

Solar Photovoltaic Glint and Glare Study

Heaton Planning Ltd

Studley Grange

March 2026

PLANNING SOLUTIONS FOR:

- Solar
- Defence
- Airports
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- Wind
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Issue	Date	Detail of Changes
1	September 2025	Initial issue
2	March 2026	Updated PV Layout and Modelling

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EXECUTIVE SUMMARY

Report Purpose

Pager Power has been retained to assess the possible effects of glint and glare from a ground-mounted solar photovoltaic development, located southwest of Swindon, Wiltshire, England. This assessment pertains to the potential impact upon road safety, residential amenity and aviation activity at Draycott Farm and Lotmead Farm Airfield.

Overall Conclusions

No impacts are predicted upon road safety, residential amenity and aviation activity. No mitigation is recommended.

Guidance and Studies

Guidelines exist in the UK (produced by the Civil Aviation Authority) and in the USA (produced by the Federal Aviation Administration) with respect to solar developments and aviation activity. The UK CAA guidance is relatively high-level and does not prescribe a formal methodology. There is no formal planning guidance for the assessment of solar reflections from solar panels towards roads and nearby dwellings. There is railway guidance with respect to signal sighting however no guidance with respect to glint and glare from building developments and railway infrastructure has been specifically produced. Pager Power has however produced guidance for glint and glare and solar photovoltaic developments, which was published in early 2017, with the fourth edition¹ published in 2022. This methodology defines a comprehensive process for determining the impact upon road safety, residential amenity, and aviation activity.

Pager Power's approach is to undertake geometric reflection calculations and, where a solar reflection is predicted, consider the screening (existing and/or proposed) between the receptor and the reflecting solar panels. For aviation activity, where a solar reflection is predicted, solar intensity calculations are undertaken where appropriate in line with the Sandia National Laboratories' FAA methodology². The scenario in which a solar reflection can occur for all receptors is then identified and discussed, and a comparison is made against the available solar panel reflection studies to determine the overall impact.

The available studies have measured the intensity of reflections from solar panels with respect to other naturally occurring and manmade surfaces. The results show that the reflections produced are of intensity similar to or less than those produced from still water and significantly less than reflections from glass and steel³.

¹ Pager Power Glint and Glare Guidance, Fourth Edition, September 2022.

² Formerly mandatory for on-airfield solar developments in the USA under the FAA's interim policy, superseded in 2021 with a policy that effectively requires individual airports to sign off on their on-airfield development as they see fit.

³ SunPower, 2009, SunPower Solar Module Glare and Reflectance (appendix to Solargen Energy, 2010).

Assessment Results - Roads

Solar reflections are geometrically possible towards 0.59km section of Hay Lane.

For all sections of road where solar reflections are geometrically possible, screening in the form of existing vegetation is predicted to significantly obstruct views of reflecting panels such that solar reflections will not be experienced by road users in practice. No impact is predicted, and mitigation is not required.

Assessment Results - Dwellings

Solar reflections are geometrically possible towards six of the 10 assessed dwellings.

For all six of these dwellings, screening in the form of existing vegetation is predicted to significantly obstruct views of reflecting panels. No impact is predicted, and mitigation is not required.

Assessment Results - High-Level Aviation

No significant impacts are predicted upon aviation activity associated with Lotmead Farm Airfield and Draycott Farm, and mitigation is not required. Detailed modelling is not recommended.

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ABOUT PAGER POWER

Pager Power is a dedicated consultancy company based in Suffolk, UK. The company has undertaken projects in 64 countries within Europe, Africa, America, Asia and Oceania.

The company comprises a team of experts to provide technical expertise and guidance on a range of planning issues for large and small developments.

Pager Power was established in 1997. Initially the company focus was on modelling the impact of wind turbines on radar systems. Over the years, the company has expanded into numerous fields including:

- Renewable energy projects;
- Building developments;
- Aviation and telecommunication systems.

Pager Power prides itself on providing comprehensive, understandable and accurate assessments of complex issues in line with national and international standards. This is underpinned by its custom software, longstanding relationships with stakeholders and active role in conferences and research efforts around the world.

Pager Power's assessments withstand legal scrutiny, and the company can provide support for a project at any stage.

1 INTRODUCTION

1.1 Overview

Pager Power has been retained to assess the possible effects of glint and glare from a ground-mounted solar photovoltaic development, located southwest of Swindon, Wiltshire, England. This assessment pertains to the potential impact upon road safety, residential amenity and aviation activity at Draycott Farm and Lotmead Farm Airfield.

This report contains the following:

- Solar development details;
- Explanation of glint and glare;
- Overview of relevant guidance and relevant studies;
- Overview of Sun movement;
- Assessment methodology;
- Identification of receptors;
- Glint and glare assessment for identified receptors;
- Results discussion.

The relevant technical analysis is presented in each section. Following the assessment, conclusions and recommendations are made.

1.2 Pager Power's Experience

Pager Power has undertaken over 1,800 Glint and Glare assessments in the UK and internationally. The studies have included assessment of civil and military aerodromes, railway infrastructure and other ground-based receptors including roads and dwellings.

1.3 Glint and Glare Definition

The definition of glint and glare is as follows⁴:

- Glint – a momentary flash of bright light typically received by moving receptors or from moving reflectors;
- Glare – a continuous source of bright light typically received by static receptors or from large reflective surfaces.

The term 'solar reflection' is used in this report to refer to both reflection types i.e. glint and glare.

⁴ These definitions are aligned with those presented within the National Policy Statement for Renewable Energy Infrastructure (EN-3) – published by the Department for Energy Security and Net Zero in January 2024 and the Federal Aviation Administration in the USA..

2 SOLAR DEVELOPMENT LOCATION AND DETAILS

2.1 Proposed Development Site Layout

The proposed development site layout⁵ is shown in Figure 1 below.

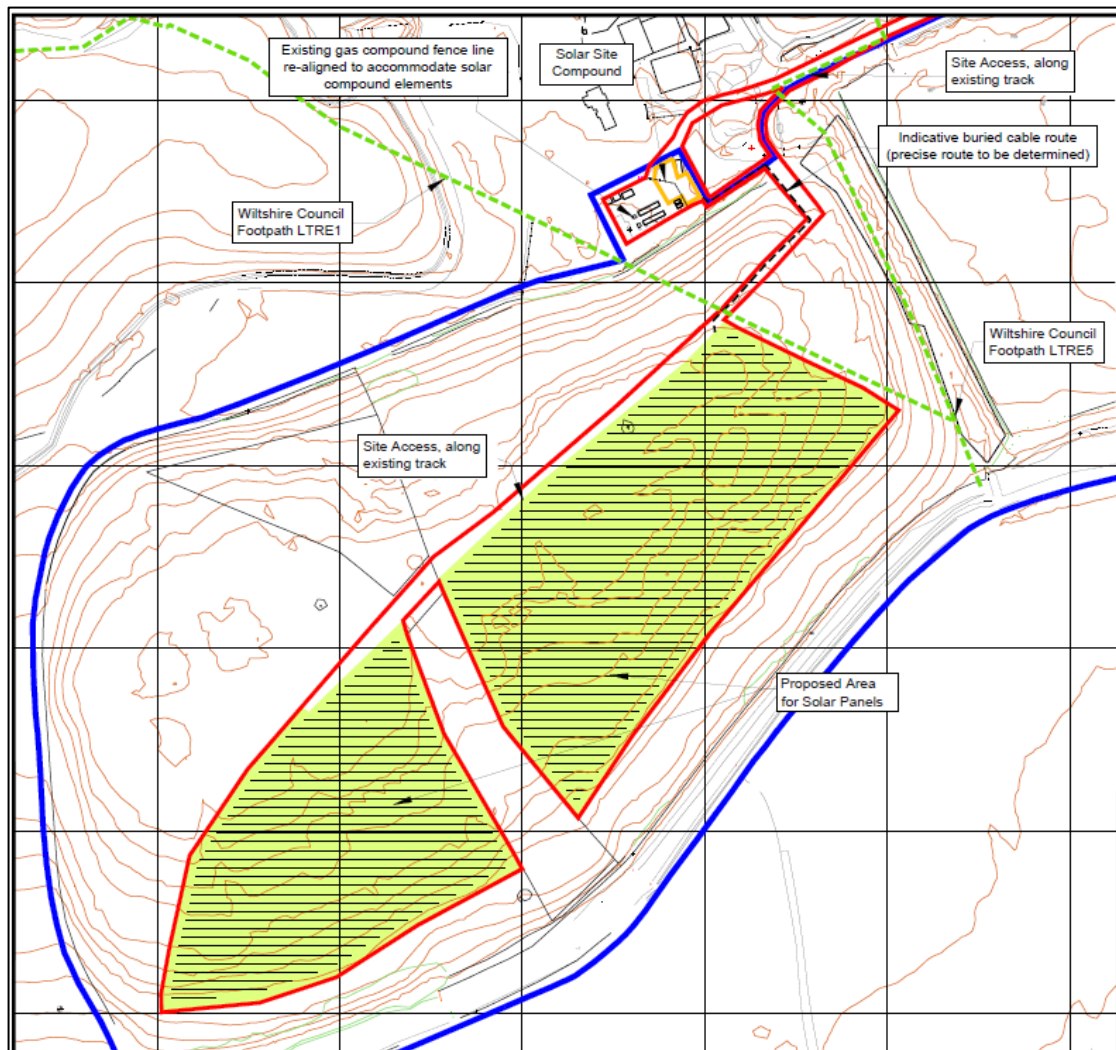


Figure 1 Proposed development site layout

⁵ Source: IBR1456-PL-105-P02-Proposed Solar PV Site Layout.pdf

Figure 2 below shows the boundary of the proposed solar arrays for the proposed development overlaid onto aerial imagery.



Figure 2 Proposed solar array boundary

2.2 Solar Panel Technical Information

The technical information used for the modelled panels in this assessment are presented in Table 1 below. The centre of the solar panel has been used as the assessed height in metres above ground level (agl)⁶.

Solar Panel Technical Information	
Azimuth angle ⁷	180°
Elevation angle (tilt) ⁸	25°
Assessed centre height (m)	2.05 agl

Table 1 Solar panel information

⁶ Minimum height = 1.1m agl, maximum height = 3m agl.

⁷ Relative to true north.

⁸ Relative to the horizontal.

3 GLINT AND GLARE ASSESSMENT METHODOLOGY

3.1 Guidance and Studies

Appendices A and B present a review of relevant guidance and independent studies regarding glint and glare issues from solar panels. The overall conclusions from the available studies are as follows:

- Specular reflections of the Sun from solar panels are possible;
- The measured intensity of a reflection from solar panels can vary from 2% to 30% depending on the angle of incidence;
- Published guidance shows that the intensity of solar reflections from solar panels are equal to or less than those from water. It also shows that reflections from solar panels are significantly less intense than many other reflective surfaces, which are common in an outdoor environment.

3.2 Background

Details of the Sun's movements and solar reflections are presented in Appendix C.

3.3 Methodology

The glint and glare assessment methodology has been derived from the information provided to Pager Power through consultation with stakeholders and by reviewing the available guidance and studies. The methodology for this glint and glare assessment is as follows:

- Identify receptors in the area surrounding the solar development;
- Consider direct solar reflections from the solar development towards the identified receptors by undertaking geometric calculations;
- Consider the visibility of the panels from the receptor's location. If the panels are not visible from the receptor, then no reflection can occur;
- Based on the results of the geometric calculations, determine whether a reflection can occur, and if so, at what time it will occur;
- Consider both the solar reflection from the solar development and the location of the direct sunlight with respect to the receptor's position;
- Consider the solar reflection with respect to the published studies and guidance - including intensity calculations where appropriate;
- Determine whether a significant detrimental impact is expected in line with the process presented in Appendix D.

3.4 Assessment Methodology and Limitations

Further technical details regarding the methodology of the geometric calculations and limitations are presented in Appendix E and F.

4 IDENTIFICATION OF RECEPTORS

4.1 Ground-Based Receptors Overview

There is no formal guidance with regard to the maximum distance at which glint and glare should be assessed. From a technical perspective, there is no maximum distance for potential reflections. The significance of a reflection however decreases with distance because the proportion of an observer's field of vision that is taken up by the reflecting area diminishes as the separation distance increases. Terrain and shielding by vegetation are also more likely to obstruct an observer's view at longer distances.

A 1km assessment area is considered appropriate for glint and glare effects on ground-based receptors – bounded by the red outlined area in Figure 3 below. Receptors within this distance are identified based on mapping and aerial photography of the region. Receptors to the north of the development are not included because solar reflections would not be geometrically possible towards the north when the azimuth angle is considered⁹.

The receptor details are presented in Appendix G.



Figure 3 1km assessment area

⁹ For fixed, south-facing panels at this latitude, reflections towards ground-based receptors located further north than any proposed panel are not geometrically possible.

4.2 Road Receptors

4.2.1 Road Receptors Overview

Road types can generally be categorised as:

- Major National – Typically a road with a minimum of two carriageways with a maximum speed limit of up to 70mph. These roads typically have fast-moving vehicles with busy traffic;
- National – Typically a road with one or more carriageways with a maximum speed limit of 60mph or 70mph. These roads typically have fast-moving vehicles with moderate to busy traffic density;
- Regional – Typically a single carriageway with a maximum speed limit of up to 60mph. The speed of vehicles will vary with a typical traffic density of low to moderate;
- Local – Typically roads and lanes with the lowest traffic densities. Speed limits vary.

Technical modelling is not recommended for local roads, where traffic densities are likely to be relatively low. Any solar reflections from the proposed development that are experienced by a road user along a local road would be considered low impact in the worst case in accordance with the guidance presented in Appendix D. The analysis has therefore considered major national, national, and regional roads that:

- Are within the 1km assessment area;
- Have a potential view of the panels.

