

Glint and Glare Assessment – ICON



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Contents

Purpose.....	3
Executive Summary	3
Regulatory Compliance	3
THE AIR NAVIGATION ORDER	3
CAP 738.....	4
INTERIM CIVIL AVIATION AUTHORITY GUIDANCE	4
CAST GUIDANCE	4
UK REGULATION 139/2019	4
Glint and glare.....	4
Development Plans	5
Aviation Receptors	5
Manchester Airport Air Traffic Control Tower	5
Runway 23R/05L & 23L/05R Approach Paths.....	5
Visual Flight Rules Corridors	6
Assessment Methodology	7
Pretext.....	7
Assessment Software	7
The Assessment Process.....	8
Assessment Limitations	8
Array Layout.....	9
Assessment Results	10
Pretext.....	10
Assessment Results	10
Conclusion/Recommendation.....	10
Appendix 1:	11
Appendix 2	16
Document Approval	17

Purpose

Manchester Airports Group (MAG) have been commissioned by Cudd Bentley to produce a 'Glint and Glare' report relating to proposed solar PV installations upon 5 units located at Sunbank Lane, North West of Manchester Airport.

The purpose of this report is to identify any glint and glare implications upon aviation receptors at Manchester Airport.

Executive Summary

When assessing the proposed PV layout, it became apparent that certain roof orientations were liable to create a glint and glare hazard to aviation operations, other orientations did not. On this basis, a comprehensive assessment of all roof areas was undertaken to provide alternative locations for any PV proposed upon roofs where the glint and glare hazard has been assessed as out of tolerance. Roughly 50% of the roof space across all units are not expected to create a glint and glare hazard and are therefore potentially viable for relocation of PVs from roof spaces assessed to be liable to cause a glint and glare hazard. Overall, Appendix 2 outlines which roofs are acceptable and which roofs present a potential glint and glare hazard to aviation. We recommend that the scheme is designed to utilise the areas of roof which have been assessed as not liable to generate a glint and glare risk.

Regulatory Compliance

The Air Navigation Order

The Air Navigation Order 2016 is a statutory instrument that consolidates and amends the provisions of the Air Navigation Order 2009. It regulates various aspects of aviation safety standards and aircraft navigation in the United Kingdom. The order covers a wide range of topics, including aircraft, air crew, passengers, cargo, air traffic, and aerodromes.

The Air Navigation Order 2016 was established to ensure compliance with the Convention on International Civil Aviation and to regulate aviation safety.

The Air Navigation Order Part 10, 240 & 241 outlines the following provisions:

-Part 10: 240: A person must not recklessly or negligently act in a manner likely to endanger an aircraft, or any person in an aircraft.

-Part 10: 241: A person must not recklessly or negligently cause or permit an aircraft to endanger any person or property.

The Air Navigation Order may be used to safeguard aerodromes where a development or activity is found to cause a hazard to aviation; glint and glare may be deemed to present a hazard to aviation. This assessment aims to identify issues pre-installation, and to avoid the creation of a hazard that would otherwise necessitate enforcement under the Air Navigation Order. Whilst this assessment aims reduce the risk of any ANO enforcement being required, it is not a guarantee that ANO enforcement will be not be necessary if in practice a glint and glare hazard is identified post installation.

CAP 738

CAP 738 is a document published by the Civil Aviation Authority (CAA) that offers guidance to those responsible for the safe operation of an aerodrome or a technical site. It helps these persons to assess the impact of proposed development or construction on the safe operation of aerodromes. The document provides valuable information on safeguarding aerodromes and technical sites.

Chapter 1, Section 1.1 (h) outlines glint and glare as a specific area of interest when safeguarding aerodromes.

Interim Civil Aviation Authority Guidance

The Civil Aviation Authority (CAA) sought to develop its policy on Solar Photovoltaic Panels (SPV) in 2010. To achieve this, the CAA examined the results of research conducted by the Federal Aviation Administration (FAA) of the effects of SPV on aviation. Additionally, they reviewed guidance issued by other organizations on this subject. The CAA has issued interim guidance on solar photovoltaic systems while it continues to develop its policy and guidance material.

CAST Guidance

The Combined Aerodrome Safeguarding Team (CAST) are an industry body supported by the Civil Aviation Authority who convene regularly to share aerodrome safeguarding best practice and provide guidance to safeguarders. CAST consists of various working groups which focus upon specific tasks and safeguarding disciplines. The Technical Focus Group and General Aviation Focus Group have produced guidance about renewable energy within proximity to aerodromes. Glint and glare are one of the primary hazards outlined within the guidance document, and Glint and Glare Assessments are listed as one of the methodologies to mitigate and assess glint and glare hazard.

