ENERPOWER
TOTAL ENERGY SOLUTIONS

16/09/2022

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Sub: Glint and Glare Assessment report for

Application Number: SD22A/0267

Site Address: Lidl Ireland GMBH, Lidl Store Fortunestown Lane, Saggart, Dublin 24, Co. Dublin, D24 XR74.

To whom it may concern,

Kindly find attached the Glint/Glare Assessment report as requested in the Planning Permission Grant(Decision Order Number: 0974) issued on 02-Aug-2022

If you have any queries, please do not hesitate to contact me by email elena.vazquez@enerpower.ie or by phone at 0896066498.

Thanks in advance.

Yours faithfully,

Elena Vazquez.

16/09/2022

Glint and Glare ASSESSMENT

Lidl Ireland GMBH
Lidl Store Fortunestown Lane,
Saggart, Dublin 24
Co. Dublin, D24 XR74.

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CONTENTS

1. EXECUTIVE SUMMARY

1.1. This aviation Glint and Glare assessment has been produced to send together with the Planning Application in The South Dublin County Council. This aviation Glint and Glare assessment has been undertaken in relation to the instalment of a solar array on a roof on lands approximately 19 km Southwest of Dublin Airport

1.2. There is no guidance or policy available across Ireland in relation to the assessment of glint and glare from Proposed Development. However, as identified by UK policy, it is recognised as a potential impact which needs to be considered for a proposed solar development.

1.3. A 30km study area is chosen for receptors. 4 aviation assets are located within 30km of the Proposed Development: Weston Airport, Casement Aerodrome , Dublin Airport and Tallaght Hospital Helipad. The receptor/s mentioned will require a detailed assessment due to the Proposed Development falling within their respective safeguarding buffer zones outlined in paragraph 4.19.

1.4. Geometric analysis was conducted for Weston Airport (2 Runways and 1 ATCT), Casement Aerodrome (4 Runways and 1 ATCT), Dublin Airport (6 Runways and 2 ATCT) and Tallaght Hospital Helipad (8 Runways),

1.5. The assessment concludes that:

- **Weston Airport: No impact predicted**
- **Casement Aerodrome:** Green Glare (Low potential for after-image) was predicted at FP 04, which is an acceptable impact according to the FAA guidelines for the runways and can be deemed not significant. Upon review of the ground elevation profile between the Proposed Development and Weston Airport, it was found that the Proposed Development would not be visible from the ATCT and the impact would therefore reduce to **None**.
- **Dublin Airport:** Green Glare (Low potential for after-image) was predicted at FP 08, FP 10, ATCT new tower, ATCT old tower, which is an acceptable impact according to the FAA guidelines for the runways and can be deemed not significant. Upon review of the ground elevation profile between the Proposed Development and Weston Airport, it was found that the Proposed Development would not be visible from the ATCT and the impact would therefore reduce to **None**.
- **Tallaght Hospital Helipad:** Green Glare (Low potential for after-image) was predicted at FP 13, FP 14, FP 15, FP 16, FP 19, which is an acceptable impact according to the FAA guidelines for the runways and can be deemed **not significant**.
- Overall impacts on aviation receptors are **acceptable** and **not significant**.

2. INTRODUCTION

BACKGROUND

2.1. MOVEO S.A. has been appointed by Enerpower (the "Applicant") to undertake a Glint and Glare Assessment for a proposed solar array development (the "Proposed Development") on the roof of Proposed Solar Panels at Lidl Store Fortunestown Lane, Saggart, Dublin 24,Co.Dublin. This aviation Glint and Glare assessment has been undertaken in relation to the instalment of a solar array on a roof on lands approximately 19 km Southwest of Dublin Airport (the "Application Site"). This is to be sent together with the Planning Application to The South Dublin County Council.

2.2. Please see **Figure 2: Appendix A** for site Layout Map with PV Solar Panels.

DEVELOPMENT DESCRIPTION

2.3. The Proposed Development comprises a 831.40m2 roof mounted solar array being installed on the roof of Proposed Solar Panels at Lidl Store Fortunestown Lane Saggart, Dublin 24 Co.Dublin, D24 XR74.

SCOPE OF REPORT

2.4. Although there may be small amounts of Glint and Glare from the metal structures associated with the solar array, the main source of Glint and Glare will be from the panels themselves and this will be the focus of this assessment.

2.5. Solar panels are designed to absorb as much light as possible and not to reflect it. However, glint can be produced as a reflection of the sun from the surface of the solar PV panel. This can also be described as a momentary flash. This may be an issue due to visual impact and viewer distraction on ground-based receptors and on aviation.

2.6. Glare is significantly less intense in comparison to Glint and can be described as a continuous source of bright light, relative to diffused lighting. This is not a direct reflection of the sun, but a reflection of the sky around the sun.

2.7. This report will concentrate on the impacts of Glint and Glare and their effects on aviation assets and will be supported with the following Appendices:

- APPENDIX A :
  - APPENDIX A: FIGURE 1 Site Layout Plan
  - APPENDIX A: FIGURE 2 Site Layout Map with PV Solar Panels
  - APPENDIX A: FIGURE 3 Proposed Solar PV Elevations 1
  - APPENDIX A: FIGURE 4 Dublin Airport Chart
  - APPENDIX A: FIGURE 5 Weston Airport Chart
  - APPENDIX A: FIGURE 6 Casement Aerodrome Chart
  - APPENDIX A: FIGURE 7 Ground elevation profile
- APPENDIX B: GLARE ANALYSIS REPORT RESULTS
- APPENDIX C: AVIATION RECEPTOR GLARE RESULTS
- APPENDIX D: SOLAR MODULE GLARE AND REFLECTANCE TECHNICAL MEMO

STATEMENT OF AUTHORITY

2.8. This Glint and Glare Assessment has been produced by MOVEO S.A.
Founding Partner director Maria Florencia Garcia having completed an architecture degree in 2012. She has been working on various technical assessments including Glint and Glare reports for numerous solar farms in Ireland.

DEFINITIONS

2.9. This study examined the potential hazard and nuisance effects of Glint and Glare in relation to aviation-based receptors. The Federal Aviation Guidance (FAA) in their *"Technical Guidance for Evaluating Selected Solar Technologies on Airports"* [1] have defined the terms 'Glint' and 'Glare' as meaning;

- Glint – *"A momentary flash of bright light"*
- Glare – *"A continuous source of bright light" ii*

[1] Harris, Miller, Miller & Hanson Inc. (November 2010). Technical Guidance for Evaluating Selected Solar Technologies on Airports; 3.1.2 Reflectivity. Technical Guidance for Evaluating Selected Solar Technologies on Airports. Available at: https://www.faa.gov/airports/environmental/policy_guidance/media/airport-solar-guide.pdf

2.10. Glint and Glare are essentially the unwanted reflection of sunlight from reflective surfaces. This study used a multi-step process of elimination to determine which receptors had the potential to experience the effects of Glint and Glare. It then examined, using a computer generated geometric model, the times of the year and the times of the day such effects could occur. This is based on the relative angles between the sun, the panels, and the receptor throughout the year.

Time Zones / Datum's

2.11. Locations in this report were given in Eastings and Northings using the 'OSNI 1952 Irish National Grid' grid reference system unless otherwise stated. Ireland uses Irish Standard Time (IST, UTC+01:00) in the summer months and Greenwich Mean Time (UTC+0) in the winter period. For the purposes of this report all time references were in GMT, however if reference was made to a time which falls within the IST then this was outlined in the report.

3. LEGISLATION AND GUIDANCE

PLANNING POLICY

3.1. The National Planning Framework (NPF) was adopted by the Irish Government on the 29th of May 2018. However, this policy document provides no current provision within the Irish Planning System for the requirement of Glint and Glare Assessments to support applications for the installation of ground mounted solar PV systems. It is therefore considered appropriate to defer to extant policy guidance within the UK planning system; the National Planning Policy Guidance (NPPG) on Renewable and Low Carbon Energy2[2].

3.2. Paragraph 013 sets out planning considerations that relate to large scale ground-mounted solar PV farms. This determines that 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. Considerations to be taken into account by local planning authorities are;

- *"the proposal's visual impact, the effect on landscape of Glint and Glare 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."*

INTERIM CAA GUIDANCE – SOLAR PHOTOVOLTAIC SYSTEMS (2010)

3.3. There is little guidance on the assessment of Glint and Glare from solar arrays with regards to aviation safety. The Civil Aviation Authority (CAA) has published interim guidance on 'Solar Photovoltaic Systems[3]', they also intend to undertake a review of the potential impacts of solar PV developments upon aviation, however this is yet to be published.