4.2.2 Identified Road Receptors

A section of Hay Lane, totalling 0.59km, has been identified within the assessment with potential views of the panels and has been taken forward for technical modelling. This road is shown in Figure 4 on the following page.

Receptors placed, approximately 100-metres apart, along these sections of road are shown on Figure 5 on page 17. A height of 1.5 metres above ground level has been taken as the typical eye level of a road user¹⁰.

All other roads within the assessment area have either been determined to be local roads or that the proposed development is not visible from them, and thus not taken forward for technical modelling.

¹⁰ This fixed height for the road receptors is for modelling purposes. Changes to the modelling height by a few metres is not expected to significantly change the modelling results. Views for elevated drivers are also considered in the results discussion, where appropriate.



Figure 4 Identified roads within 1km assessment boundary and Hay Lane labelled above



Figure 5 Receptors placed along Hay Lane

4.3 Dwelling Receptors

4.3.1 Dwelling Receptors Overview

The analysis has considered dwellings that:

- Are situated within the 1km assessment area; and
- Have a potential view of the panels.

In residential areas with multiple layers of dwellings, only the outer dwellings have been considered for assessment. This is because they will mostly obscure views of the solar panels to the dwellings behind them, which will therefore not be impacted by the proposed development. This is because the line of sight will be removed, or they will experience comparable effects to the closest assessed dwelling.

Additionally, in some cases, a single receptor point may be used to represent a small number of separate addresses. In such cases, the results for the receptor will be representative of the adjacent observer locations, such that the overall level of effect in each area is captured reliably.

4.3.2 Identified Dwelling Receptors

The assessed dwelling receptors are shown in Figure 6 on the following page. In total, 10 dwellings have been assessed. An additional 1.8m height above ground is used in the modelling to simulate the typical viewing height of an observer on the ground floor¹¹.

¹¹ This fixed height for the dwelling receptors is for modelling purposes. Changes to the modelling height by a few metres is not expected to significantly change the modelling results. Views above ground floor are considered in the results discussion where necessary.



Figure 6 Overview of assessed dwelling receptors 1 to 10

5 ASSESSED REFLECTOR AREAS

5.1 Reflector Area

The bounding coordinates for the proposed development have been extrapolated from the site plans. The data can be found in Appendix G. Figure 7 below shows the assessed reflector area that has been used for modelling purposes.

The Pager Power model has used a resolution of 15m for this assessment. This means that a geometric calculation is undertaken for each identified receptor every 15m from within the defined area. This resolution is sufficiently high to maximise the accuracy of the results – increasing the resolution further would not significantly change the modelling output. If a reflection is experienced from an assessed panel location, then it is likely that a reflection will be viewable from similarly located panels within the proposed solar development.



Figure 7 Assessed reflector area

6 GLINT AND GLARE ASSESSMENT – TECHNICAL RESULTS

6.1 Overview

The following sub-sections summarise the results of the assessment:

- The key considerations for each receptor type. The criteria are determined by the assessment process for each receptor, which are set out in Appendix D.
- Geometric results of the assessment based solely on bare-earth terrain i.e., without consideration of screening in the form of buildings, dwellings, (existing or proposed) vegetation, and/or terrain. The modelling output for receptors, shown in Appendix H, presents the precise predicted times and the reflecting panel areas.
- Whether a reflection will be experienced in practice. When determining the visibility of the reflecting panels for an observer, a conservative review of the available imagery, landscape strategy plan, google earth viewshed (high-level terrain analysis), and/or site photography (if available) is undertaken, whereby it is assumed views of the panels are possible if it cannot be reliably determined that existing and/or proposed screening will remove effects. Detailed screening analysis may be undertaken to determine visibility, where appropriate.
- The impact significance and any mitigation recommendations/requirements.
- The desk-based review of the available imagery, where appropriate.

6.2 Road Results

6.2.1 Key Considerations

The process for quantifying impact significance is defined in the report appendices. The key considerations for road users along major national, national, and regional roads are:

- Whether a reflection is predicted to be experienced in practice;
- The location of the reflecting panel relative to a road user's direction of travel.

Where no solar reflections are geometrically possible or where solar reflections are predicted to be significantly screened, no impact is predicted, and mitigation is not required.

Where reflections originate from outside of a road user's main field of view (50 degrees either side of the direction of travel), or where the separation distance to the nearest visible reflecting panel is over 1km, the impact significance is low, and mitigation is not recommended.

Where reflections are predicted to be experienced from inside of a road user's main field of view, expert assessment of the following factors is required to determine the impact significance:

- Whether visibility is likely for elevated drivers (applicable to dual carriageways and motorways only) – there is typically a higher density of elevated drivers (such as HGVs) along dual carriageways and motorways compared to other types of road;
- Whether a solar reflection is fleeting in nature. Small gap/s in screening (e.g., an access point to the site) may not result in a sustained reflection for a road user;

- The separation distance to the panel area – larger separation distances reduce the proportion of an observer's field of view that is affected by glare;
- The position of the Sun – effects that coincide with direct sunlight appear less prominent than those that do not;
- Whether the solar reflection originates from directly in front of a road user – a solar reflection that is directly in front of a road user is more hazardous than a solar reflection to one side.

Following consideration of these relevant factors, where the solar reflection is not deemed significant, a low impact is predicted, and mitigation is not recommended. Where the solar reflection is deemed significant, the impact significance is moderate, and mitigation is recommended.

Where reflections originate from directly in front of a road user and there are no mitigating factors, the impact significance is high, and mitigation is required.

6.2.2 Geometric Modelling Results Overview

The results of the modelling indicate that solar reflections are geometrically possible towards sections of Hay Lane.

Table 2 on the following page presents the following:

- Geometric modelling results (without consideration of screening);
- Desk-based review of identified screening (presented in more detail in the following sub-section);
- Consideration of any mitigating factors (where appropriate);
- Predicted impact significance.

Road Receptor	Geometric Modelling Results (without consideration of screening)	Identified Screening (desk-based review)	Relevant Factors	Predicted Impact Classification
A1 - A6	Solar reflections would originate from <u>outside</u> a road user's main horizontal field of view	Existing vegetation and terrain screening predicted to significantly obstruct views of reflecting panels such that views are <u>not predicted to be possible</u> in practice Proposed vegetation planting will further bolster screening	N/A	No impact
A7	Solar reflections would originate from <u>Inside</u> a road user's main horizontal field of view when travelling North	Existing vegetation and terrain screening predicted to significantly obstruct views of reflecting panels such that views are <u>not predicted to be possible</u> in practice Proposed vegetation planting will further bolster screening	N/A	No impact

Table 2 Geometric modelling results and assessment of impact significance – road receptors

6.2.3 Desk-Based Review of Imagery

The identified screening in the form of vegetation is outlined in yellow, and the reflecting panel area is shown in white in Figure 8 on the following page. Google Streetview imagery represents views of the proposed development along the sections of road where the reflecting panels are predicted to be significantly obstructed. Blue triangles are used to illustrate a road users primary field of view at each Streetview section.



Figure 8 Screening of PV panels accompanied by street view of relevant receptors

6.3 Dwelling Results

6.3.1 Key Considerations

The key considerations for quantifying the impact significance for dwelling receptors are:

- Whether a reflection is predicted to be experienced in practice;
- The duration of the predicted effects, relative to thresholds of:
 - Three months per year;
 - 60 minutes on any given day.

Where no solar reflections are geometrically possible or where solar reflections are predicted to be significantly screened, no impact is predicted, and mitigation is not required.

Where effects are predicted to be experienced for **less** than three months per year and **less** than 60 minutes on any given day, or where the separation distance to the nearest visible reflecting panel is over 1km, the impact significance is low, and mitigation is not recommended.

Where effects are predicted to be experienced for **more** than three months per year and/or for **more** than 60 minutes on any given day expert assessment of the following mitigating factors is required to determine the impact significance:

- Whether solar reflections will be experienced from all storeys. The ground floor is typically considered the main living space and therefore has a greater significance with respect to residential amenity;
- The separation distance to the panel area. Larger separation distances reduce the proportion of an observer's field of view that is affected by glare;
- The position of the Sun. Effects that coincide with direct sunlight appear less prominent than those that do not. The Sun is a far more significant source of light;
- Whether the dwelling appears to have windows facing the reflecting areas. An observer may need to look from a wide angle to observe the reflecting areas.

Following consideration of these relevant factors, where the solar reflection is not deemed significant, a low impact is predicted, and mitigation is not recommended. Where the solar reflection is deemed significant, the impact significance is moderate, and mitigation is recommended.

Where effects are predicted to be experienced for **more** than three months per year and **more** than 60 minutes on any given day and there are no mitigating factors, the impact significance is high, and mitigation is required.

6.3.2 Geometric Modelling Results Overview

Solar reflections are geometrically possible towards six out of the 10 assessed dwelling receptors.

Table 3 on the following pages presents the following:

- Geometric modelling results (without consideration of screening);
- Desk-based review of identified screening (presented in more detail in the following sub-section);
- Consideration of relevant mitigating factors (where appropriate);
- Predicted impact significance.

Dwelling Receptor	Geometric Modelling Results (without consideration of screening)	Identified Screening (desk-based review)	Relevant Factors	Predicted Impact Classification
1 - 2	Solar reflections <u>are geometrically possible</u> for: <u>Less</u> than three months per year <u>Less</u> than 60 minutes per any one day	Existing vegetation and terrain screening predicted to significantly obstruct views of reflecting panels such that views are <u>not predicted to be possible</u> in practice	N/A	No impact
3	Solar reflections <u>are geometrically possible</u> for: <u>More</u> than three months per year <u>Less</u> than 60 minutes per any one day	N/A	N/A	No impact
4 - 7	Solar reflections are not geometrically possible	Existing vegetation and terrain screening predicted to significantly obstruct views of reflecting panels such that views are <u>not predicted to be possible</u> in practice	N/A	No impact
8 - 10	Solar reflections <u>are geometrically possible</u> for: <u>More</u> than three months per year <u>Less</u> than 60 minutes per any one day	Existing vegetation and terrain screening predicted to significantly obstruct views of reflecting panels such that views are <u>not predicted to be possible</u> in practice	N/A	No impact

Table 3 Geometric modelling results and assessment of impact significance - dwelling receptors

6.3.3 Desk-Based Review of Imagery

The identified screening in the form of existing vegetation and buildings are outlined in yellow, and panel areas shown in white with the reflecting area shown in pink , within Figures 9 to 14 on the following pages.