UK Regulation 139/2019

UK Regulation 139/2019, also known as the UK Aerodromes Regulation, outlines the requirements for the certification, management, operation, and maintenance of aerodromes in the UK. This regulation ensures that aerodromes meet safety standards and operational criteria to maintain a high level of aviation safety. Specifically, section GM1 ADR-DSN.M.615 General (k) outlines guidance with regards to luminance of solar panels.

Glint and glare

Glint and glare are important considerations in aviation, especially in relation to solar renewable energy systems near airports. Glint refers to the momentary flash of bright light, while glare is a continuous source of bright light. These phenomena can potentially affect pilots and air traffic control personnel, leading to safety concerns.

It is important for developers and planning authorities to consider the potential effects of glint and glare when proposing solar projects near airports. By adhering to glint and glare regulations, aviation safety can be maintained while harnessing the benefits of solar energy.

One method of reviewing glint and glare impact is through assessing the potential for after image. The industry standard SGHAT assessment tool categorises glare into the following:

<u>Key</u>	<u>Impact</u>
Green	A low potential for temporary after image
Yellow	Potential for temporary after image
Red	Potential for permanent eye damage

It is *generally* accepted that green glare is operationally acceptable to aviation operations, and is regularly encountered during flying activities, although any glint and glare should be taken into an operational context resulting in each output being bespoke e.g. large quantities of green glare towards final approach paths or any green glare to ATC may not be acceptable. Both yellow and red glare are generally not acceptable towards aviation receptors. Assessing overall maximum luminance from proposed PV arrays can also be useful as part of any wider assessment.

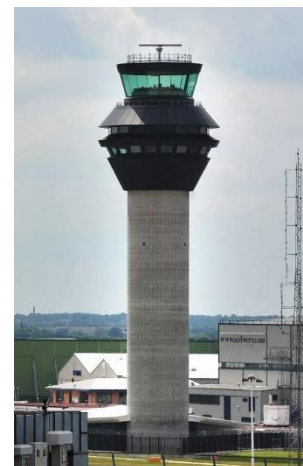
Development Plans

Overall, multiple arrays are proposed across 5 units located near Sunbank Lane. The closest unit (ICON 3) is located c.812 metres from Runway 23R/05L at Manchester Airport. Cudd Bentley provided proposed PV arrangements for all 5 units, which can be seen within Annexe 1. The proposed arrangement drawings provided details for ICON 1 with regards to orientation of the proposed arrays and the roof pitch; subsequent communication with Cudd Bentley outlined that all units were to be assessed with a 6-degree roof pitch, with orientation and height parameters identified through satellite imagery.

Aviation Receptors

Manchester Airport Air Traffic Control Tower

The current Manchester Airport Air Traffic Control Tower was built in 2013 and is 60 metres above ground level – making it the 2nd tallest in the UK. Glint and glare can have a considerable impact upon the ability of the air traffic control tower to operate; it is crucial that effective visuals are maintained from the tower to ensure sound situational awareness by air traffic control personnel. It is important that any glint and glare towards the tower is managed accordingly to maintain safe operations.

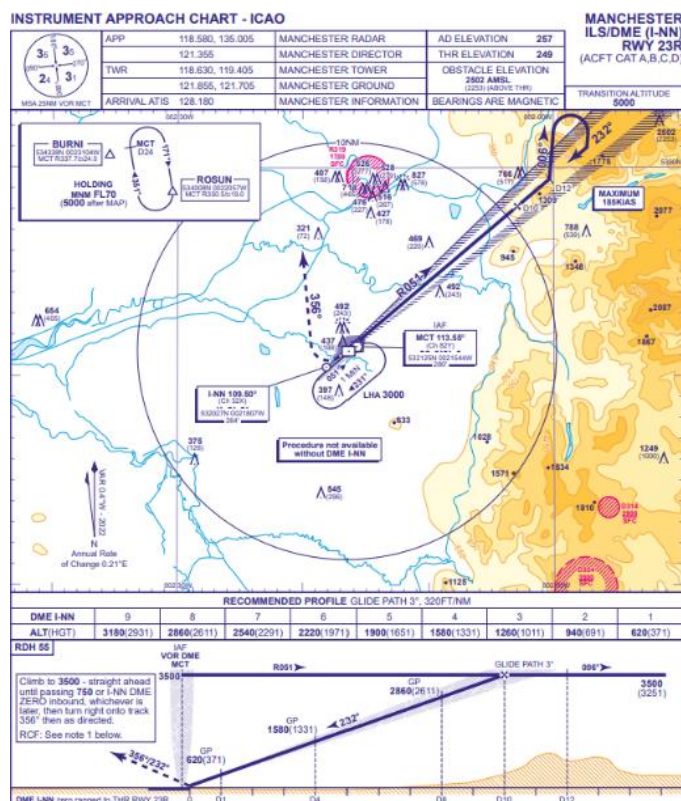


Runway 23R/05L & 23L/05R Approach Paths

When aircraft operate at Manchester Airport, they utilise the approach/departure paths established for Manchester Airport. For aircraft approaches, procedures are established for a 10 nautical mile approach path on a 3-degree glide slope. This enables aircraft to utilise the instrument landing system.