[2] NPPG Renewable and Low Carbon Energy. Available at: http://planningguidance.communities.gov.uk/blog/guidance/renewable-and-low-carbon-energy/particular-planning-considerations-for-hydropower-active-solar-technology-solar-farms-and-wind-turbines/#paragraph_012

[3] CAA (2010) Interim CAA Guidance – Solar Photovoltaic Systems. Available at: http://www.enstoneflyingclub.co.uk/files/caa_view_on_solar_panel_instalations.pdf?PHPSESSID=8900a41db8a205da84fca7bbc14eae69

3.4. The interim guidance identifies the key safety issues with regards to aviation, including *"glare, dazzling pilots leading them to confuse reflections with aeronautical lights."* It is outlined that solar farm developers should be aware of the requirements to comply with the Air Navigation Order (ANO), published in 2009. In particular, developers should take cognisant of the following articles of the ANO[4], including:

- *"**Article 137** – Endangering safety of an aircraft – A person must not recklessly or negligently act in a manner likely to endanger an aircraft, or any person in an aircraft."*
- ***Article 221*** *- Lights liable to endanger – "A person must not exhibit in the United Kingdom any light which:*

  – a) by reason of its glare is liable to endanger aircraft taking off or from landing at an aerodrome; or

  – b) by reason of its liability to be mistaken for an aeronautical ground light liable to endanger aircraft"

- ***Article 222*** *– Lights which dazzle or distract – "A person must not in the United Kingdom direct or shine any light at any aircraft in flight so as to dazzle or distract the pilot of the aircraft."*

3.5. These Articles are considered within the assessment of Glint and Glare of the Proposed Development.

US FEDERAL AVIATION ADMINISTRATION POLICY

3.6. The US Federal Aviation Administration (FAA) in their Solar Guide (Federal Aviation Authority, 2010)[5] incorporates a chapter on the impact and assessment of glint from solar panels. It concludes that (although subject to revision):

"...evidence suggests that either significant glare is not occurring during times of operation or if glare is occurring, it is not a negative effect and is a minor part of the landscape to which pilots and tower personnel are exposed."

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[4] CAA (2015) Air Navigation: The Order and Regulations. Available at: http://publicapps.caa.co.uk/docs/33/CAP%20393%20Fourth%20edition%20Amendment%201%20April%202015.pdf

[5] FAA (2010), Technical Guidance for Evaluating Selected Solar Technologies on Airports. Available at: https://www.faa.gov/airports/environmental/policy_guidance/media/airport-solar-guide-print.pdf

3.7. The current policy (Federal Register, 2013)[6] demands that an ocular impact assessment must be assessed at 1-minute intervals from when the sun rises above the horizon until the sun sets below the horizon. Specifically, the developer must use the 'Solar Glare Hazard Analysis Tool' (SGHAT) tool specifically and reference its results as this was developed by the FAA and Sandia National Laboratories as a standard and approved methodology for assessing potential impacts on aviation interests, although it notes other assessment methods may be considered. The SGHAT tool has since been licensed to a private organisation who were also involved in its development and it is the software model used in this assessment.

3.8. Crucially, the policy provides a quantitative threshold which is lacking in the UK guidance. This outlines that a development will not automatically receive an objection on glint grounds if low intensity glint is visible to pilots on final approach. In other words, low intensity glint with a low potential to form a temporary after-image would be considered acceptable under US guidance. Due to the lack of legislation and guidance within the UK, this US document has been utilised as guidance for this report.

3.9. The FAA guidance states that for a solar PV (and therefore any reflective surface) development to obtain FAA approval or to receive no objection, the following two criteria must be met:

- No potential for glint or glare in the existing or planned Air Traffic Control Tower (ATCT); and
- No potential for glare (glint) or "low potential for after-image" along the final approach path for any existing or future runway landing thresholds (including planned or interim phases), as shown by the approved layout plan (ALP). The final approach path is defined as 2 miles from 50 feet above the landing threshold using a standard 3-degree glide path.

3.10. The geometric analysis included later in this report, which defines the extent and time at which Glint and Glare may occur, is required by the FAA as the methodology to be used when assessing Glint and Glare impacts on aviation receptors. This report follows the methodology required by the FAA as it offers the most robust assessment method currently available.

[6] FAA (2013), Interim Policy, FAA Review of Solar Energy System Projects on Federally Obligated Airports. Available at: https://www.federalregister.gov/documents/2013/10/23/2013-24729/interim-policy-faa-review-of-solar-energy-system-projects-on-federally-obligated-airports

THE SOUTH DUBLIN COUNTY COUNCIL DEVELOPMENT PLAN

3.11. The South Dublin County Development Plan 2022-2028 was made on 22nd June 2022 and came into effect on 3rd August 2022.

3.12. The South Dublin County Development Plan sets out the framework to guide future development with the focus placed on the places we live, the places we work, and how we interact and move between these places while protecting our environment. The aim is to progress to a more sustainable development pattern for South Dublin in the immediate and long-term future up to 2040 and beyond.

Chapter 10's introduction reads:

'The '2021 Climate Action Plan' represents the Government's all of society approach, aimed at enabling Ireland to meet the EU targets to reduce carbon emissions by 51 per cent between 2021 and 2030, and lays the foundations for achieving net zero carbon emissions by 2050. Within that context South Dublin County Council through its strategic County Development Plan seeks to exceed those targets or meet them earlier, creating reliable, robust and efficient energy systems which enable growth across all sectors, and which supports the future development of the County. In line with the LGMAs Delivering on Climate Action 2030, the Council will continue to make every effort to increase energy efficiency and unlock renewable energy potential in the County. '

In the same chapter, the E7 solar power policy states one of the objectives:

' Promote the development of solar energy infrastructure in the County, including the building of integrated and commercial-scale solar projects subject to a viability assessment and environmental safeguards including the protection of natural or built heritage features, biodiversity and views and prospects.'

4. METHODOLOGY

4.1. A desk-based assessment was undertaken to identify when and where Glint and Glare may be visible at aviation receptors within the vicinity of the Proposed Development, throughout the day and the year.

SUN POSITION AND REFLECTION MODEL

Sun Data Model

4.2. The calculations in the solar position calculator are based on equations from Astronomical Algorithms[7]. The sunrise and sunset results are theoretically accurate to within a minute for locations between +/- 72° latitude, and within 10 minutes outside of those latitudes. However, due to variations in atmospheric composition, temperature, pressure, and conditions, observed values may vary from calculations.

Solar Reflection Model

4.3. The position of the sun is calculated at one-minute intervals of a typical year, in this instance the year assessed is 2022.

4.4. To determine if a reflection will reach a receptor, the following variables are required:

- Sun position;
- Observer location; and
- Tilt, orientation, and extent of the modules in the solar array.

4.5. The model assumes that the azimuth and horizontal angle of the sun is the same across the whole solar farm. This is considered acceptable due to the distance of the sun from the Proposed Development and the miniscule differences in location of the sun over the Proposed Development.

[7] Jean Meeus, Astronomical Algorithms (Second Edition), 1999

4.6. Once the position of the sun is known for each time interval, a vector reflection equation determines the reflected sun vector, based on the normal vector of the solar array panels.

This assumes that the angle of reflection is equal to the angle of incidence reflected across a normal plane. In this instance, the plane being the vector which the solar panels are facing.

4.7. On knowing the vector of the solar reflection, the azimuth is calculated and the horizontal reflection from multiple points within the solar farm. These are then compared with the azimuth and horizontal angle of the receptor from the solar farm to determine if it is within range to receive solar reflections.

4.8. The solar reflection in the model is considered to be specular as a worst-case scenario. In practice, the light from the sun will not be fully reflected as solar panels are designed to absorb light rather than reflect it. The previous text and **Appendix D** outline the reflective properties of solar glass and compares it to other reflective surfaces. Although the exact figures in this report are not conclusive, it is included as a visual guide and it agrees with most other reports, in that solar glass has less reflective properties than other types of glass and that the amount of reflective energy decreases as the angle of incidence decreases.