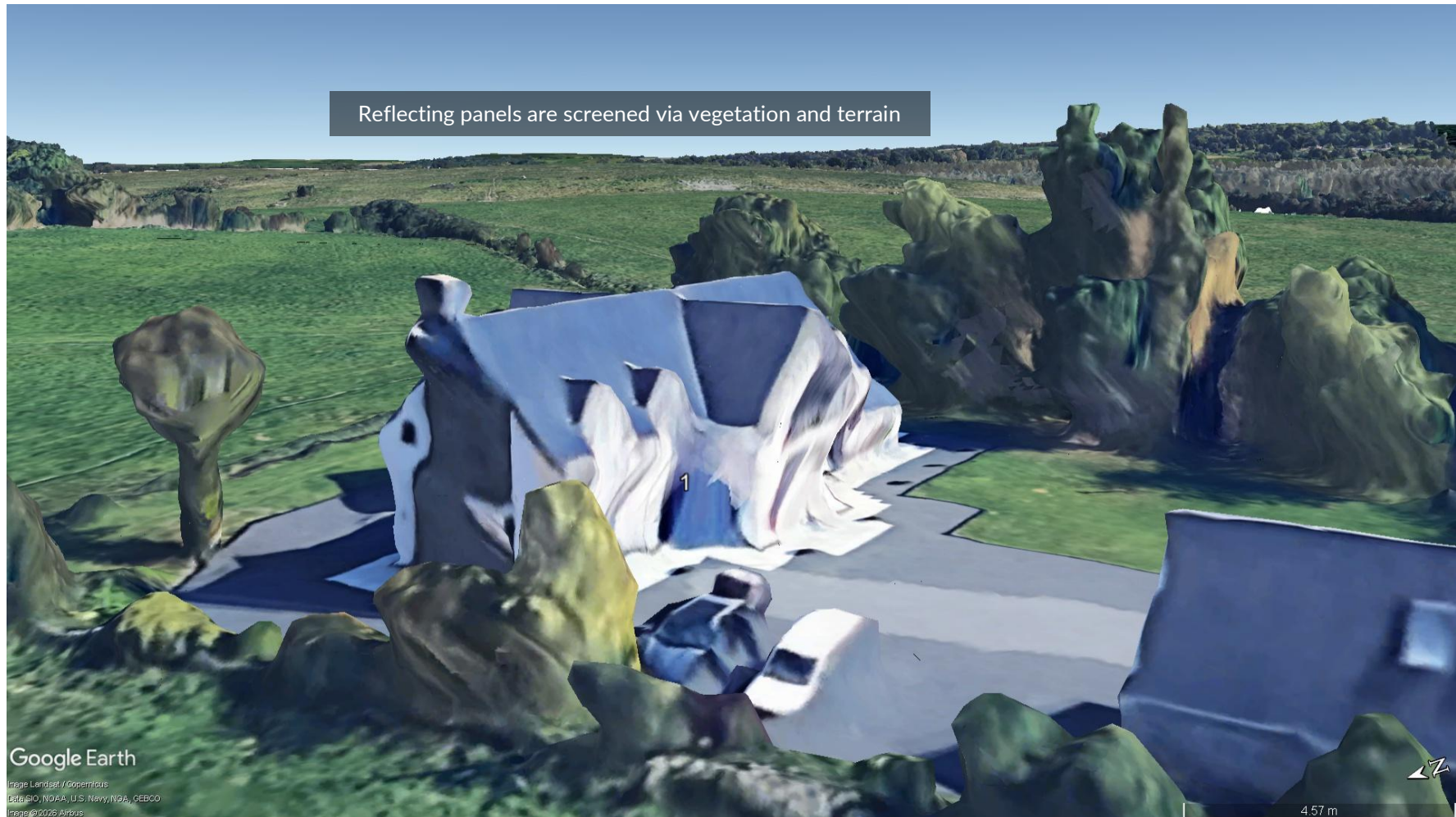


Figure 9 Screening relevant to dwelling receptor 1



Figure 10 Screening relevant to dwelling receptor 2



Figure 11 Screening relevant to dwelling receptor 3

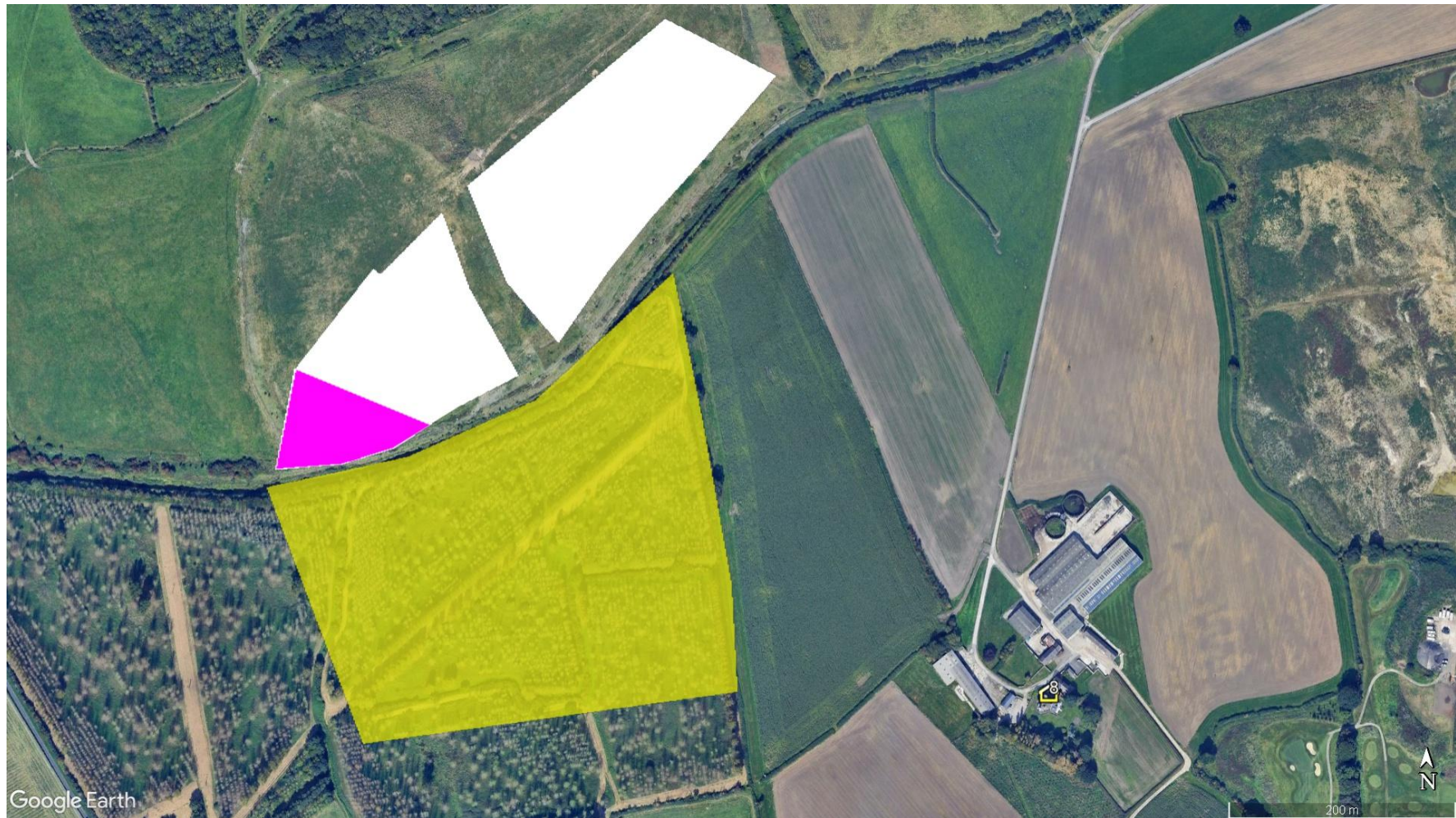


Figure 12 Screening relevant to dwelling receptor 8



Figure 13 Screening relevant to dwelling receptor 9



Figure 14 Screening relevant to dwelling receptor 10

7 HIGH-LEVEL AVIATION

7.1 Overview

Glint and glare assessment for aviation receptors is typically undertaken for licensed aerodromes within 10km of a proposed solar development. Geometric modelling for unlicensed general aviation aerodromes is typically required within 5km of a proposed development. At ranges of 10 - 20km, the requirement for assessment is much less common, with typically assessment only being undertaken for licensed aerodromes at these ranges. Assessment of any aviation effects for developments over 20km is not a usual requirement.

The following sub-sections present high-level assessments and conclusions of aviation concerns for Lotmead Farm Airstrip and Draycott Farm.

The proposed development size, distance between the aerodrome and proposed development, and industry experience are considered to determine the impact during the assessment.

7.2 High-Level Assessment of Lotmead Farm Airfield and Draycott Farm

7.2.1 Airfield details

Lotmead Farm airfield and Draycott Farm are unlicensed airfields approximately 9.9km and 8.5km northeast of the proposed development, respectively. They both have one operational runway and no ATC Tower. The runway details¹² are presented below:

- Lotmead Farm Airfield : 02/20 (grass);
- Draycott Farm: 18/36 (grass).

The location of Lotmead Farm Airfield and Draycott Farm, and 1-mile splayed approach paths for each runway threshold relative to the proposed development are shown in Figure 18 on the following page.

¹² As determined from aerial imagery.

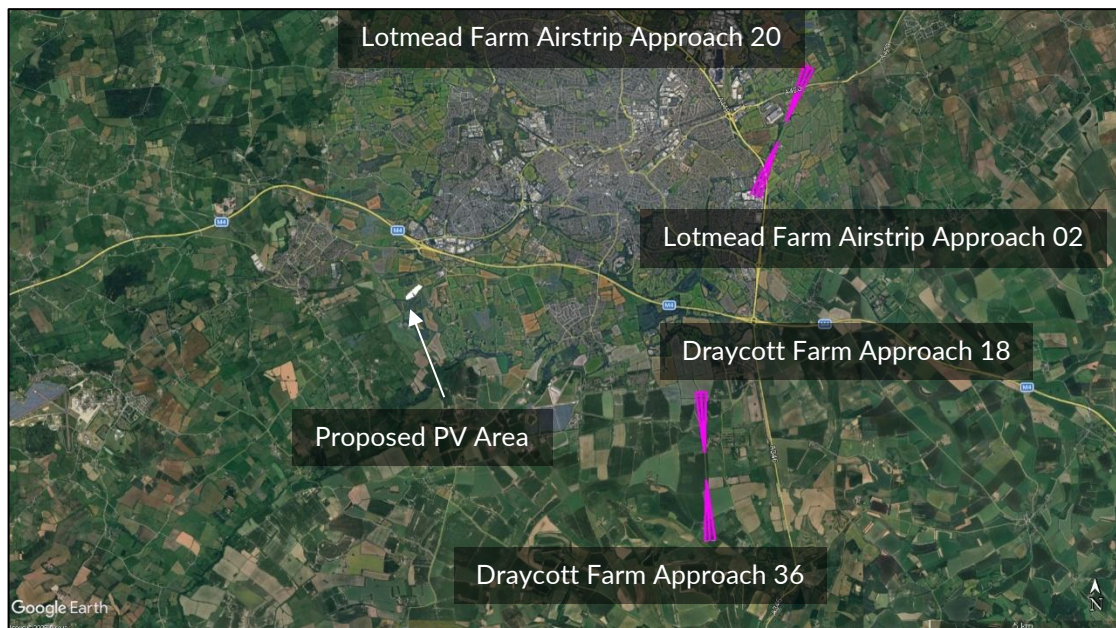


Figure 15 Lotmead Farm Airstrip and Draycott Farm relative to the proposed development

7.2.2 Assessment

The following can be concluded for Lotmead Farm Airstrip and Draycott Farm with regards to the proposed development:

- Solar reflections originating from the proposed development towards the 1-mile splayed approach path for runway threshold 18 and 02 will be outside a pilot's primary field-of-view, and would therefore not be considered significant, considering the associated guidance (Appendix D) and industry best practice pertaining to approach paths;
- Solar reflections towards the 1-mile splayed approach path for runway thresholds 36 and 20 will have glare intensities no greater than 'low potential for temporary after-image'. Considering the associated guidance (Appendix D) and industry best practice pertaining to approach paths, the glare intensity is considered acceptable, and therefore, it can be reliably concluded that this level of glare is also acceptable for the visual circuits.

7.2.3 Conclusions

No significant impacts upon aviation activity associated with Lotmead Farm Airstrip and Draycott Farm are predicted, and mitigation is not required. Detailed modelling is not recommended.

8 OVERALL CONCLUSIONS

8.1 Assessment Results - Roads

Solar reflections are geometrically possible towards a 0.59km section of Hay Lane.

For all sections of road where solar reflections are geometrically possible, screening in the form of existing vegetation is predicted to significantly obstruct views of reflecting panels such that solar reflections will not be experienced by road users in practice. No impact is predicted, and mitigation is not required.

8.2 Assessment Results - Dwellings

Solar reflections are geometrically possible towards six of the 10 assessed dwellings.

For all six of these dwellings, screening in the form of existing vegetation is predicted to significantly obstruct views of reflecting panels. No impact is predicted, and mitigation is not required.

8.3 Assessment Results - High-Level Aviation

No significant impacts are predicted upon aviation activity associated with Lotmead Farm Airfield and Draycott Farm, and mitigation is not required. Detailed modelling is not recommended.

8.4 Overall Conclusions

No impacts are predicted upon road safety, residential amenity and aviation activity. No mitigation is recommended.

APPENDIX A – OVERVIEW OF GLINT AND GLARE GUIDANCE

Overview

This section presents details regarding the relevant guidance and studies with respect to the considerations and effects of solar reflections from solar panels, known as 'Glint and Glare'.

This is not a comprehensive review of the data sources, rather it is intended to give an overview of the important parameters and considerations that have informed this assessment.

UK Planning Policy

Renewable and Low Carbon Energy

The National Planning Policy Framework under the planning practice guidance for Renewable and Low Carbon Energy¹³ (specifically regarding the consideration of solar farms, paragraph 013) states:

'What are the particular planning considerations that relate to large scale ground-mounted solar photovoltaic Farms?

The deployment of large-scale solar farms can have a negative impact on the rural environment, particularly in undulating landscapes. However, the visual impact of a well-planned and well-screened solar farm can be properly addressed within the landscape if planned sensitively.

Particular factors a local planning authority will need to consider include:

...

- the proposal's visual impact, the effect on landscape of glint and glare (see guidance on landscape assessment) and on **neighbouring uses and aircraft safety**;
- the extent to which there may be additional impacts if solar arrays follow the daily movement of the sun;

...

The approach to assessing cumulative landscape and visual impact of large-scale solar farms is likely to be the same as assessing the impact of wind turbines. However, in the case of ground-mounted solar panels it should be noted that with effective screening and appropriate land topography the area of a zone of visual influence could be zero.'

¹³ Renewable and low carbon energy, Ministry of Housing, Communities & Local Government, date: 18 June 2015, accessed on: 01/11/2021

National Policy Statement for Renewable Energy Infrastructure

The National Policy Statement for Renewable Energy Infrastructure (EN-3)¹⁴ sets out the primary policy for decisions by the Secretary of State for nationally significant renewable energy infrastructure. Sections 2.10.102-106 state:

'2.10.102 Solar panels are specifically designed to absorb, not reflect, irradiation.¹⁵ However, solar panels may reflect the sun's rays at certain angles, causing glint and glare. Glint is defined as a momentary flash of light that may be produced as a direct reflection of the sun in the solar panel. Glare is a continuous source of excessive brightness experienced by a stationary observer located in the path of reflected sunlight from the face of the panel. The effect occurs when the solar panel is stationed between or at an angle of the sun and the receptor.'

2.10.103 Applicants should map receptors to qualitatively identify potential glint and glare issues and determine if a glint and glare assessment is necessary as part of the application.

2.10.104 When a quantitative glint and glare assessment is necessary, applicants are expected to consider the geometric possibility of glint and glare affecting nearby receptors and provide an assessment of potential impact and impairment based on the angle and duration of incidence and the intensity of the reflection.

2.10.105 The extent of reflectivity analysis required to assess potential impacts will depend on the specific project site and design. This may need to account for 'tracking' panels if they are proposed as these may cause differential diurnal and/or seasonal impacts.

2.10.106 When a glint and glare assessment is undertaken, the potential for solar PV panels, frames and supports to have a combined reflective quality may need to be assessed, although the glint and glare of the frames and supports is likely to be significantly less than the panels.'

The EN-3 does not state which receptors should be considered as part of a quantitative glint and glare assessment. Based on Pager Power's extensive project experience, typical receptors include residential dwellings, road users, aviation infrastructure, and railway infrastructure.

Sections 2.10.134-136 state:

'2.10.134 Applicants should consider using, and in some cases the Secretary of State may require, solar panels to comprise of (or be covered with) anti-glare/anti-reflective coating with a specified angle of maximum reflection attenuation for the lifetime of the permission.

