The risk of construction accidents as they relate to human health and safety would be covered in the CEMP and specific risk assessment method statements, prepared in response to conditions attached to any consent. These would include identifying site specific risks and preparing assessments to minimise and manage the risk such as equipment safe handling, personal protection equipment, amongst others. As a result, construction accidents are not considered further within this chapter.

16.4.5 Operational Phase

Electrical infrastructure will be located across the Development in the form of an electrical substation and battery storage facility which will be subject to routine maintenance such that it is not considered to pose a significant risk of creating an accident. Additionally, effects upon population and human health are unlikely due to the remoteness of the Development, the low population density, and adherence to required safety clearances around turbines.

A possible but rare source of danger to human or animal life from a wind turbine would be the loss of a piece of the blade or, in the most exceptional circumstances, of the

[13] Renewable UK (2015) Wind Turbine Safety Rules, Third Edition. Available at: https://c.ymcdn.com/sites/www.renewableuk.com/resource/resmgr/Docs/Health_&_Safety/WindTurbineSafetyRulesIssue3.pdf [Accessed 06/12/18]

[14] Renewable UK (2015) Guidance on the Application of Wind Turbine Safety Rules, Third Edition. Available at: https://cdn.ymaws.com/www.renewableuk.com/resource/resmgr/docs/health_&_safety/wtsr_1506.pdf [Accessed 15/11/2018]

[15] Renewable UK (2015) Onshore Wind Health & Safety Guidelines. Available at: http://c.ymcdn.com/sites/www.renewableuk.com/resource/collection/AE19ECA8-5B2B-4AB5-96C7-ECF3F0462F75/OnshoreWind_HealthSafety_Guidelines.pdf [Accessed 06/12/18]

whole blade from an operational turbine. Many blades are composite structures with no bolts or other separate components. Even for blades with separate control surfaces on or comprising the tips of the blade, separation is highly unlikely. Wind turbines have an exemplary safety record with no recorded instances of fatalities to any member of the public anywhere in the world. The turbines are also designed to shut down automatically during high wind speed conditions, typically in excess of 60 mph.

There is a risk of ice accumulation on turbine blades, nacelles and towers under certain conditions such as periods of very cold weather with high humidity. In those instances where icing of blades occurs, fragments of ice might be released from blades, particularly when the machine is started. The wind turbines would be fitted with vibration sensors to detect any imbalance which might be caused by icing of the blades. This enables the operation of machines with iced blades to be inhibited to eliminate the risk of ice throw.

The possibility of attracting lightning strikes applies to all tall structures, and wind turbines are no different. Appropriate lightning protection measures are incorporated in wind turbines to ensure that lightning is conducted harmlessly past the sensitive parts of the nacelle and down into the ground.

The Scottish Government Online Advice (2014) states: '*Although wind turbines erected in accordance with best engineering practice should be stable structures, it may be advisable to achieve a set-back from roads and railways of at least the height of the turbine proposed, to assure safety*'.

The distance between the nearest proposed turbines and public roads is well in excess of tip height. In respect of footpaths, many wind farms in Scotland are open access and allow members of the public to walk close to the turbine towers.

16.4.6 Statement of Significance

Due to its location, the Site is not prone to natural disasters. Whilst adverse weather conditions, most notably high wind speed events, ice producing conditions and lightning strikes, do occur within Scotland, wind turbines are designed to withstand extreme weather conditions. Brake mechanisms, vibration sensors and lightning protection measures are installed on turbines allowing them to be operated under optimal conditions and inhibited during extreme weather events.

The risk of construction accidents as they relate to human health and safety are detailed and managed through the CDM Regulations and in the CEMP through specific construction risk assessment method statements, which will be prepared in accordance with conditions attached to any consent of the Development.

Therefore, the overall risk of health and safety including major accidents and disasters is considered negligible and not significant in terms of the EIA Regulations.