4.9. Most modern panels have a slight surface texture which should have a small effect on diffusing the solar radiation further; although, this has not been modelled to conform with the worst-case scenario assessment.

Determination of Ocular Impact

4.10. The software used for this assessment is based on the Sandia Laboratories Solar Glare Hazard Analysis Tool (SGHAT). This tool is specifically mentioned in the FAA guidance as the software which should be used in this type of assessment.

4.11. Determination of the ocular impact requires knowledge of the direct normal irradiance, PV module reflectance, size and orientation of the array, optical properties of the PV module, and ocular parameters. These values are used to determine the retinal irradiance and subtended source angle used in the ocular hazard plot.

4.12. The ocular impact[8] of viewed glare can be classified into three levels based on the retinal irradiance and subtended source angle: low potential for after-image (green), potential for after-image (yellow), and potential for permanent eye damage (red).

4.13. Green glare can be ignored when looking at ground based and some aviation receptors. Green glare does not cause temporary flash blindness and happens at an instant with very slight disturbance. As per FAA guidelines mitigation is only required for green glare when affecting an Air Traffic Control Tower, but not for when affecting pilots. Therefore, it can be assumed that green glare is acceptable for ground-based receptors.

4.14. The subtended source angle represents the size of the glare viewed by an observer, while the retinal irradiance determines the amount of energy impacting the retina of the observer. Larger source angles can result in glare of high intensity, even if the retinal irradiance is low.

Relevant Parameters of the Proposed Development

1.1. For an easier understanding, solar panels have been grouped into one group as shown in figure 1.

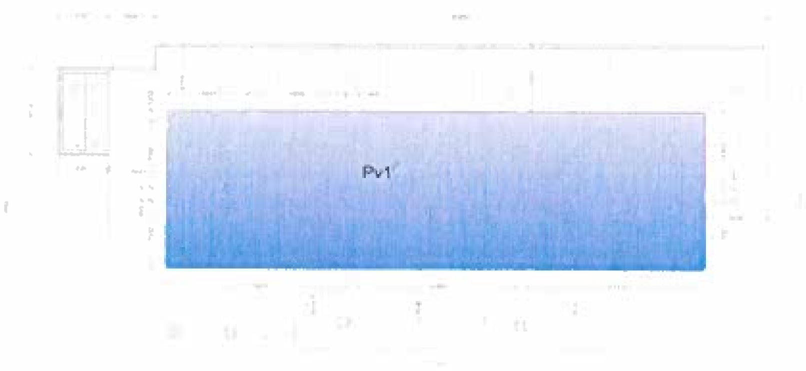

figure 1

[8] Ho, C.K., C.M. Ghanbari, and R.B. Diver, 2011, Methodology to Assess Potential Glint and Glare Hazards From Concentrating Solar Power Plants: Analytical Models and Experimental Validation, Journal of Solar Energy Engineering-Transactions of the Asme, 133(3).

The photovoltaic (PV) panels are oriented in eastwards and westwards direction, (as seen in the box below), to align with the undulation of the roof and will remain in a fixed position throughout the day and during the year (i.e. they will not rotate to track the movement of the sun). The panels will be analysed considering the following conditions:

NAME	ORIENTATION	TILT	AREA
PV1	80.000	4	831.40

4.15. The maximum height of the building is 6.98m, so this will be the height that is used to determine the worst-case scenario for potential Glint and Glare.

IDENTIFICATION OF RECEPTORS

Aviation

4.16. Glint is only considered to be an issue with regards to aviation safety when the solar development lies within proximity to a runway, particularly when the aircraft is descending to land. En-route activities are not considered an issue as the flight will most likely be at a higher altitude than the solar reflection.

4.17. Should a solar development be proposed within the safeguarded zone of an aerodrome, a full geometric study may be required (depending on the orientation from the Proposed Development) which would determine if there is potential for Glint and Glare at key locations, most likely on the descent to land. This assessment has been produced in response to The South Dublin County Council Council's request for a Glint and Glare assessment to be undertaken.

4.18. Buffer zones to identify aviation assets vary depending on the safeguarding criteria of that asset. All aerodromes within 30km will be identified, however generally the detailed assessments are only required within: 20km for large international aerodromes, 10km for military aerodromes and 5km for small aerodromes.

MAGNITUDE OF IMPACT

Moving Receptors (Aviation)

Approach Paths

4.19. Each final approach path which has the potential to receive glint is assessed using the Solar Glare Hazard Analysis Tool (SGHAT) model. The model assumes an approach bearing on the runway centreline, a 3-degree glide path with the origin 50ft (15.24m) above the runway threshold.

4.20. The computer model considers the pilot's field of view. The azimuthal field of view ("AFOV") or horizontal field of view ("HFOV") as it is sometimes referred to, refers to the extents of the pilot's horizontal field of view measured in degrees left and right from directly in front of the cockpit. The vertical field of view ("VFOV") refers to the extent of the pilot's vertical field of view measured in degrees from directly in front of the cockpit. The HFOV is modelled at 90 degrees left and right from the front of the cockpit whilst the VFOV is modelled at 30 degrees.

4.21. The FAA guidance states that there should be no potential for glare or "low potential for after image" at any existing or future planned runway landing thresholds in order for the proposed Development to be acceptable.

Air Traffic Control Tower (ATCT)

4.22. An air traffic controller uses the visual control room to monitor and direct aircraft on the ground, approaching and departing the aerodrome. It is essential that air traffic controllers have a clear and unobstructed view of aviation activity. The key areas on an aerodrome are the views towards the runway thresholds, taxiways, and aircraft bays.

4.23. The FAA guidance states that no solar reflection towards the ATCT should be produced by a proposed solar development, however this should be assessed on a site by site basis and will depend on the operations at a particular aerodrome.

4.24. In order to determine the impact on the ATCT, the location and height of the tower will need to be fed into the SGHAT model and where there is a potential for 'low potential for After Image' or more, then mitigation measures will be required.

ASSESSMENT LIMITATIONS

4.25. Below is a list of assumptions and limitations of the model and methods used within this report:

- The model does not 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 model 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;

- Due to variations in atmospheric composition, temperature, pressure and conditions, observed values may vary slightly from calculated positions; and

- The model does not account for the effects of diffraction; however, buffers are applied as a factor of safety.

5. BASELINE CONDITIONS

Aviation Receptors

5.1. Aerodromes within 30km of the proposed solar development can be found in Table **5-1**.

Table 5-1: Airfields within 20km of the Proposed Development

Airfield	Distance (km)	Use
Weston Airport	8.60	Airport
Casement Aerodrome	2.83	Military Aerodrome
Dublin Airport	18.95	Airport
Tallaght Hospital Helipad	2.86	HelipaD
Millicent Airfield	17.72	Airfield
Gowran Grange Aerodrome	18.57	Aerodrome
Allenwood Airstrip	28.21	Airstrip
Kilbrook Airstrip	28.42	Airstrip
Dunshaughlin Airstrip	28.50	Airstrip
Moyglare Airstrip	19.59	Airstrip
Dolly's Grove Airfield	17.42	Airfield
Ellistown Airstrip	29.80	Airstrip
Ballyboughal Aerodrome	27.00	Aerodrome

5.2. The Proposed Development is located within the safeguarding buffer zones of 4 aviation assets. Weston Airport, Casement Aerodrome, Dublin Airport and Tallaght Hospital Helipad, require a detailed assessment.

5.3. As Millicent airfield, Gowran Grange aerodrome, Allenwood airstrip, Kilbrook airstrip, Dunshaughlin airstrip, Moyglare airstrip, Dolly's Grove airfield, Ellistown airstrip and Ballyboughal aerodrome are not large and do not fall within 5km of the Proposed Development, there is no need for a detailed assessment. This is in accordance with what was outlined in the methodology chapter above.

Tallaght Hospital Helipad

5.4. Tallaght Hospital Helipad is used primarily by the hospital for the transportation of patients into the hospital. Due to the random nature at which a helicopter can approach a helipad, all directions will be assessed in detail. Each direction that is mentioned in **Table 5-2** is the direction in which the helicopter will approach the helipad from. I.e. North will mean that the helicopter is travelling from north to south

Table 5-2: Tallaght Hospital Helipad Approach paths

Helipad Approach	Bearing (°)
North	180.00
Northeast	225.00
East	270.00
Southeast	315.00
South	360.00
Southwest	045.00
West	090.00
Northwest	135.00

5.5. Each direction will be assessed as a 2-mile flight path to ensure that every possible approach into the helipad can be assessed.