2.10.135 Applicants may consider using screening between potentially affected receptors and the reflecting panels to mitigate the effects.

2.10.136 Applicants may consider adjusting the azimuth alignment of or changing the elevation tilt angle of a solar panel, within the economically viable range, to alter the angle of incidence.

¹⁴ [National Policy Statement for Renewable Energy Infrastructure \(EN-3\)](#), Department for Energy Security & Net Zero, date: January 2024, accessed on: 17/01/2024.

¹⁵ Most commercially available solar panels are designed with anti-reflective glass or are produced with anti-reflective coating and have a reflective capacity that is generally equal to or less hazardous than other objects typically found in the outdoor environment, such as bodies of water or glass buildings.

In practice this is unlikely to remove the potential impact altogether but in marginal cases may contribute to a mitigation strategy.'

The mitigation strategies listed within the EN-3 are relevant strategies that are frequently utilised to eliminate or reduce glint and glare effects towards surrounding observers. The most common form of mitigation is the implementation of screening along the site boundary.

Sections 2.10.158-159 state:

2.10.158 Solar PV panels are designed to absorb, not reflect, irradiation. However, the Secretary of State should assess the potential impact of glint and glare on nearby homes, motorists, public rights of way, and aviation infrastructure (including aircraft departure and arrival flight paths).

2.10.159 Whilst there is some evidence that glint and glare from solar farms can be experienced by pilots and air traffic controllers in certain conditions, there is no evidence that glint and glare from solar farms results in significant impairment on aircraft safety. Therefore, unless a significant impairment can be demonstrated, the Secretary of State is unlikely to give any more than limited weight to claims of aviation interference because of glint and glare from solar farms.

The EN-3 goes some way in acknowledging that the issue is more complex than presented in the early draft issues; though, this is still unlikely to be welcomed by aviation stakeholders, who will still request a glint and glare assessment on the basis that glare may lead to an impact upon aviation safety.

Finally, the EN-3 relates solely to nationally significant renewable energy infrastructure and therefore does not apply to all planning applications for solar farms.

Assessment Process – Ground-Based Receptors

No process for determining and contextualising the effects of glint and glare has been determined when assessing the impact of solar reflections upon surrounding roads and dwellings. Therefore, the Pager Power approach is to determine whether a reflection from the proposed solar development is geometrically possible and then to compare the results against the relevant guidance/studies to determine whether the reflection is significant.

The Pager Power approach has been informed by the policy presented above, current studies (presented in Appendix B) and stakeholder consultation. Further information can be found in Pager Power's Glint and Glare Guidance document¹⁶ which was produced due to the absence of existing guidance and a specific standardised assessment methodology.

¹⁶ Solar Photovoltaic Development Glint and Glare Guidance, Fourth Edition, March 2022. Pager Power.

Assessment Process – Railways

Railway operations is not mentioned specifically within this guidance however it is stated that a developer will need to consider ‘*the proposal’s visual impact, the effect on landscape of glint and glare and on neighbouring uses...*’. In the UK, Network Rail is a statutory consultee when a development is located in close proximity to its infrastructure.

No process for determining and contextualising the effects of glint and glare are, however, provided. Therefore, the Pager Power approach is to determine whether a reflection from a development is geometrically possible and then to compare the results against the relevant guidance/studies to determine whether the reflection is significant.

Railway Assessment Guidelines

The following section provides an overview of the relevant railway guidance with respect to the siting of signals on railway lines. Network Rail is the stakeholder of the UK’s railway infrastructure. Whilst the guidance is not strictly applicable in other countries, the general principles within the guidance is expected to apply.

A railway operator’s concerns would likely to relate to the following:

1. The development producing solar glare that affects train drivers; and
2. The development producing solar reflections that affect railway signals and create a risk of a phantom aspect signal.

Railway guidelines are presented on the following pages. These relate specifically to the sighting distance for railway signals.

Reflections and Glare

The extract below and on the following page is taken from Section A5 – Reflections and glare (pages 64-65) of the ‘Signal Sighting Assessment Requirements’¹⁷ which details the requirement for assessing glare towards railway signals.

Reflections and glare

Rationale

Reflections can alter the appearance of a display so that it appears to be something else.

Guidance

A5 is present if direct glare or reflected light is directed into the eyes or into the lineside signalling asset that could make the asset appear to show a different aspect or indication to the one presented.

A5 is relevant to any lineside signalling asset that is capable of presenting a lit signal aspect or indication.

¹⁷ Source: Signal Sighting Assessment Requirements, June 2016. Railway Group Guidance Note. Last accessed 18.10.2016.

The extent to which excessive illumination could make an asset appear to show a different signal aspect or indication to the one being presented can be influenced by the product being used. Requirements for assessing the phantom display performance of signalling products are set out in GKRT0057 section 4.1.

Problems arising from reflection and glare occur when there is a very large range of luminance, that is, where there are some objects that are far brighter than others. The following types of glare are relevant:

- a) Disability glare, caused by scattering of light in the eye, can make it difficult to read a lit display.
- b) Discomfort glare, which is often associated with disability glare. While being unpleasant, it does not affect the signal reading time directly, but may lead to distraction and fatigue.

Examples of the adverse effect of disability glare include:

- a) When a colour light signal presenting a lit yellow aspect is viewed at night but the driver is unable to determine whether the aspect is a single yellow or a double yellow.
- b) Where a colour light signal is positioned beneath a platform roof painted white and the light reflecting off the roof can make the signal difficult to read.

Options for mitigating against A5 include:

- a) Using a product that is specified to achieve high light source: phantom ratio values.
- b) Alteration to the features causing the glare or reflection.
- c) Provision of screening.

Glare is possible and should be assessed when the luminance is much brighter than other light sources. Glare may be unpleasant and therefore cause distraction and fatigue, or may make the signal difficult to read and increase the reading time.

Determining the Field of Focus

The extract on the following pages is taken from Appendix F - Guidance on Field of Vision (pages 98-101) of the 'Signal Sighting Assessment Requirements'¹⁸ which details the visibility of signals, train drivers' field of vision and the implications with regard to signal positioning.

Asset visibility

The effectiveness of an observer's visual system in detecting the existence of a target asset will depend upon its:

- a) Position in the observer's visual field.
- b) Contrast with its background.
- c) Luminance properties.
- d) The observer's adaptation to the illumination level of the environment.

¹⁸ Source: Signal Sighting Assessment Requirements, June 2016. Railway Group Guidance Note. Last accessed 28.08.2020.

It is also influenced by the processes relating to colour vision, visual accommodation, and visual acuity. Each of these issues is described in the following sections.

Field of vision

The field of vision, or visual field, is the area of the visual environment that is registered by the eyes when both eyes and head are held still. The normal extent of the visual field is approximately 135° in the vertical plane and 200° in the horizontal plane.

The visual field is usually described in terms of central and peripheral regions: the central field being the area that provides detailed information. This extends from the central point (0°) to approximately 30° at each eye. The peripheral field extends from 30° out to the edge of the visual field.

F.6.3 Objects positioned towards the centre of the observer's field of vision are seen more quickly and identified more accurately because this is where our sensitivity to contrast is the highest. Peripheral vision is particularly sensitive to movement and light.

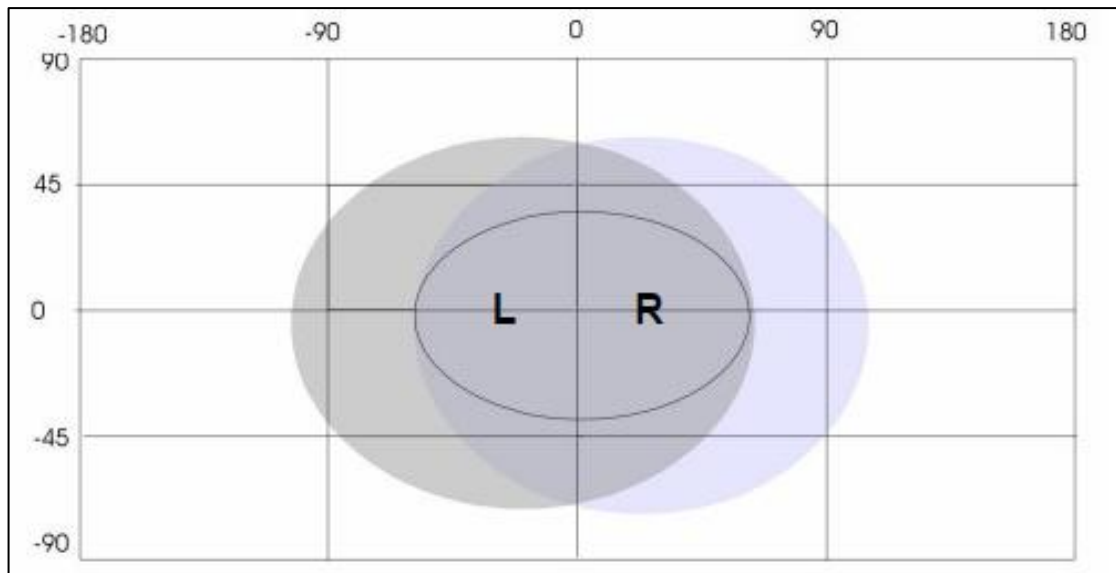


Figure G 21 - Field of view

In Figure G 21, the two shaded regions represent the view from the left eye (L) and the right eye (R) respectively. The darker shaded region represents the region of binocular overlap. The oval in the centre represents the central field of vision.

Research has shown that drivers search for signs or signals towards the centre of the field of vision. Signals, indicators and signs should be positioned at a height and distance from the running line that permits them to be viewed towards the centre of the field of vision. This is because:

- As train speed increases, drivers become increasingly dependent on central vision for asset detection. At high speeds, drivers demonstrate a tunnel vision effect and focus only on objects in a field of $\pm 8^\circ$ from the direction of travel.
- Sensitivity to movement in the peripheral field, even minor distractions can reduce the visibility of the asset if it is viewed towards the peripheral field of vision. The presence of clutter to the sides of the running line can be highly distracting (for example, fence posts,

lamp-posts, traffic, or non-signal lights, such as house, compatibility factors or security lights).

Figure G 22 and Table G 5 identify the radius of an 80 cone at a range of close-up viewing distances from the driver's eye. This shows that, depending on the lateral position of a stop signal, the optimal (normal) train stopping point could be as far as 25 m back from the signal to ensure that it is sufficiently prominent.

The dimensions quoted in Table G 5 assume that the driver is looking straight ahead. Where driver-only operation (DOO) applies, the drivers' line of sight at the time of starting the train is influenced by the location of DOO monitors and mirrors. In this case it may be appropriate to provide supplementary information alongside the monitors or mirrors using one of the following:

- a) A co-acting signal.
- b) A miniature banner repeater indicator.
- c) A right away indicator.
- d) A sign to remind the driver to check the signal aspect.

In order to prevent misreading by trains on adjacent lines, the co-acting signal or miniature banner repeater may be configured so that the aspect or indication is presented only when a train is at the platform to which it applies.

'Car stop' signs should be positioned so that the relevant platform starting signals and / or indicators can be seen in the driver's central field of vision.

If possible, clutter and non-signal lights in a driver's field of view should be screened off or removed so that they do not cause distraction.

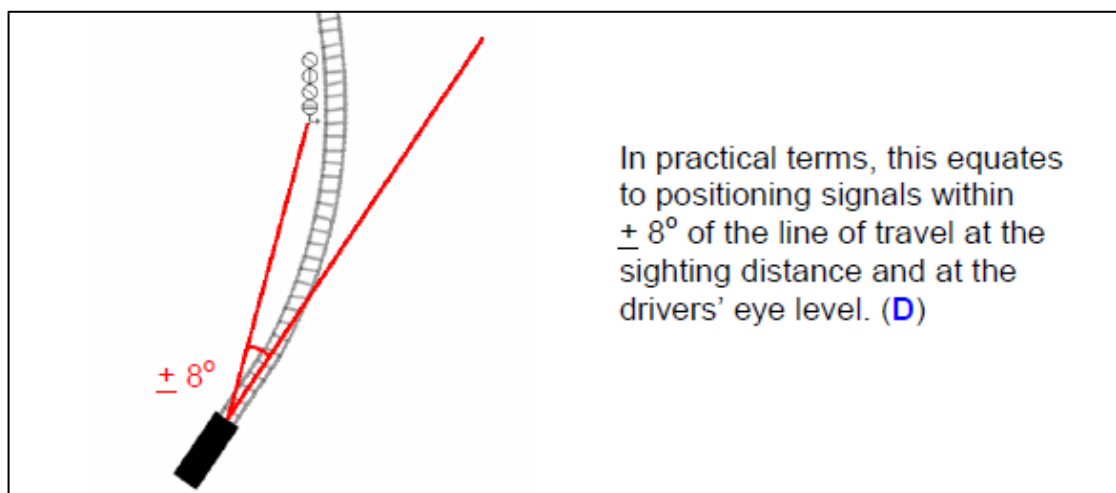


Figure G 22 - Signal positioning

'A' (m)	'B' (m)	Typical display positions
5	0.70	-
6	0.84	-
7	0.98	-
8	1.12	-
9	1.26	-
10	1.41	-
11	1.55	-
12	1.69	-
13	1.83	-
14	1.97	-
15	2.11	<i>A stop aspect positioned 3.3 m above rail level and 2.1 m from the left hand rail is within the 8° cone at 15.44 m in front of the driver</i>
16	2.25	-
17	2.39	-
18	2.53	<i>A stop aspect positioned 5.1 m above rail level and 0.9 m from the left hand rail is within the 8° cone at 17.93 m in front of the driver</i>
19	2.67	-
20	2.81	-
21	2.95	-
22	3.09	-
23	3.23	-
24	3.37	-
25	3.51	<i>A stop aspect positioned 3.3 m above rail level and 2.1 m from the right hand rail is within the 8° cone at 25.46 m in front of the driver</i>

Table G 5 – 8° cone angle co-ordinates for close-up viewing

The distance at which the 8° cone along the track is initiated is dependent on the minimum reading time and distance which is associated to the speed of trains along the track. This is discussed below.