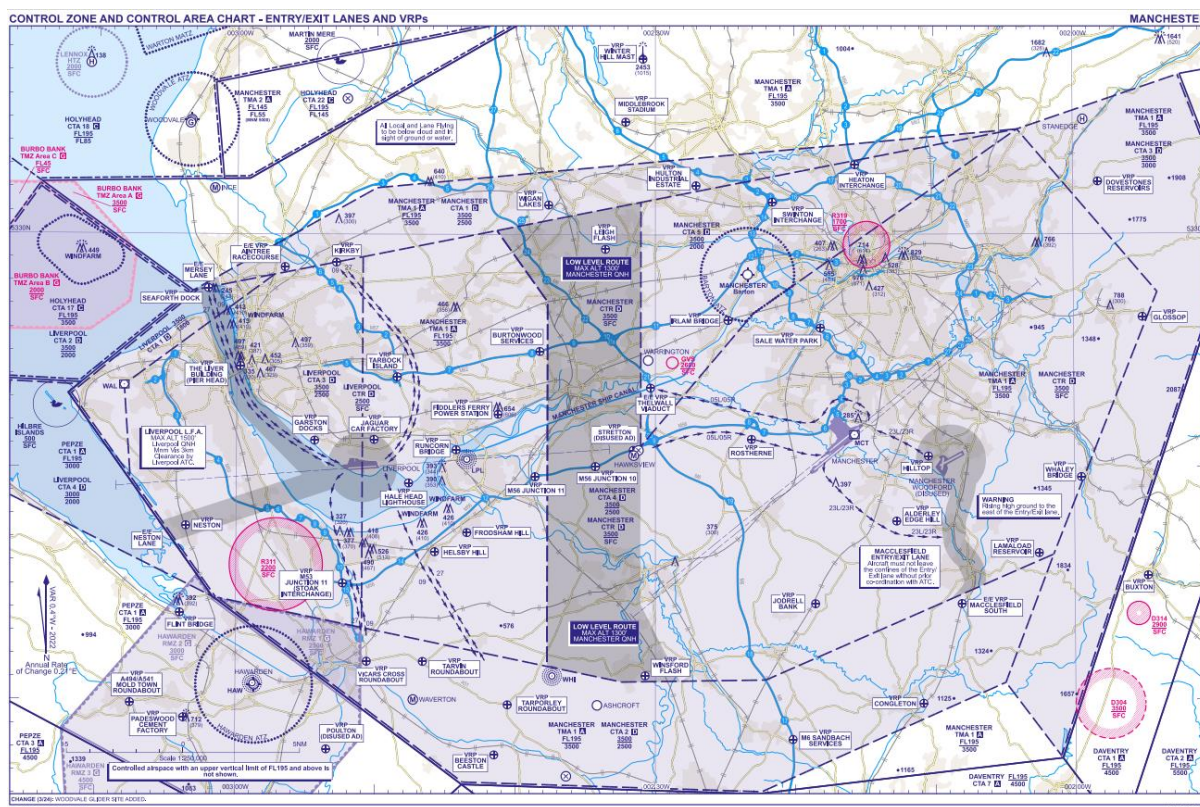
This phase of flight is one of the most critical for safe aircraft operations, and results in high workloads for flight crew. This glint and glare assessment reviews the approach and departure paths, with specific sensitivity paid to the final 2 nautical miles of the approaches.

The UK Aeronautical Information Package (AIP) contains charts depicting the approaches to Manchester Airport, an example of which can be seen below:



Visual Flight Rules Corridors

Aircraft generally operate on either Visual Flight Rules (VFR) or Instrument Flight Rules (IFR), where aircraft are operating under VFR this is done via the tracking of ground-based structures and visual reference points (such as roads, rivers, and landmarks). Most commercial air traffic will utilise IFR flight rules, meaning that generally they follow the defined SIDs, and STARs stipulated within the UK AIP. To reduce the potential for conflict between VFR and IFR flights, VFR lanes have been established at Manchester Airport. The VFR lanes are depicted below shown by the blue arrows:



A requirement of flying VFR is that the pilot maintains visual reference with the ground and landmarks. This means that VFR flight is required to maintain below cloud level and clear outside visibility is essential to maintain safe operations. Therefore, the introduction of a glint and glare hazard within a VFR lane has the potential to create a hazard to safe flight with the potential to cause ocular damage to flight crew.