Casement Aerodrome

5.6. Casement Aerodrome (ICAO code EIME) is designated as a Military Aerodrome. It is located approximately 7NM (13 km) southwest of the city of Dublin. For the Casement Aerodrome Chart **See Figure 2: Appendix A.**

5.7. The elevation of the aerodrome at the Aerodrome Reference Point (ARP) is 319ft (97.23m). It has two asphalt strip runways, details of which are given in Table 5-3.

Table 5-3: Runways at Casement Aerodrome

Runway Designation	True Bearing (°)	Length (m)	Width (m)
04	040.93	1462	45
10	101.93	1828	45
22	220.93	1462	45
28	281.93	1828	45

5.8. The threshold locations and heights of the runways at Casement Aerodrome are given in **Table 5-4.**

Table 5-4: Runway Threshold Locations and Heights

Runway Designation	Threshold Latitude	Threshold Longitude	Height AOD (m)
04	53° 17′ 36.90″ N	006° 27′ 13.73″ W	96.93
10	53° 18′ 16.88″ N	006° 28′ 07.75″ W	97.23
22	53° 18′ 12.63″ N	006° 26′ 22.02″ W	92.66
28	53° 18′ 05.85″ N	006° 26′ 40.68″ W	96.01

5.9. The Airfield Reference Point (ARP) is located at the midpoint of the main runway. The actual location of the ARP is given in Table **5-5**. This table also shows the location and height of the ATCT.

5.10. The overall height above local ground level of the Control Tower Building has been estimated as 15m using photographs of the installation as a guide and referencing them to everyday objects.

Table 5-5: Casement Aerodrome Airfield Reference Point

	Latitude	Longitude	Eastings	Northings
ARP	53° 18′ 11″ N	006° 27′ 19″ W	103277	387719
ATCT	53° 18′ 20″ N	006° 26′ 30″ W	104192	387932

Weston Aerodrome

5.11. Weston Aerodrome (ICAO code EIWT) is designated as a Civil Aerodrome. It is located approximately 8NM (14.82 km) west of the city of Dublin. For the Weston Aerodrome Chart **See Figure 3: Appendix A.**

5.12. The elevation of the aerodrome at the Aerodrome Reference Point (ARP) is 155ft (47.24m). It has two asphalt strip runways, details of which are given in **Table 5-6**.

Table 5-6: Runways at Weston Aerodrome

Runway Designation	True Bearing (°)	Length (m)	Width (m)
07	063.30	924	24
25	243.27	924	25

5.13. The threshold locations and heights of the runways at Weston Airport are given in Table **5-7**.

Table 5-7: Runway Threshold Locations and Heights

Runway Designation	Threshold Latitude	Threshold Longitude	Height AOD (m)
07	53° 21' 01.48" N	006° 29' 40.17" W	47.24
25	53° 21' 15.03" N	006° 28' 55.66" W	46.33

5.14. The Airfield Reference Point (ARP) is located at the midpoint of the main runway. The actual location of the ARP is given in **Table 5-8**. This table also shows the location and height of the ATCT.

5.15. The overall height above local ground level of the Control Tower Building has been estimated as 15m using photographs of the installation as a guide and referencing them to everyday objects.

Table 5-8: Weston Aerodrome Airfield Reference Point

	Latitude	Longitude	Eastings	Northings
ARP	53° 21' 08" N	006° 29' 17" W	101420	393329
ATCT	53° 21' 20" N	006° 29' 22" W	101370	393704

Dublin Airport

5.16. Dublin Airport (ICAO code EIDW) is designated as an International Civil Aerodrome. It is located approximately 5.3NM (10 km) north of the city of Dublin, Ireland. For the Dublin Airport Aerodrome Chart **See Figure 4: Appendix A.**

5.17. The elevation of the aerodrome at the Aerodrome Reference Point (ARP) is 242ft (73.76m). It has four asphalt strip runways, details of which are given in **Table 5-9**.

5.18. Work has already been finalised on the construction of a new ATCT at Dublin Airport. The new tower is required in order to provide clear sightlines to the planned parallel Northern Runway (which will be designated 10L and 28R, with the existing 10-28 runway being re-designated 10R and 28L). The new runway and ATCT, as well as all the existing ones have been considered in this assessment.

Table 5-9: Runways at Dublin Airport

Runway Designation	True Bearing (°)	Length (m)	Width (m)
10L	095.24	3,110	45
10R	095.24	2,637	45
28L	275.27	2,637	45
28R	275.27	3,110	45
16	156.58	2,072	61
34	336.59	2,072	61

5.19. The threshold locations and heights of the runways at Dublin Airport are given in **Table 5-10**.

Table 5-10: Runway Threshold Locations and Heights

Runway Designation	Threshold Latitude	Threshold Longitude	Height AOD (m)
10L	53° 26′ 13.811″ N	006° 16′ 49.010″ W	71.94
10R	53° 25′ 20.75″ N	006° 17′ 24.27″ W	73.76
28L	53° 25′ 12.94″ N	006° 15′ 02.08″ W	61.57

28R	53° 26' 6.191" N	006° 14' 45.479" W	63.44
16	53° 26' 13.16" N	006° 15' 43.12" W	66.14
34	53° 25' 11.66" N	006° 14' 58.54" W	61.57

5.20. The Airfield Reference Point (ARP) is located at the midpoint of the main runway. The actual location of the ARP is given in **Table 5-11**. This table also shows the locations of the old and new ATCTs.

5.21. The overall height above local ground level of the old ATCT is 22m and the new ATCT is going to be 86.9m tall.

Table 5-11: Dublin Airport Airfield Reference Point

	Latitude	Longitude	Eastings	Northings
ATCT(New)	53° 25' 44" N	006° 15' 52" W	116820	400930
ATCT	53° 25' 42" N	006° 15' 43" W	116983	400858
ARP	53° 25' 17" N	006° 16' 12" W	116402	400118

6. IMPACT ASSESSMENT

6.1. Following the methodology outlined earlier in this report, geometrical analysis comparing the azimuth and horizontal angle of the receptors from the Proposed Development and the solar reflection was conducted. Although this assessment did not consider obstructions such as intervening vegetation and buildings, discussion on the potentially impacted receptors is provided where necessary.

AVIATION RECEPTORS

1.1. **Table 6-1** shows a summary of the modelling results for each of the runway approach paths as well at the ATCT whilst the detailed results and ocular impact charts can be viewed in **Appendix C.**

Table 6-1: Summary of Component Glare Results

Runway Approach	Results – Predicted reflection times (GMT)		Glare Type			Remarks
	am	pm				
FP 01 Casement	-	-	-	-	-	No impact predicted
FP 02 Casement	-	-	-	-	-	No impact predicted
FP 03 Casement	-	-	-	-	-	No impact predicted
FP 04 Casement		15:30 to 16:30	Low	-	-	Green Glare
FP 05 Weston	-	-	-	-	-	No impact predicted
FP 06 Weston	-	-	-	-	-	No impact predicted
FP 07 Dublin	-	-	-	-	-	No impact predicted
FP 08 Dublin	-	15:30 to 16:30	Low	-	-	Green Glare
FP 09 Dublin	-	-	-	-	-	No impact predicted
FP 10 Dublin	-	15:30 to	Low	-	-	Green Glare

		16:30				
FP 11 Dublin	-	-	-	-	-	No impact predicted
FP 12 Dublin	-	-	-	-	-	No impact predicted
FP 13 Tallaght	-	15:00 to 16:30	Low	-	-	Green Glare
FP 14 Tallaght	-	16:30 to 18:00	Low	-	-	Green Glare
FP 15 Tallaght	-	17:30 to 18:00	Low	-	-	Green Glare
FP 16 Tallaght	-	17:30 to 19:30	Low	-	-	Green Glare
FP 17 Tallaght	-	-	-	-	-	No impact predicted
FP 18 Tallaght	-	-	-	-	-	No impact predicted
FP 19 Tallaght	09:00 to 10:00	-	Low	-	-	Green Glare
FP 20 Tallaght	-	-	-	-	-	No impact predicted
ATCT 1 Dublin new tower	-	14:30 to 15:15	Low	-	-	Green Glare
ATCT 2 Dublin old tower	-	14:30 to 15:15	Low	-	-	Green Glare
ATCT 3 Weston	-	-	-	-	-	No impact predicted
ATCT 4 Casement	-	-	-	-	-	No impact predicted

1.2. As can be seen in Table **6-1** , only green glare is expected to impact the runways, FP 04 at Casement Aerodrome; FP 08, FP 10, ATCT new tower, ATCT old tower at Dublin Airport; and FP 13, FP 14, FP 15, FP 16, FP 19 at Tallaght Hospital Helipad. Green glare is described as 'Low Potential for After Image' which is an **acceptable impact** when pilots are approaching runways/helipads, according to the FAA guidance. The impact on approach at those runways is therefore deemed as **not significant**.