Determining the Assessed Minimum Reading Time

The extract below is taken from section B5 (pages 8-9) of the 'Guidance on Signal Positioning and Visibility' which details the required minimum reading time for a train driver when approaching a signal.

'B5.2.2 Determining the assessed minimum reading time

GE/RT8037

The assessed minimum reading time shall be no less than eight seconds travelling time before the signal.

The assessed minimum reading time shall be greater than eight seconds where there is an increased likelihood of misread or failure to observe. Circumstances where this applies include, but are not necessarily limited to, the following:

- a) the time taken to identify the signal is longer (for example, because the signal being viewed is one of a number of signals on a gantry, or because the signal is viewed against a complex background)*
- b) the time taken to interpret the information presented by the signal is longer (for example, because the signal is capable of presenting route information for a complex layout ahead)*
- c) there is a risk that the need to perform other duties could cause distraction from viewing the signal correctly (for example, the observance of lineside signs, a station stop between the caution and stop signals, or DOO (P) duties)*
- d) the control of the train speed is influenced by other factors (for example, anticipation of the signal aspect changing).*

The assessed minimum reading time shall be determined using a structured format approved by the infrastructure controller.'

The distance at which a signal should be clearly viewable is determined by the maximum speed of the trains along the track. If there are multiple signals present at a location then an additional 0.2 seconds reading time is added to the overall viewing time.

Signal Design and Lighting System

Many railway signals are now LED lights and not filament (incandescent) bulbs. The benefits of an LED signal over a filament bulb signal with respect to possible phantom aspect illuminations are as follows:

- An LED railway signal produces a more intense light making them more visible to approaching trains when compared to the traditional filament bulb technology¹⁹;

¹⁹ Source: Wayside LED Signals – Why it's Harder than it Looks, Bill Petit.

- No reflective mirror is present within the LED signal itself unlike a filament bulb. The presence of the reflective surfaces greatly increases the likelihood of incoming light being reflecting out making the signal appear illuminated.

Many LED signal manufacturers^{20,21,22} claim that LED signal lights significantly reduce or completely remove the likelihood of a phantom aspect illumination occurring.

²⁰ Source: http://www.unipartdorman.co.uk/assets/unipart_dorman_rail_brochure.pdf. (Last accessed 21.02.18).

²¹ Source: <http://www.vmstech.co.uk/downloads/Rail.pdf>. (Last accessed 21.02.18).

²² Source: Siemens, Sigmaguard LED Tri-Colour L Signal – LED Signal Technology at Incandescent Prices. Datasheet 1A-23. (Last accessed 22.02.18).

APPENDIX B – OVERVIEW OF GLINT AND GLARE STUDIES

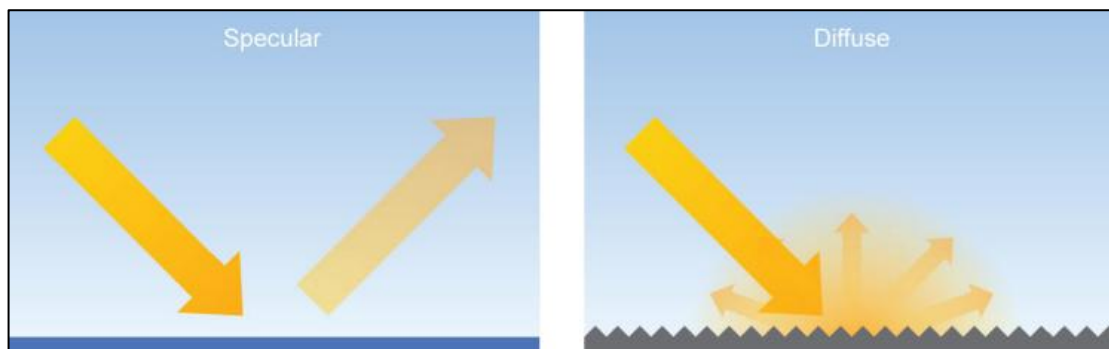
Overview

Studies have been undertaken assessing the type and intensity of solar reflections from various surfaces including solar panels and glass. An overview of these studies is presented below.

The guidelines presented are related to aviation safety. The results are applicable for the purpose of this analysis.

Reflection Type from Solar Panels

Based on the surface conditions reflections from light can be specular and diffuse. A specular reflection has a reflection characteristic similar to that of a mirror; a diffuse will reflect the incoming light and scatter it in many directions. The figure below, taken from the FAA guidance²³, illustrates the difference between the two types of reflections. Because solar panels are flat and have a smooth surface most of the light reflected is specular, which means that incident light from a specific direction is reradiated in a specific direction.



Specular and diffuse reflections

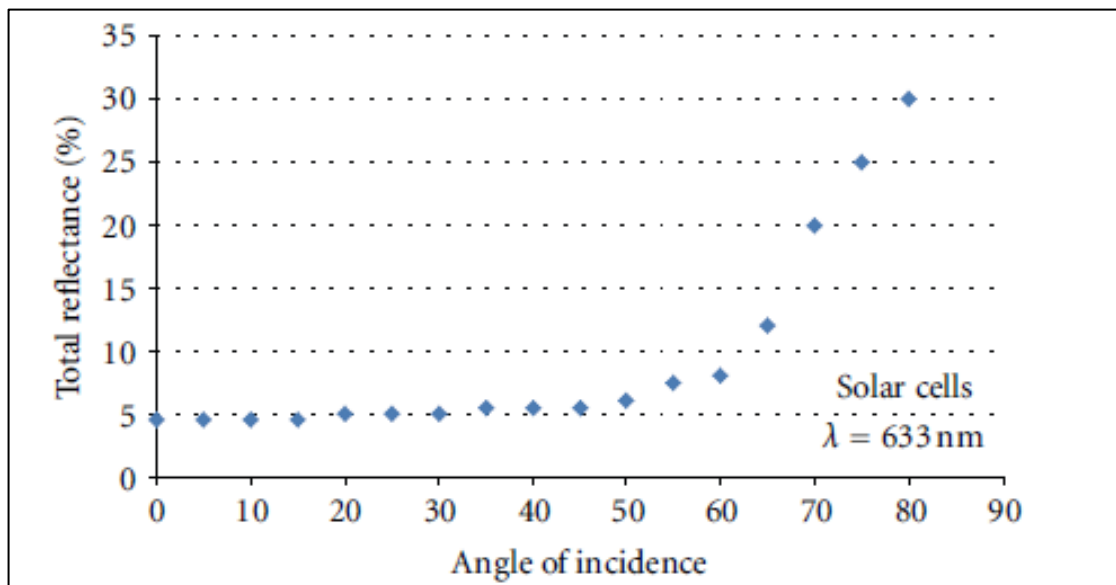
²³Technical Guidance for Evaluating Selected Solar Technologies on Airports, Federal Aviation Administration (FAA), date: 04/2018, accessed on: 19/12/2023.

Solar Reflection Studies

An overview of content from identified solar panel reflectivity studies is presented in the subsections below.

Evan Riley and Scott Olson, "A Study of the Hazardous Glare Potential to Aviators from Utility-Scale Flat-Plate Photovoltaic Systems"

Evan Riley and Scott Olson published in 2011 their study titled: A Study of the Hazardous Glare Potential to Aviators from Utility-Scale Flat-Plate Photovoltaic Systems²⁴. They researched the potential glare that a pilot could experience from a 25 degree fixed tilt PV system located outside of Las Vegas, Nevada. The theoretical glare was estimated using published ocular safety metrics which quantify the potential for a postflash glare after-image. This was then compared to the postflash glare after-image caused by smooth water. The study demonstrated that the reflectance of the solar cell varied with angle of incidence, with maximum values occurring at angles close to 90 degrees. The reflectance values varied from approximately 5% to 30%. This is shown on the figure below.



Total reflectance % when compared to angle of incidence

The conclusions of the research study were:

- The potential for hazardous glare from flat-plate PV systems is similar to that of smooth water;
- Portland white cement concrete (which is a common concrete for runways), snow, and structural glass all have a reflectivity greater than water and flat plate PV modules.

²⁴ Evan Riley and Scott Olson, "A Study of the Hazardous Glare Potential to Aviators from Utility-Scale Flat-Plate Photovoltaic Systems," ISRN Renewable Energy, vol. 2011, Article ID 651857, 6 pages, 2011. doi:10.5402/2011/651857

FAA Guidance – “Technical Guidance for Evaluating Selected Solar Technologies on Airports”²⁵

The 2010 FAA Guidance included a diagram which illustrates the relative reflectance of solar panels compared to other surfaces. The figure shows the relative reflectance of solar panels compared to other surfaces. Surfaces in this figure produce reflections which are specular and diffuse. A specular reflection (those made by most solar panels) has a reflection characteristic similar to that of a mirror. A diffuse reflection will reflect the incoming light and scatter it in many directions. A table of reflectivity values, sourced from the figure within the FAA guidance, is presented below.

Surface	Approximate Percentage of Light Reflected ²⁶
Snow	80
White Concrete	77
Bare Aluminium	74
Vegetation	50
Bare Soil	30
Wood Shingle	17
Water	5
Solar Panels	5
Black Asphalt	2

Relative reflectivity of various surfaces

Note that the data above does not appear to consider the reflection type (specular or diffuse).

An important comparison in this table is the reflectivity compared to water which will produce a reflection of very similar intensity when compared to that from a solar panel. The study by Riley and Olsen study (2011) also concludes that still water has a very similar reflectivity to solar panels.

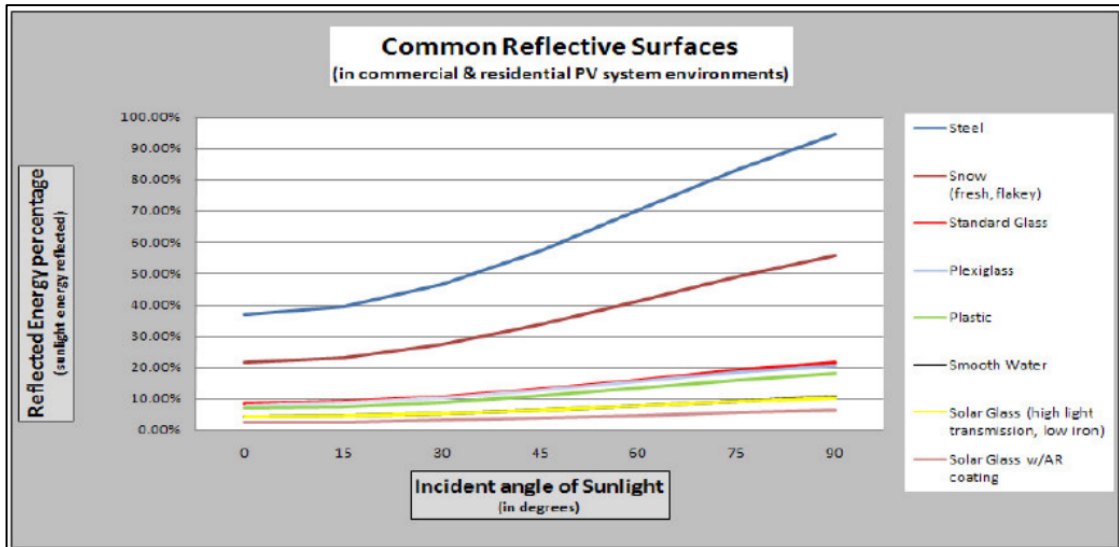
²⁵ Technical Guidance for Evaluating Selected Solar Technologies on Airports, Federal Aviation Administration (FAA), date: 04/2018, accessed on: 19/12/2023.

²⁶ Extrapolated data, baseline of 1,000 W/m² for incoming sunlight.

SunPower Technical Notification (2009)

SunPower published a technical notification²⁷ to 'increase awareness concerning the possible glare and reflectance impact of PV Systems on their surrounding environment'.

The figure presented below shows the relative reflectivity of solar panels compared to other natural and manmade materials including smooth water, standard glass and steel.



Common reflective surfaces

The results, similarly to those from Riley and Olsen study (2011) and the FAA (2010), show that solar panels produce a reflection that is less intense than those of 'standard glass and other common reflective surfaces'.

With respect to aviation and solar reflections observed from the air, SunPower has developed several large installations near airports or on Air Force bases. It is stated that these developments have all passed FAA or Air Force standards with all developments considered "No Hazard to Air Navigation". The note suggests that developers discuss any possible concerns with stakeholders near proposed solar farms.

²⁷ Source: Technical Support, 2009. SunPower Technical Notification – Solar Module Glare and Reflectance.

APPENDIX C – OVERVIEW OF SUN MOVEMENTS AND RELATIVE REFLECTIONS

The Sun's position in the sky can be accurately described by its azimuth and elevation. Azimuth is a direction relative to true north (horizontal angle i.e. from left to right) and elevation describes the Sun's angle relative to the horizon (vertical angle i.e. up and down).