Assessment Methodology

Pretext

A proposed PV array layout was provided by Cudd Bentley for each unit; this enabled an initial glint and glare review. During the process of assessing the proposed arrays it became clear that many of the proposed arrays would have been located on roofs which would have presented a significant glint and glare hazard. Considering this, the assessment approach was changed from assessing a specific array alignment to assessing the whole roofs as to identify areas where PV placement might not create large glare risks. This approach not only provides adequate safeguarding protection but also provides flexibility and options for Cudd Bentley to relocate panels from areas of the roof expected to produce unacceptable glare to areas of the roof whereas glare has been assessed as acceptable.

Assessment Software

The Solar Glare Hazard Analysis Tool (SGHAT) tool has been utilised to inform this glint and glare assessment. The SGHAT tool is utilised internationally and is an industry leader in glint/glare analysis for aviation receptors. This tool is provided by Forge Solar and is updated on a regular basis.

The Assessment Process

MAG has developed detailed models for their airports within the SGHAT software. These models consist of the relevant aviation receptors outlined above; to develop these models a mixture of published aeronautical information, charts and real-world aircraft data have been utilised.

The specific assessment parameters are then entered into the SGHAT assessment tool to create an accurate model of the proposals.

Once the proposal details have been entered into the assessment model and verified, the programme will execute, and the predictions will be delivered.

Following successful operation of the SGHAT assessment the aerodrome safeguarding authority will then complete a sense-check of the outcomes provided by the model and rectify any identified irregularities.

Finally, the results are analysed for any potential impact to aviation operations and conclusions presented in report format.

Assessment Limitations

Although the methodology outlined above utilises industry leading software, and expert subject matter analysis, there will always be limitations upon any assessment method.

SGHAT Software Limitations/Assumptions:

The following information is provided by the SGHAT software which outlines the assumptions and limitations of the software:

“Green” glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

“Yellow” glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.

The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.

Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints.

Additional analyses of array sub-sections can provide additional information on expected glare. This primarily affects V1 analyses of path receptors. Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine

the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis. The analysis does not automatically consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc. The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)

The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.

The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.

The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modelling methods. Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum. Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.”

Other Limitations

Although best endeavours are made to ensure the accuracy of the data inputted into the SGHAT model, the risk of incorrect values being inserted cannot be irradicated. Where errors are identified remedial action can be taken to rectify any errors.

Where the proposals subsequently change following the production of this glint and glare report this has the potential to change the glint and glare outcome. Therefore, any changes outside the scope of this existing report which are not subsequently assessed may result in unexpected glint and glare impacts. There is also potential that notwithstanding acceptable model outcomes that in practice post-installation that reports of glint and glare may occur; this assessment aims to try and avoid a situation whereas changes might be required post-installation – although this cannot be guaranteed.

Array Layout

The assessment array layout can be seen within the full SGHAT results; these results contain over 1000 pages so including them all within this report is not feasible, but the full SGHAT assessment results can be provided upon request.

Overall, in line with the assessment methodology outlined within this document, all roof areas have been assessed as to provide flexibility and options with regards to potential PV placement.

Assessment Results

Pretext

As outlined previously an approach of assessing the entire roof space of the units was undertaken, this provides opportunities and flexibility for the potential PV installation. Overall, the map within Annexe 2 outlines the roofs suitable for PV deployment in green and the roofs whereas PV deployment is liable to create a hazard to aviation are shown in red.

Assessment Results

See Appendix 2 at the end of this document for the map showing roofs where PV installation would be acceptable. The acceptable roofs have been chosen based upon predictions that they do not emit any glare towards Air Traffic Control and emit no or very limited glare with low duration and luminosity towards the 2 nautical mile approach paths.

Conclusion/Recommendation

The findings of our technical appraisal showed that whilst certain roofs are liable to induce an unacceptable glint and glare hazard to aviation, that there are a significant number of roofs whereas PV installations have been assessed as acceptable. Therefore, the recommendation of this Glint and Glare Report is that the proposed arrays are located within the green roof areas shown within Appendix 2 and match the existing roof pitch and elevation as assessed by this report.

Appendix 1:
ICON 1 – Proposed arrays



Icon 2 – Proposed arrays



Icon 3 - Proposed arrays



Icon 4 - Proposed arrays



Alpha Terrace - Proposed arrays



Appendix 2



Document Approval

Author: Ross Franklin, Aerodrome Safeguarding Technical Officer

Signature:

A handwritten signature in black ink, appearing to be the initials 'RF'.

Date: 24/04/2025

Reviewer: Diane Jackson, Aerodrome Safeguarding Manager

Signature:

A handwritten signature in black ink, appearing to be 'Diane Jackson'.

Date: 25/04/2025