1.3. The impact on **Dublin New ATCT,** has been assessed and it shows that there will be 7.5 hours of green glare impact predicted per year on the ATCT. (this number represents 0.084% of the total amount of hours in a year). The FAA guidance advises that glare towards the ATC Tower is not acceptable. This guidance is not applicable globally, but it is commonly referenced. Upon review of the ground elevation between the Proposed Development and the ATCT, there is a considerable difference in ground levels. This difference will block all views into the Proposed Development from the ATCT, this will block all views into the Proposed Development from the ATCT. Therefore, the impact is reduced to **None** and **not significant. See Appendix A Figure 7**

1.4. The impact on **Dublin Old ATCT**, has been assessed and it shows that there will be 7.7 hours of green glare impact predicted per year on the ATCT. (this number represents 0.087% of the total amount of hours in a year). The FAA guidance advises that glare towards the ATC Tower is not acceptable. This guidance is not applicable globally, but it is commonly referenced. Upon review of the ground elevation between the Proposed Development and the ATCT, there is a considerable difference in ground levels. This difference will block all views into the Proposed Development from the ATCT, this will block all views into the Proposed Development from the ATCT. Therefore, the impact is reduced to **None** and **not significant. See Appendix A Figure 7**

1.5. Is valid to add as well that as the Proposed Development is located circa 19 km away from the ATCTs and within an area where there are other industrial rooftops, of which many look to have reflective properties, the Proposed Development's glare is not anticipated to be distinguishable. Therefore, the impacts can be reduced to **None** and **Not Significant**.

1.6. Ireland normally gets between 1100 and 1600 hours of sunshine each year. The sunniest months are May and June. During these months, sunshine duration averages between 5 and 6.5 hours per day over most of the country. The extreme southeast gets the most sunshine, averaging over 7 hours a day in early summer. In this Case **both ATCT'S in Dublin Airport**, green glare is expected to impact **only in december and january**. Therefore, the impacts can be reduced to **None** and **Not Significant**.

1.7. It must be emphasised at this point that all results, whether from FAA endorsed SGHAT software or our own proprietary software, are theoretical by default, in that they assume that the sun is always shining and at full intensity. The results do not account for climate and inherent weather patterns that occur across the island of Ireland. According to the Met Eireann website (https://www.met.ie/), the monthly averages of daily duration of sunshine are approximately **44% of daylight hours (5,3 hours)** in the vicinity of the site. While we cannot correlate the exact periods of sunlight with our predicted periods of potential glare, it is clear that the figures for the periods and duration of glare listed in this report are conservative and would likely be subject to a substantial reduction in reality. Therefore, the impact is reduced to **None** and **not significant**.

1.8. Also, The user manual for SGHAT also points out that "to minimise unexpected glare, windows of air traffic control towers and airplane cockpits are coated with anti-reflective glazing and operators will wear polarised eyewear." This also helps to reduce the impact to **None** and **not significant**.

7. SUMMARY

7.1. This aviation Glint and Glare assessment has been produced to send together with the Planning Application in The South Dublin County Council. This aviation Glint and Glare assessment has been undertaken in relation to the instalment of a solar array on a roof on lands approximately 19 km Southwest of Dublin Airport

7.2. There is no guidance or policy available across Ireland in relation to the assessment of glint and glare from Proposed Development. However, as identified by UK policy, it is recognised as a potential impact which needs to be considered for a proposed solar development.

7.3. A 30km study area is chosen for receptors. 4 aviation assets are located within 30km of the Proposed Development: Weston Airport, Casement Aerodrome , Dublin Airport, Tallaght Hospital Helipad. The receptor/s mentioned will require a detailed assessment due to the Proposed Development falling within their respective safeguarding buffer zones outlined in paragraph 4.19.

7.4. Geometric analysis was conducted for Dublin Airport (6 Runways and 2 ATCT), Casement Aerodrome (4 Runways and 1 ATCT), Tallaght Hospital Helipad (8 Runways), Weston Airport (2 Runways and 1 ATCT)

7.5. The assessment concludes that:

- **Weston Airport: No impact predicted**
- **Casement Aerodrome:** Green Glare (Low potential for after-image) was predicted at FP 04, which is an acceptable impact according to the FAA guidelines for the runways and can be deemed not significant. Upon review of the ground elevation profile between the Proposed Development and Weston Airport, it was found that the Proposed Development would not be visible from the ATCT and the impact would therefore reduce to **None**.
- **Dublin Airport:** Green Glare (Low potential for after-image) was predicted at FP 08, FP 10, ATCT new tower, ATCT old tower, which is an acceptable impact according to the FAA guidelines for the runways and can be deemed not significant. Upon review of the ground elevation profile between the Proposed Development and Weston Airport, it was found that the Proposed Development would not be visible from the ATCT and the impact would therefore reduce to **None**.

- Tallaght Hospital Helipad: Green Glare (Low potential for after-image) was predicted at FP 13, FP 14, FP 15, FP 16, FP 19, which is an acceptable impact according to the FAA guidelines for the runways and can be deemed not significant.

- Overall impacts on aviation receptors are **acceptable** and **not significant.**

8. APPENDICES

APPENDIX A: FIGURES

- APPENDIX A: FIGURE 1 Site Layout Plan
- APPENDIX A: FIGURE 2 Site Layout Map with PV Solar Panels
- APPENDIX A: FIGURE 3 Proposed Solar PV Elevations
- APPENDIX A: FIGURE 4 Dublin Airport Chart
- APPENDIX A: FIGURE 5 Weston Airport Chart
- APPENDIX A: FIGURE 6 Casement Aerodrome Chart
- APPENDIX A: FIGURE 7 Ground elevation profile

APPENDIX B: GLARE ANALYSIS REPORT RESULTS

APPENDIX C: AVIATION RECEPTOR GLARE RESULTS

APPENDIX D: SOLAR MODULE GLARE AND REFLECTANCE TECHNICAL MEMO

Grid Reference: O 05531 27312
X(Easting): 305531
Y(Northing): 227312
Latitude, Longitude = 53.285849556,-6.418179808

Centre Point Coordinates (ITM)
X(ITM): 705473
Y(ITM): 727337

Ordnance Survey Ireland

JOB: Proposed Solar Panels at Lidl Store Fortunestown Lane Saggart, Dublin 24 Co. Dublin, D24 XR74

CLIENT: Lidl Ireland GMBH

TITLE: Site Location Map

PLAN No.: 01

SCALE: 1:1,000@A1

Rev A 20/04/2022
Drawing by Elena Vazquez

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Waterford Business Park, Unit 24 Cork Rd, Waterford

Site subject to planning application outlined in solid RED.	
Adjacent lands under the control of the applicant outlined in BLUE.	
Waysleaves outlined in YELLOW.	
Farm Tracks BROWN	