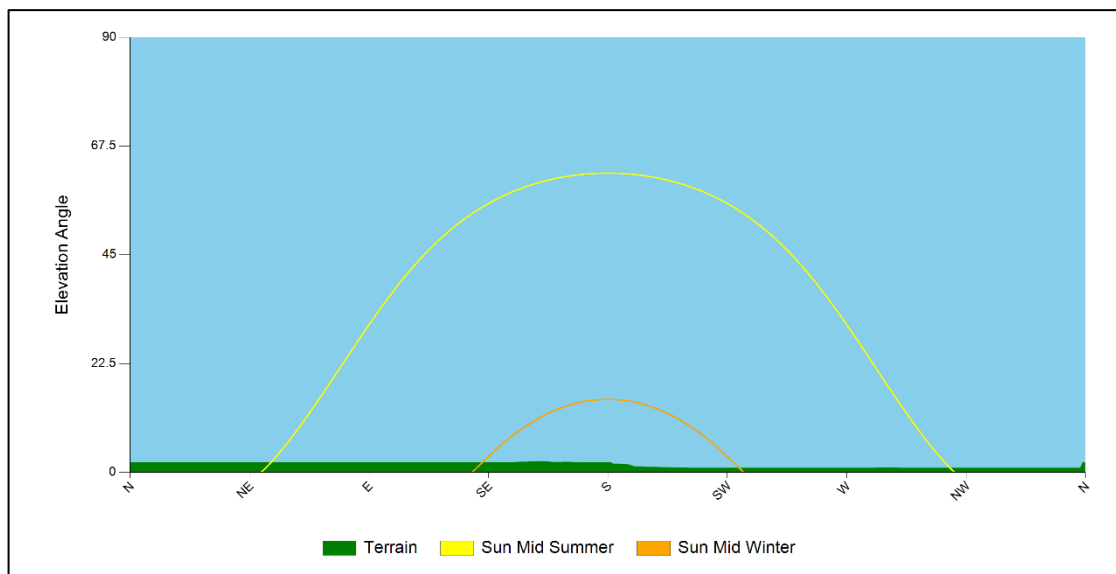
The Sun's position can be accurately calculated for a specific location. The following data being used for the calculation:

- Time;
- Date;
- Latitude;
- Longitude.

The following is true at the location of the solar development:

- The Sun is at its highest around midday and is to the south at this time;
- The Sun rises highest on 21 June (longest day);
- On 21 December, the maximum elevation reached by the Sun is at its lowest (shortest day).

The combination of the Sun's azimuth angle and vertical elevation will affect the direction and angle of the reflection from a reflector. The figure below shows terrain at the horizon from the proposed development location as well as the sunrise and sunset curves throughout the year.



Sunrise and sunset curves

APPENDIX D – GLINT AND GLARE IMPACT SIGNIFICANCE

Overview

The significance of glint and glare will vary for different receptors. The following section presents a general overview of the significance criteria with respect to experiencing a solar reflection.

Impact Significance Definition

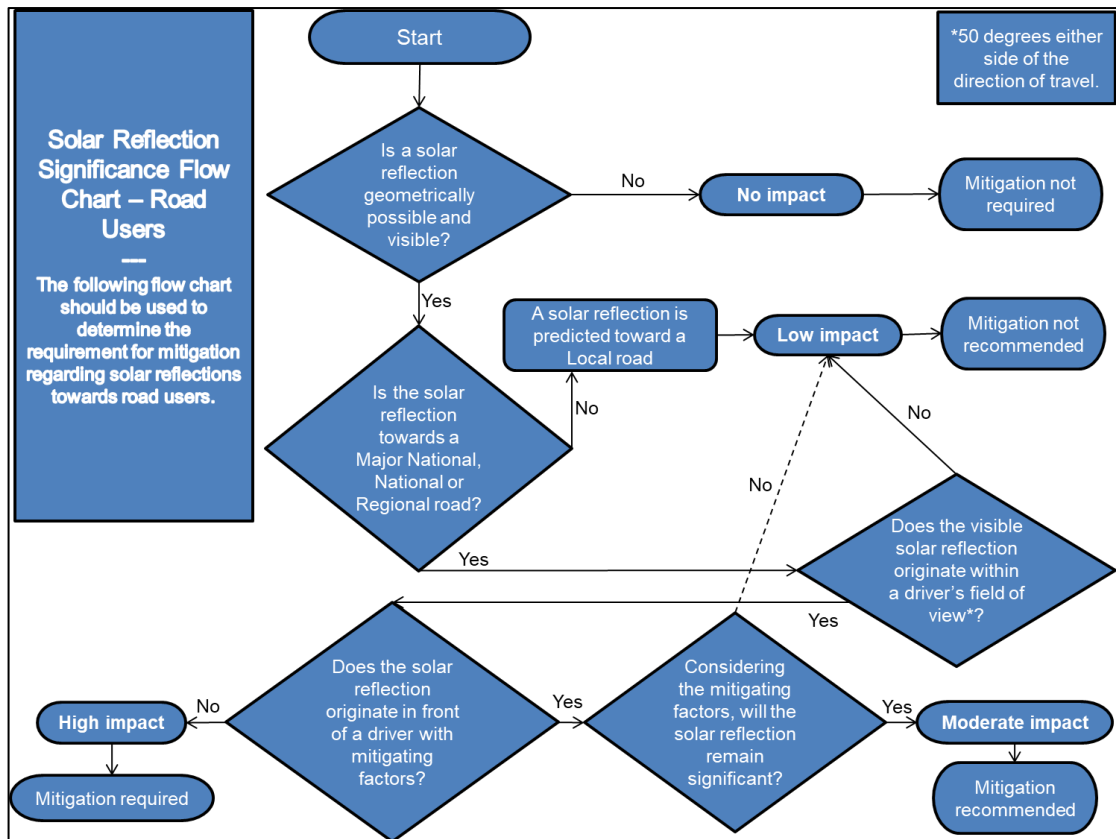
The table below presents the recommended definition of 'impact significance' in glint and glare terms and the requirement for mitigation under each.

Impact Significance	Definition	Mitigation
No Impact	A solar reflection is not geometrically possible or will not be visible from the assessed receptor.	No mitigation required.
Low	A solar reflection is geometrically possible however any impact is considered to be small such that mitigation is not required e.g. intervening screening will limit the view of the reflecting solar panels significantly.	No mitigation recommended.
Moderate	A solar reflection is geometrically possible and visible however it occurs under conditions that do not represent a worst-case given individual receptor criteria.	Mitigation recommended.
High	A solar reflection is geometrically possible and visible under worst-case conditions that will produce a significant impact given individual receptor criteria	Mitigation will be required if the proposed development is to proceed.

Impact significance definition

Impact Significance Determination for Road Receptors

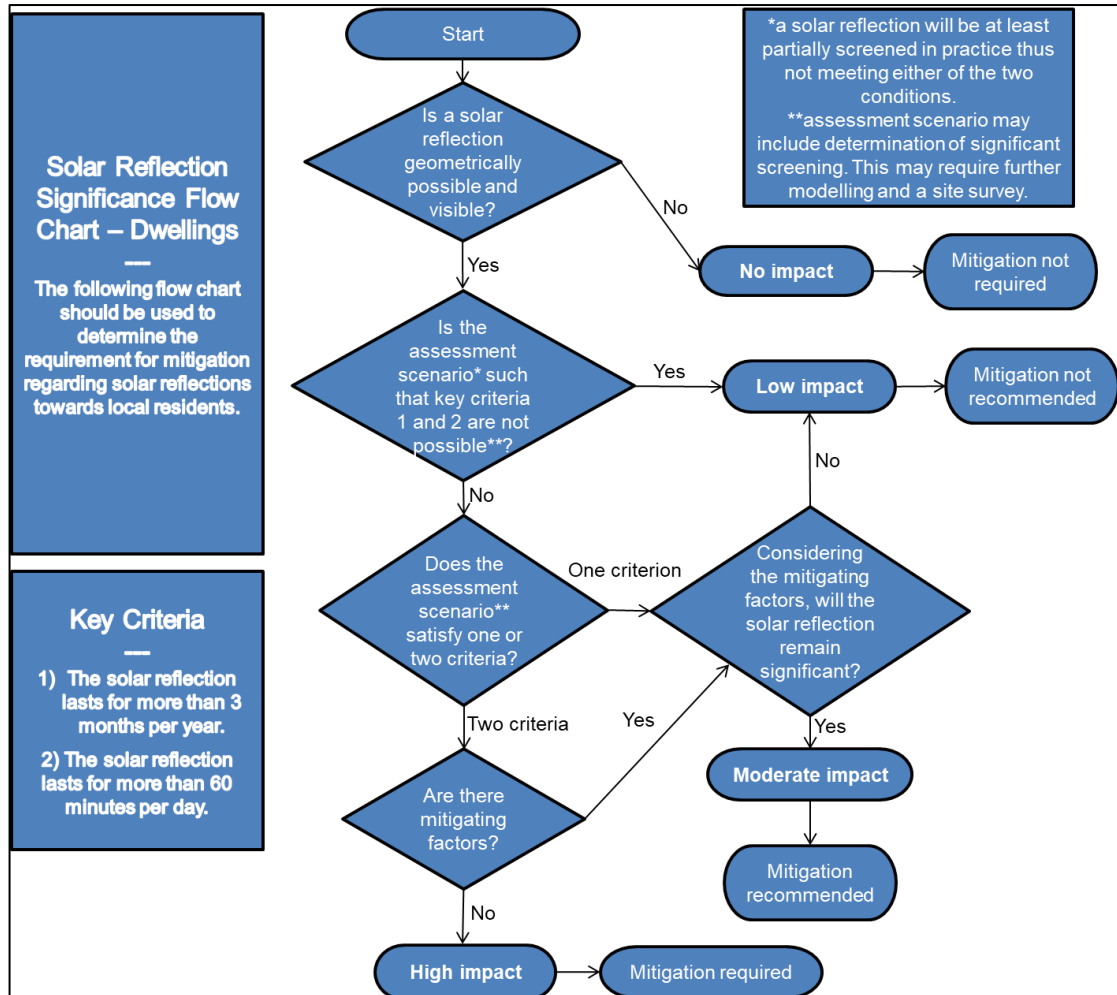
The flow chart presented below has been followed when determining the impact significance for road receptors.



Road user impact significance flow chart

Impact Significance Determination for Dwelling Receptors

The flow chart presented below has been followed when determining the impact significance for dwelling receptors.



Dwelling impact significance flow chart

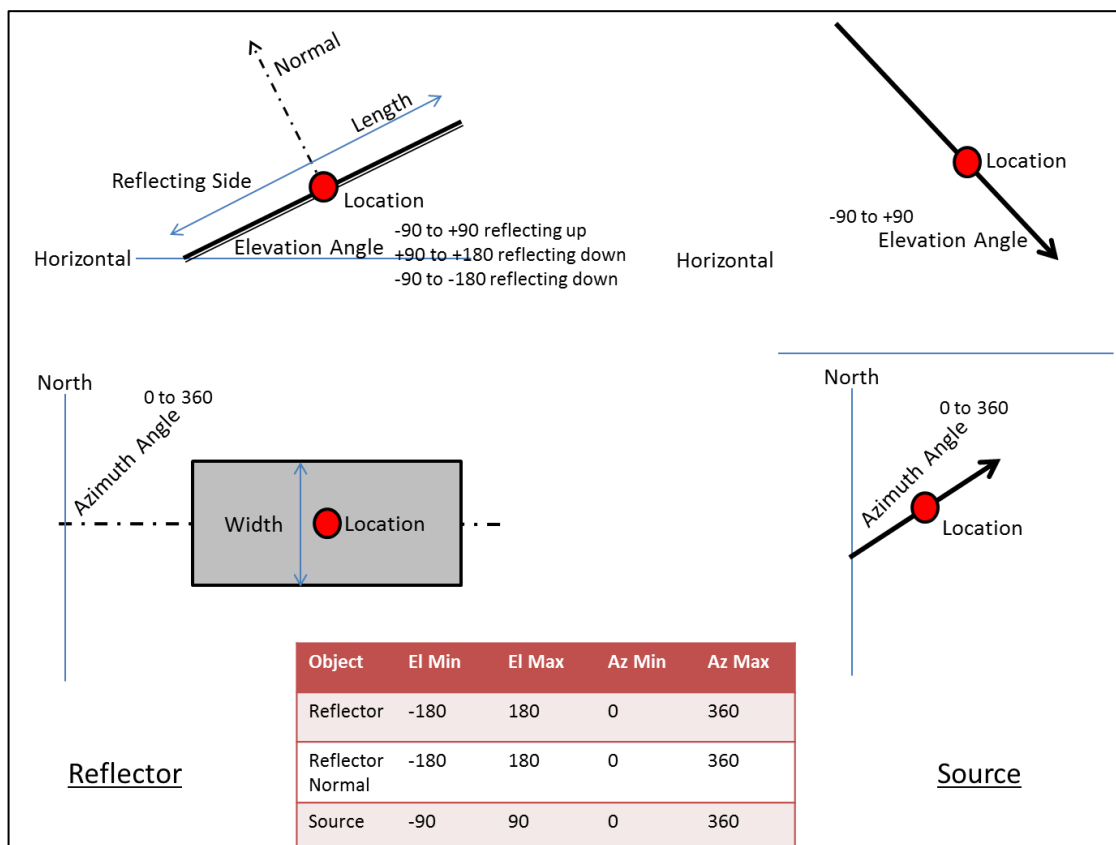
APPENDIX E – REFLECTION CALCULATIONS METHODOLOGY

Pager Power Methodology

The calculations are three dimensional and complex, accounting for:

- The Earth's orbit around the Sun;
- The Earth's rotation;
- The Earth's orientation;
- The reflector's location;
- The reflector's 3D Orientation.

Reflections from a flat reflector are calculated by considering the normal which is an imaginary line that is perpendicular to the reflective surface and originates from it. The diagram below may be used to aid understanding of the reflection calculation process.