(dotted green)	Grass
(green circles)	Trees

N
W E
S

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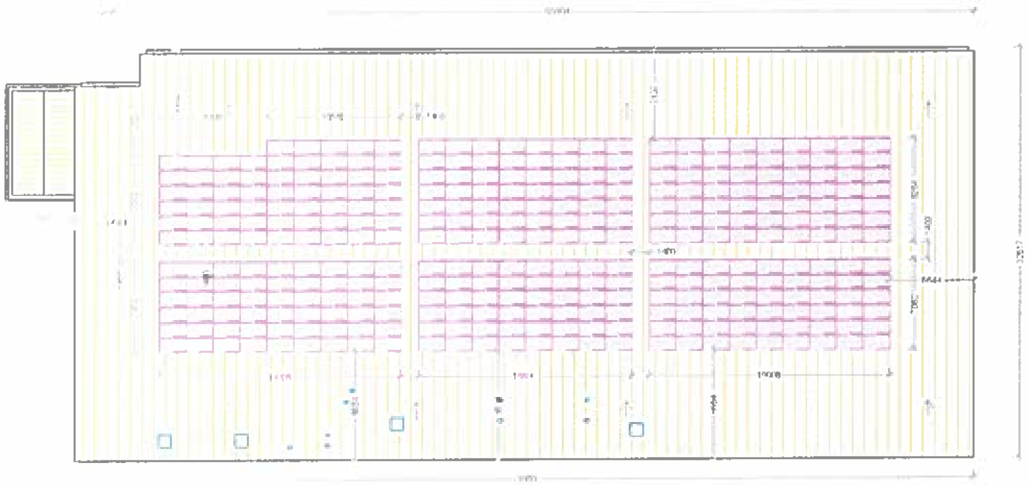

TOTAL PANELS = 334 panels

334 Panels @ 450 Wp = 150.30 kWp

JOB : Proposed Solar Panels at
Lidl Store Fortunestown Lane
Saggart, Dublin 24
Co. Dublin, D24 XR74

CLIENT: Lidl Ireland GMBH

TITLE: Proposed Solar PV Roof Plan

PLAN No.: 06

SCALE: 1:200@A1

Rev A 20/04/2022
Drawing by Elena Vazquez

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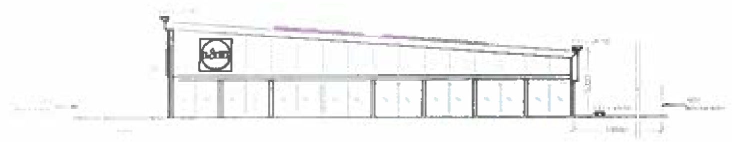
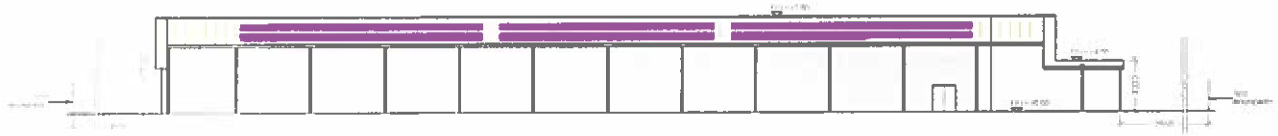
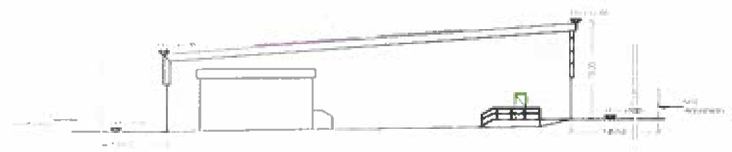


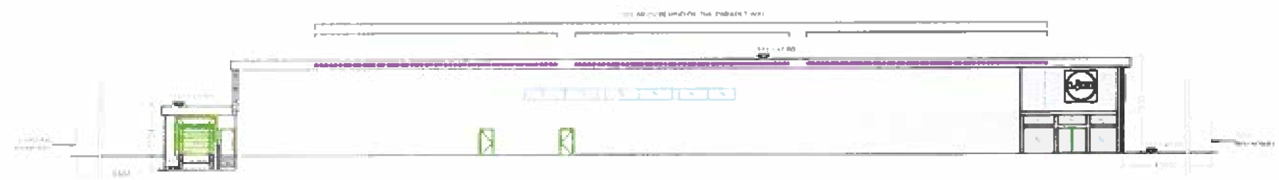
PROPOSED SOUTH EAST ELEVATION



PROPOSED NORTH EAST ELEVATION

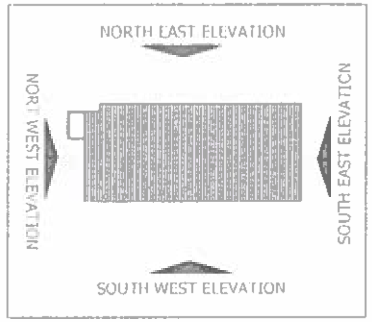


PROPOSED NORTH WEST ELEVATION



PROPOSED SOUTH WEST ELEVATION

KEY PLAN



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3. This drawing is to be read in conjunction with all relevant structural, services and architectural drawings, specifications and schedules.
4. All dimension are in millimeters and levels in meters unless note otherwise.

JOB :	Proposed Solar Panels at Lidl Store Fortunestown Lane Saggart, Dublin 24 Co. Dublin, D24 XR74
CLIENT:	Lidl Ireland GMBH
TITLE:	Proposed Solar PV Elevation Plan
PLAN No.:	07
SCALE:	1:200@A1

Rev A 20/04/2022
Drawing by Elena Vazquez

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AERODROME CHART - ICAO

53 25 17 N
006 16 12 W
ELEV 243 FT

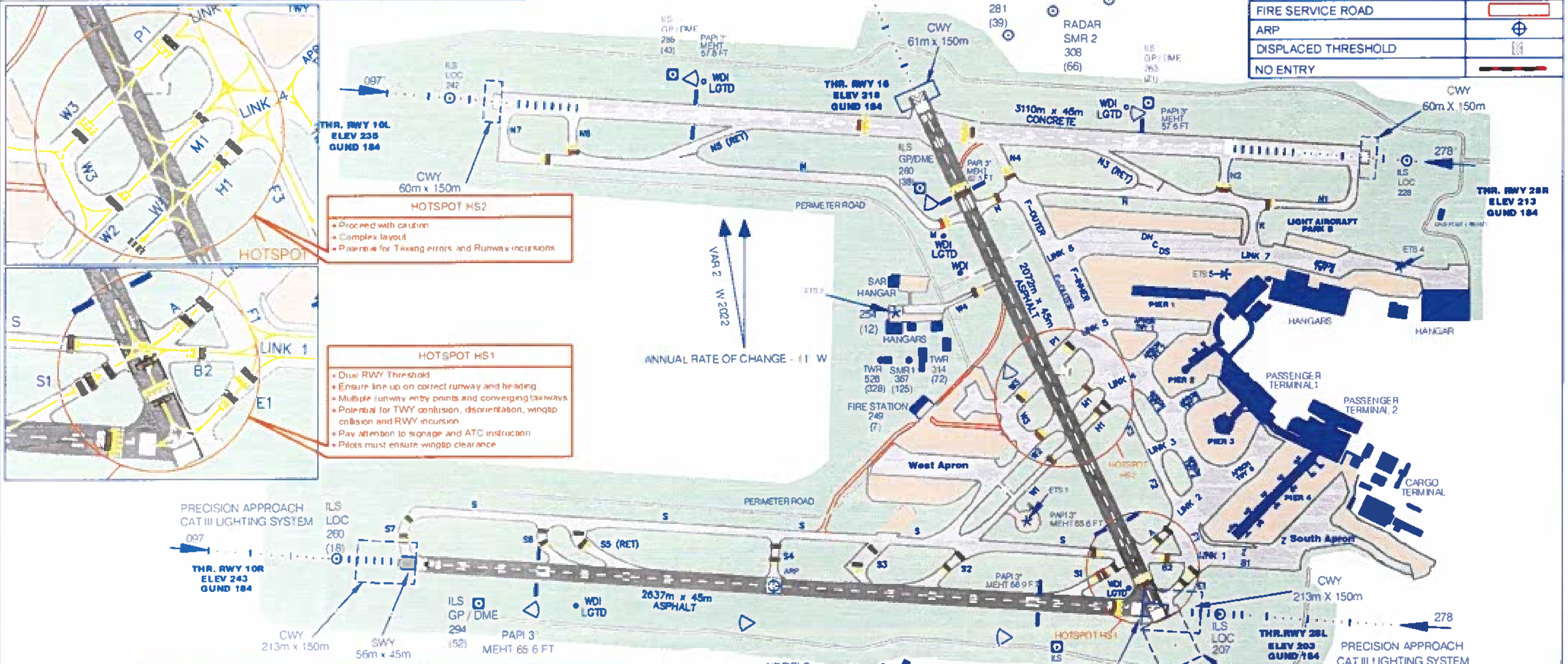
TWR 118 600MHz ATIS 124 530
GND 121 800MHz 122 985
GND 125 885MHz

RWY	DIRECTION	THR		BEARING STRENGTH
10R	97°	53 25 20 75 N	006 17 24 27 W	PCN 92/R/B/W/T
28L	278°	53 25 12 94 N	006 15 02 08 W	
16	159°	53 26 13 16 N	006 15 43 12 W	PCN 84/R/B/W/T
34	339°	53 25 11 66 N	006 14 58 54 W	
10L	97°	53 26 13 79 N	006 16 50 22 W	PCN 114/R/C/W/T
28R	278°	53 26 06 73 N	006 14 41 87 W	

CONSULT NOTAM FOR LATEST INFORMATION

DUBLIN AIRPORT/ IRELAND

LEGEND	
RVR	
DISUSED PAVEMENT	
STOPBAR	
RUNWAY HOLDING POSITION MARKINGS	
HOT SPOT	
CLEARWAY	
STOPWAY	
ENGINE TEST SITE, ETS	
FIRE SERVICE ROAD	
ARP	
DISPLACED THRESHOLD	
NO ENTRY	



NOTE 1	RWY 10R/28L IS PROVIDED WITH 7.5M WIDE ASPHALT SHOULDERS
NOTE 2	RWY 10L/28R IS PROVIDED WITH 7.5M WIDE CONCRETE SHOULDERS
NOTE 3	ALL TAXIWAYS 23M WIDE EXCEPT TWY W4: 15M, LINK 1: 33M, LINK 2: 65M, LINK 3: 42M, LINK 4: 33M, B1, B2 AND N1: 24M, S5: 30M, F1, M1 AND W2: 25M, N2: 27M, N6: 26M, N7: 25M
NOTE 4	TAXIWAYS S5, N3 AND N5 ARE THE ONLY RAPID EXIT TAXIWAYS (RET) AT DUBLIN AIRPORT
NOTE 5	BEARINGS ARE MAGNETIC
NOTE 6	LINEAR DIMENSIONS IN METRES
NOTE 7	ELEVATIONS IN FEET AMSL
NOTE 8	HEIGHTS IN FEET ABOVE AERODROME ELEVATION SHOWN IN BRACKETS

SCALE
METRES 0 500 1000
FEET 0 1000 2000 3000

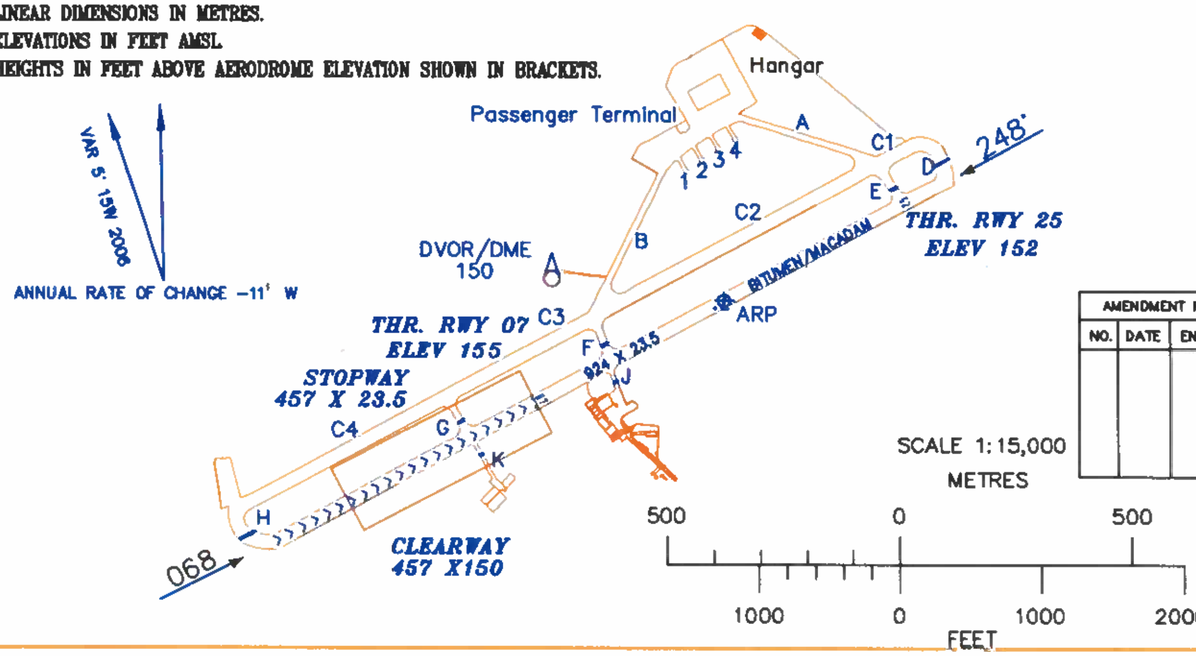
CHANGES: New Northern Runway, New Note 2 and Note 3 revised along with old Note 8 removed and New Legend.

AERODROME CHART - ICAO	53 21 08.25 N 006 29 17.92 W	ELEV 155FT	TWR 122.4 GND 119.425 ATIS 118.875	CONSULT NOTAM FOR LATEST INFORMATION	**WESTON AIRPORT/ DUBLIN**

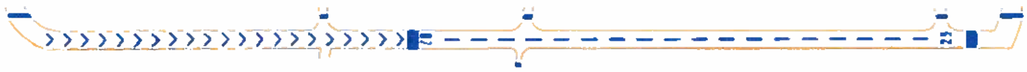
RWY	DIRECTION	THR		BEARING STRENGTH
07	068°	53 21 01.48 N	006 29 40.17 W	PCN 45/F/A/W/T
25	248°	53 21 15.03 N	006 28 55.66 W	

LEGEND	
HELICOPTER STANDS	1
RUNWAY HOLDING POSITION MARKING	

BEARINGS ARE MAGNETIC.
LINEAR DIMENSIONS IN METRES.
ELEVATIONS IN FEET AMSL.
HEIGHTS IN FEET ABOVE AERODROME ELEVATION SHOWN IN BRACKETS.



AMENDMENT RECORD		
NO.	DATE	ENTERED BY



MARKING AIDS RUNWAY 07/25

NIL

LIGHTING AIDS RUNWAY 07/25

Helicopter Stand	Latitude	Longitude	Max Wingspan	Max Length	Conditions
01	53 21 17.18 N	006 29 22.05 W			
02	53 21 17.96 N	006 29 20.18 W			
03	53 21 18.67 N	006 29 18.25 W			
04	53 21 19.31 N	006 29 16.26 W			

NOTE 1: TAXIWAY AND APRON : PCN 45/F/A/W/T.
NOTE 2: TAXIWAY C1, C2, C3 AND C4: 30M WIDE.
NOTE 3: TAXIWAY A, B, D, E, F, G, H AND J: 16M WIDE.
NOTE 4: TAXIWAY K: 7M WIDE.

CHANGES: NEW ARP COORDINATES; NEW THRESHOLD COORDINATES FOR RUNWAY 25 AND 07; NEW THRESHOLD ELEVATION RUNWAY 07

AERODROME CHART ICAO N 53°18'10.77" W 006°27'19.46" ELEV 319ft

TWR 123.500
GND 121.755
ATIS 122.805

CONSULT NOTAM FOR LATEST INFORMATION

BALDONNEL/CASEMENT

RWY	DIRECTION	THR	BEARING STRENGTH
04	044°	N 53°17'36.90" W 006°27'13.73"	PCN 46/F/D/W/T
10	105°	N 53°18'16.88" W 006°28'07.75"	PCN 52/F/D/W/T
22	224°	N 53°18'12.63" W 006°26'22.02"	PCN 46/F/D/W/T
28	285°	N 53°18'05.85" W 006°26'40.68"	PCN 52/F/D/W/T