Reflection calculation process

The following process is used to determine the 3D Azimuth and Elevation of a reflection:

- Use the Latitude and Longitude of reflector as the reference for calculation purposes;
- Calculate the Azimuth and Elevation of the normal to the reflector;
- Calculate the 3D angle between the source and the normal;
- If this angle is less than 90 degrees a reflection will occur. If it is greater than 90 degrees, no reflection will occur because the source is behind the reflector;
- Calculate the Azimuth and Elevation of the reflection in accordance with the following:
 - The angle between source and normal is equal to angle between normal and reflection;
 - Source, Normal and Reflection are in the same plane.

APPENDIX F – ASSESSMENT LIMITATIONS AND ASSUMPTIONS

Pager Power's Model

The model considers 100% sunlight during daylight hours which is highly conservative.

The model does not account for terrain between the reflecting solar panels and the assessed receptor where a solar reflection is geometrically possible.

The model considers terrain between the reflecting solar panels and the visible horizon (where the sun may be obstructed from view of the panels)²⁸.

It is assumed that the panel elevation angle assessed represents the elevation angle for all of the panels within each solar panel area defined.

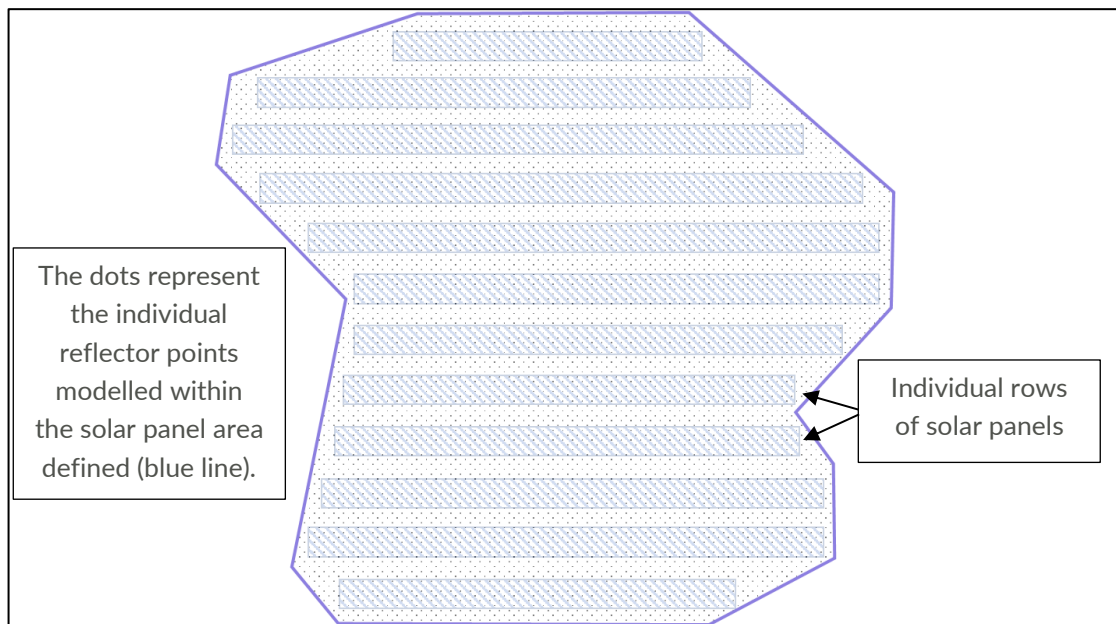
It is assumed that the panel azimuth angle assessed represents the azimuth angle for all of the panels within each solar panel area defined.

Only a reflection from the face of the panel has been considered. The frame or the reverse or frame of the solar panel has not been considered.

The model assumes that a receptor can view the face of every panel (point, defined in the following paragraph) within the development area whilst in reality this, in the majority of cases, will not occur. Therefore, any predicted solar reflection from the face of a solar panel that is not visible to a receptor will not occur in practice.

A finite number of points within each solar panel area defined is chosen based on an assessment resolution so that a comprehensive understanding of the entire development can be formed. This determines whether a solar reflection could ever occur at a chosen receptor. The model does not consider the specific panel rows or the entire face of the solar panel within the development outline, rather a single point is defined every 'x' metres (based on the assessment resolution) with the geometric characteristics of the panel. A panel area is however defined to encapsulate all possible panel locations. See the figure below which illustrates this process.

²⁸ UK only.



Solar panel area modelling overview

A single reflection point is chosen for the geometric calculations. This suitably determines whether a solar reflection can be experienced at a receptor location and the time of year and duration of the solar reflection. Increased accuracy could be achieved by increasing the number of heights assessed however this would only marginally change the results and is not considered significant.

The available street view imagery, satellite mapping, terrain and any site imagery provided by the developer has been used to assess line of sight from the assessed receptors to the modelled solar panel area, unless stated otherwise. In some cases, this imagery may not be up to date and may not give the full perspective of the installation from the location of the assessed receptor.

Any screening in the form of trees, buildings etc. that may obstruct the Sun from view of the solar panels is not within the modelling unless stated otherwise. The terrain profile at the horizon is considered if stated.

APPENDIX G – RECEPTOR AND REFLECTOR AREA DETAILS

Road Receptor Data

The road receptor data is presented in the table below. An additional 1.5m height has been added to the elevation to account for the eye-level of a road user.

No.	Latitude (°)	Longitude (°)	Assessed Height (m amsl)	No.	Latitude (°)	Longitude (°)	Assessed Height (m amsl)
A1	51.53566	-1.84253	104.65	A5	51.53566	-1.84253	104.65
A2	51.53480	-1.84211	105.64	A6	51.53480	-1.84211	105.64
A3	51.53394	-1.84165	106.85	A7	51.53394	-1.84165	106.85
A4	51.53308	-1.84122	108.41				

Road receptor data

Dwelling Receptor Data

The dwelling receptor data is presented in the table below. An additional 1.8m height has been added to the elevation to account for the eye-level of an observer at these dwellings.

No.	Latitude (°)	Longitude (°)	Assessed Height (m amsl)	No.	Latitude (°)	Longitude (°)	Assessed Height (m amsl)
1	51.53469	-1.86313	104.73	6	51.52857	-1.85779	103.80
2	51.53416	-1.86688	99.99	7	51.52799	-1.85681	105.10
3	51.53150	-1.86430	99.80	8	51.53015	-1.84905	112.04
4	51.52675	-1.86540	101.80	9	51.53017	-1.84356	111.93
5	51.52524	-1.86014	104.88	10	51.53042	-1.84041	112.06

Dwelling receptor data

Modelled Reflector Area

The modelled reflector area is presented in the table below.

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-1.85899	51.53198	6	-1.85653	51.53344
2	-1.85813	51.53202	7	-1.85690	51.53406
3	-1.85747	51.53215	8	-1.85768	51.53355
4	-1.85667	51.53247	9	-1.85778	51.53360
5	-1.85587	51.53274	10	-1.85876	51.53279

Panel Area 1

No.	Longitude (°)	Latitude (°)	No.	Longitude (°)	Latitude (°)
1	-1.85657	51.53428	5	-1.85415	51.53404
2	-1.85604	51.53349	6	-1.85341	51.53456
3	-1.85536	51.53300	7	-1.85255	51.53520
4	-1.85474	51.53358	8	-1.85401	51.53566

Panel Area 2

APPENDIX H – DETAILED MODELLING RESULTS

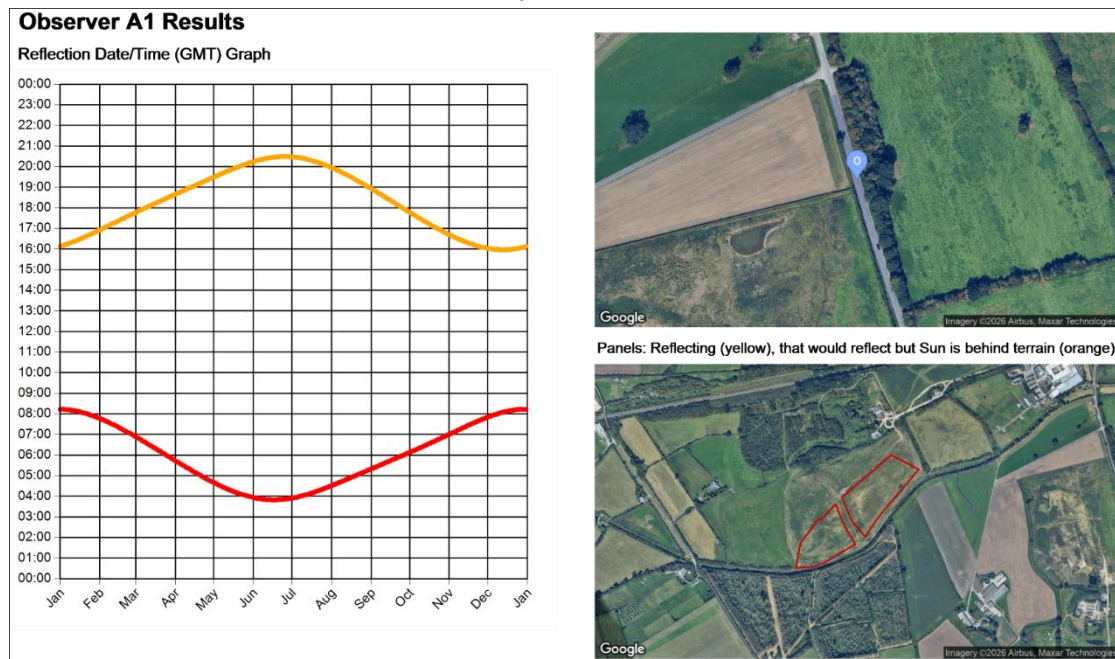
Overview

The Pager Power charts for selected receptors are shown below and on the following pages. Further modelling charts can be provided upon request. Each chart shows:

- The receptor (observer) location – top right image. This also shows the azimuth range of the Sun itself at times when reflections are possible. If sunlight is experienced from the same direction as the reflecting panels, the overall impact of the reflection is reduced as discussed within the body of the report;
- The reflecting panels – bottom right image. The reflecting area is shown in yellow. If the yellow panels are not visible from the observer location, no issues will occur in practice. Additional obstructions which may obscure the panels from view are considered separately within the analysis;
- The reflection date/time graph – left hand side of image. The blue line indicates the dates and times at which geometric reflections are possible. This relates to reflections from the yellow areas;
- The sunrise and sunset curves throughout the year (red and yellow lines).

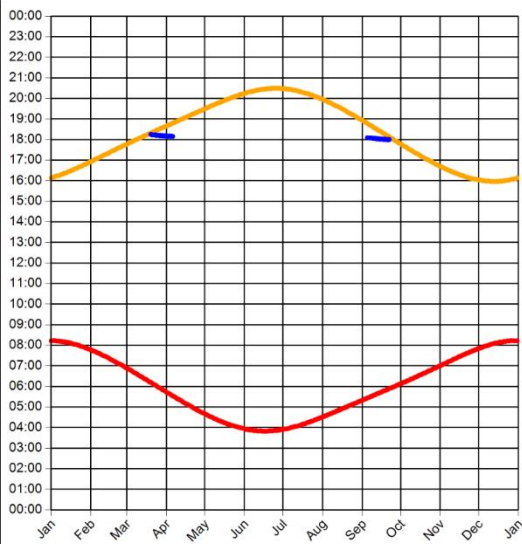
Road Receptors

Results have been included for all road receptors.



Observer A2 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0.8°
Max observer difference angle: 6.1°

Observer Location Sun azimuth range is 270.1° - 274.1° (yellow)

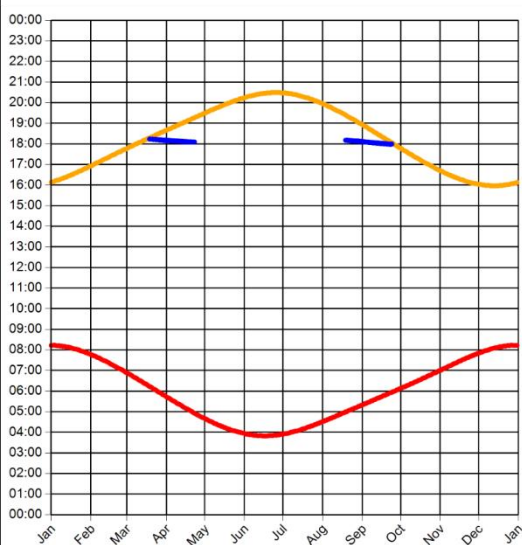


Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)



Observer A3 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 0.4°
Max observer difference angle: 11.1°

Observer Location Sun azimuth range is 269.6° - 278° (yellow)

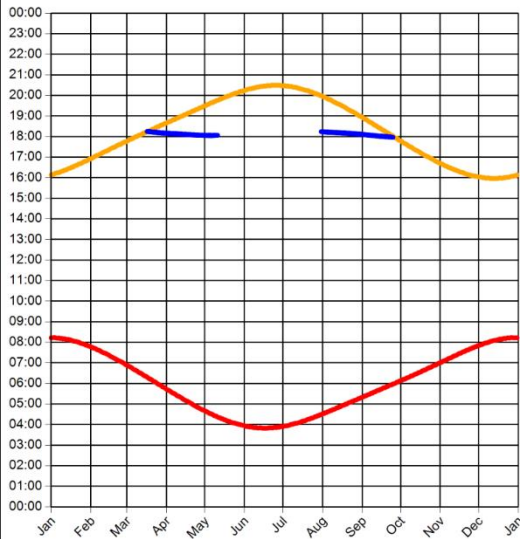


Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)



Observer A4 Results

Reflection Date/Time (GMT) Graph



Observer Location Sun azimuth range is 269.2° - 281.6° (yellow)

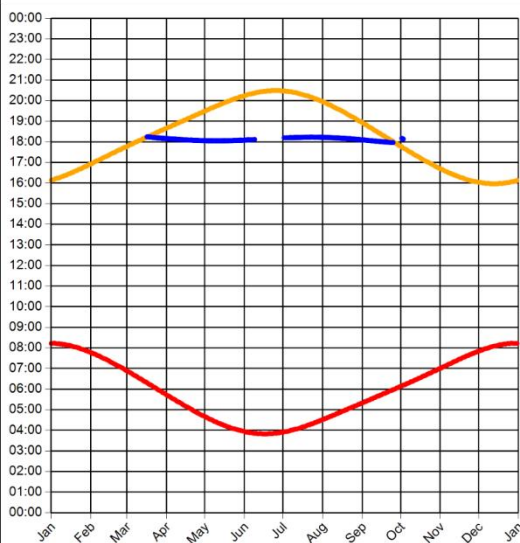


Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)

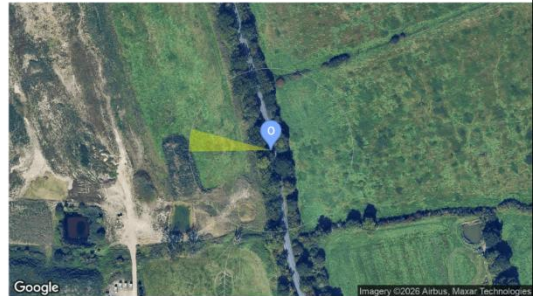


Observer A5 Results

Reflection Date/Time (GMT) Graph



Observer Location Sun azimuth range is 269.1° - 284.9° (yellow)

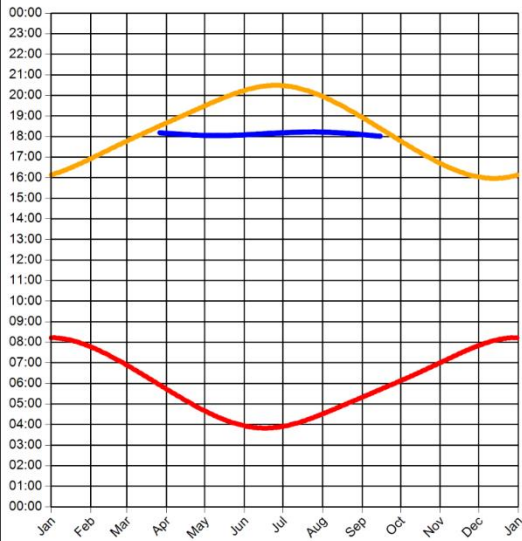


Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)



Observer A6 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 3.5°
Max observer difference angle: 20.5°

Observer Location Sun azimuth range is 271.5° - 285.3° (yellow)

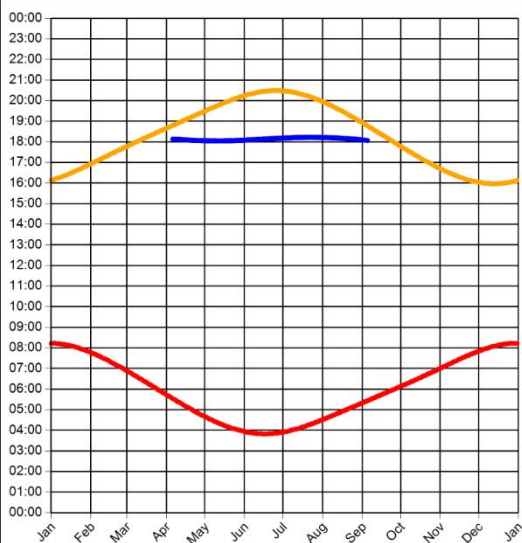


Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)



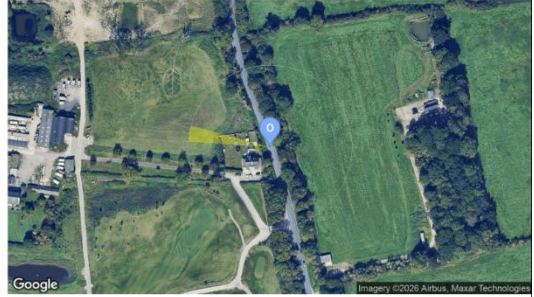
Observer A7 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 6.7°
Max observer difference angle: 20.5°

Observer Location Sun azimuth range is 273.8° - 285.2° (yellow)

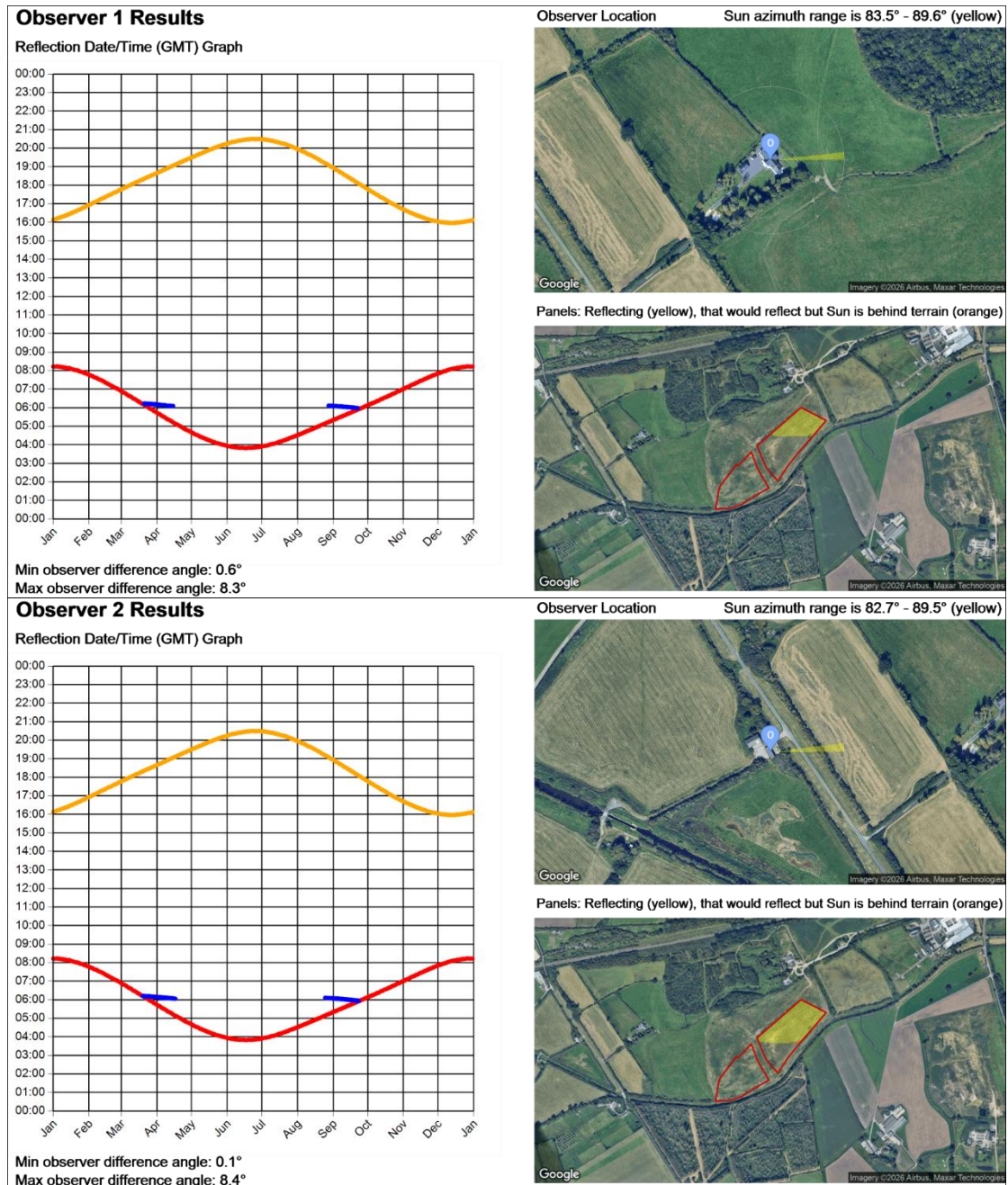


Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)



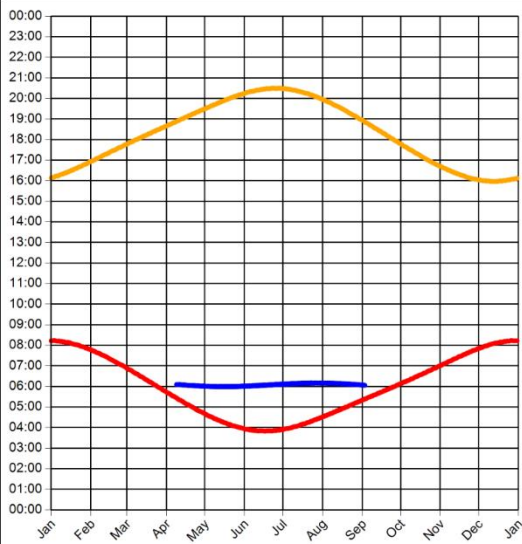
Dwelling Receptors

Results have been included for all dwelling receptors.



Observer 3 Results

Reflection Date/Time (GMT) Graph

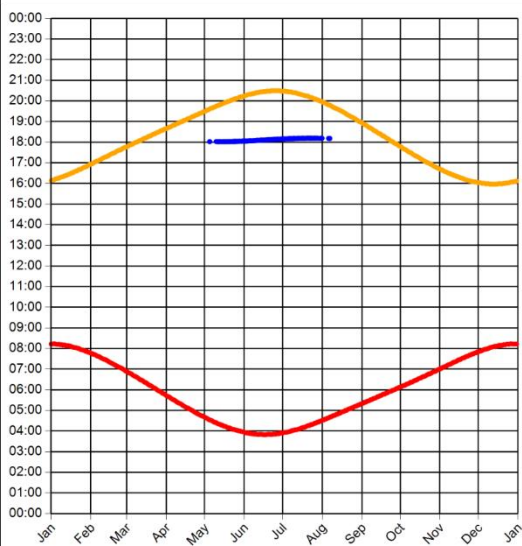


Min observer difference angle: 5.7°

Max observer difference angle: 19°

Observer 8 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 15.3°

Max observer difference angle: 21.3°

Observer Location

Sun azimuth range is 74° - 84.6° (yellow)



Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)



Observer Location

Sun azimuth range is 279.9° - 284.9° (yellow)

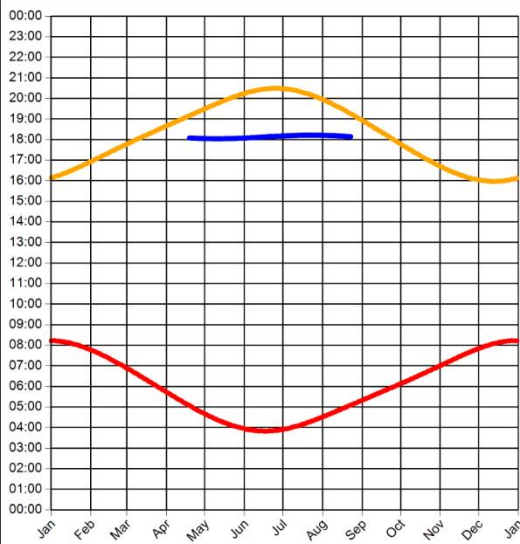


Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)



Observer 9 Results

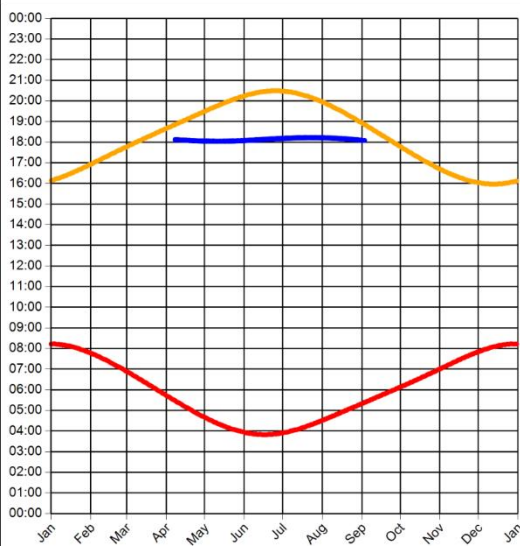
Reflection Date/Time (GMT) Graph



Min observer difference angle: 10.6°
Max observer difference angle: 20.8°

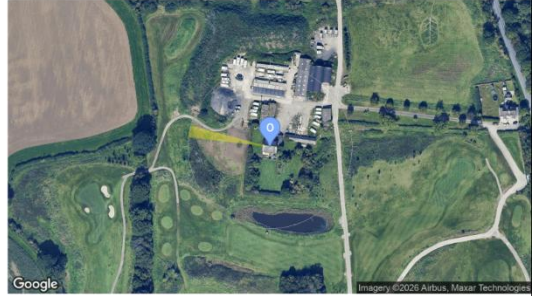
Observer 10 Results

Reflection Date/Time (GMT) Graph



Min observer difference angle: 7.3°
Max observer difference angle: 20.6°

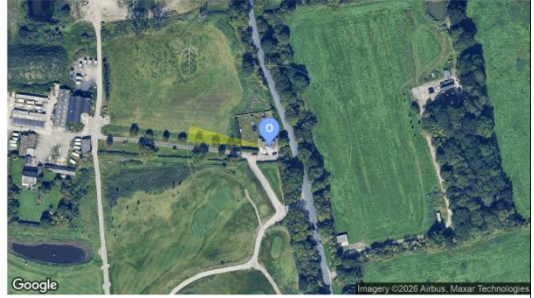
Observer Location Sun azimuth range is 276.7° - 285.2° (yellow)



Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)



Observer Location Sun azimuth range is 274.3° - 285.2° (yellow)



Panels: Reflecting (yellow), that would reflect but Sun is behind terrain (orange)





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