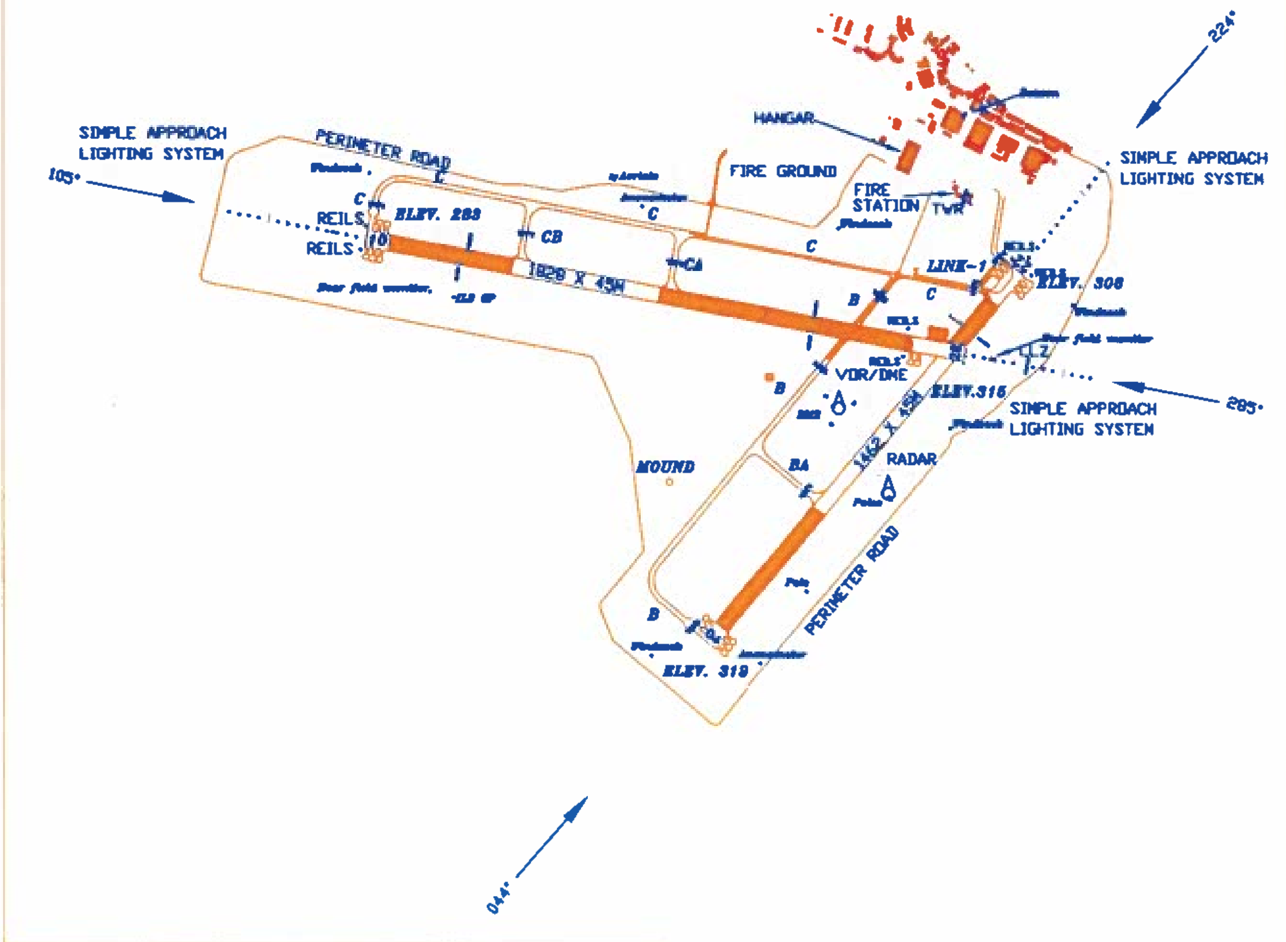
BEARINGS ARE MAGNETIC.

ELEVATIONS SHOWN IN FEET AMSL.

HEIGHTS IN FEET ABOVE AERODROME ELEVATION SHOWN IN BRACKETS.

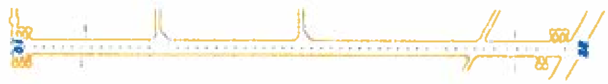
LINEAR DIMENSIONS IN METRES.

ANNUAL RATE OF CHANGE -11' W

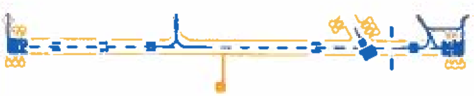


MARKING AIDS RWY 10/28

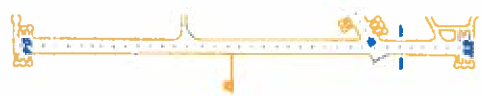
LIGHTING AIDS RWY 10/28



MARKING AIDS RWY 04/22

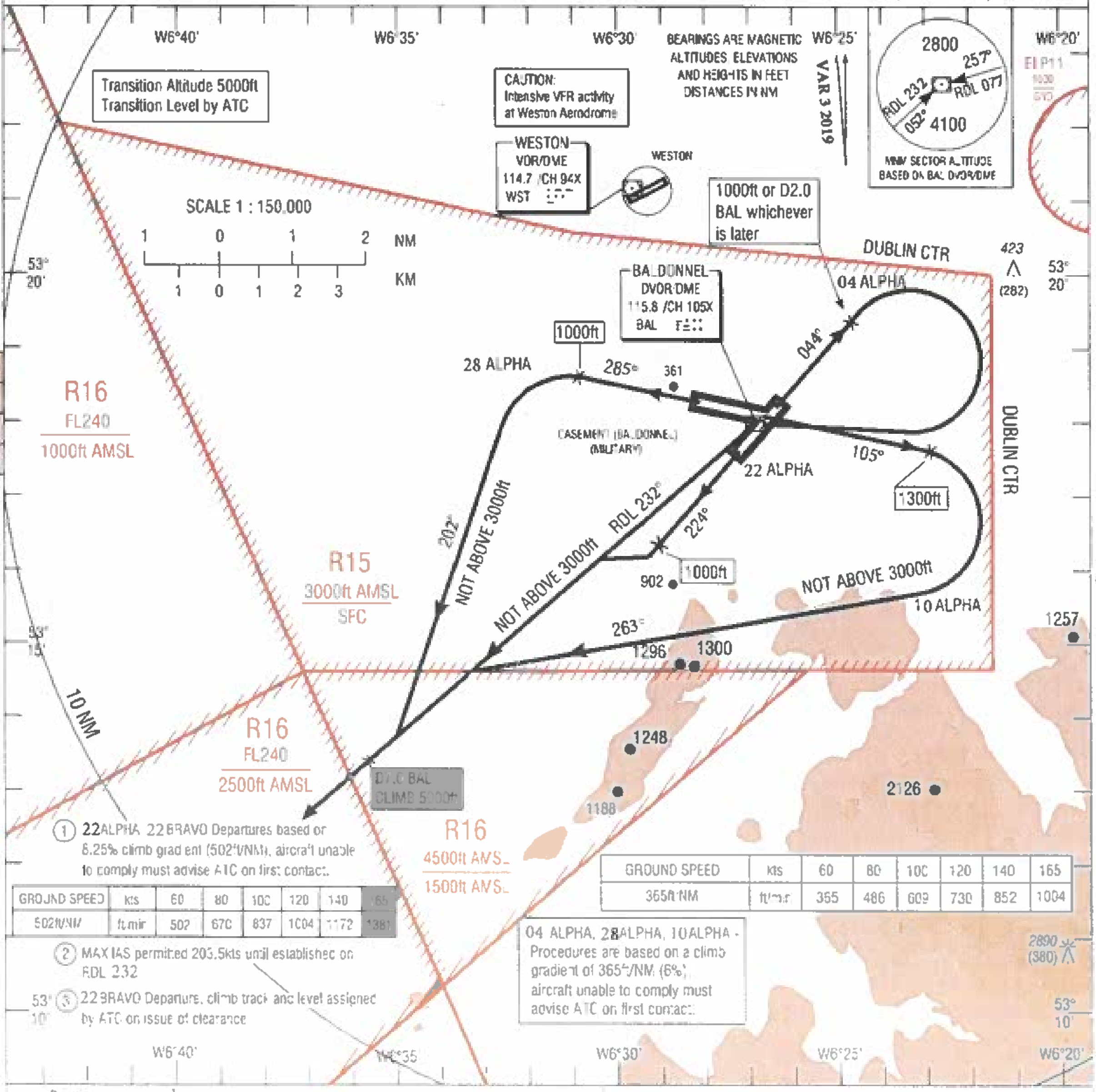


LIGHTING AIDS RWY 04/22



CHANGES : MAGNETIC VARIATION, BEARINGS, RUNWAY DESIGNATORS AND FREQUENCIES.

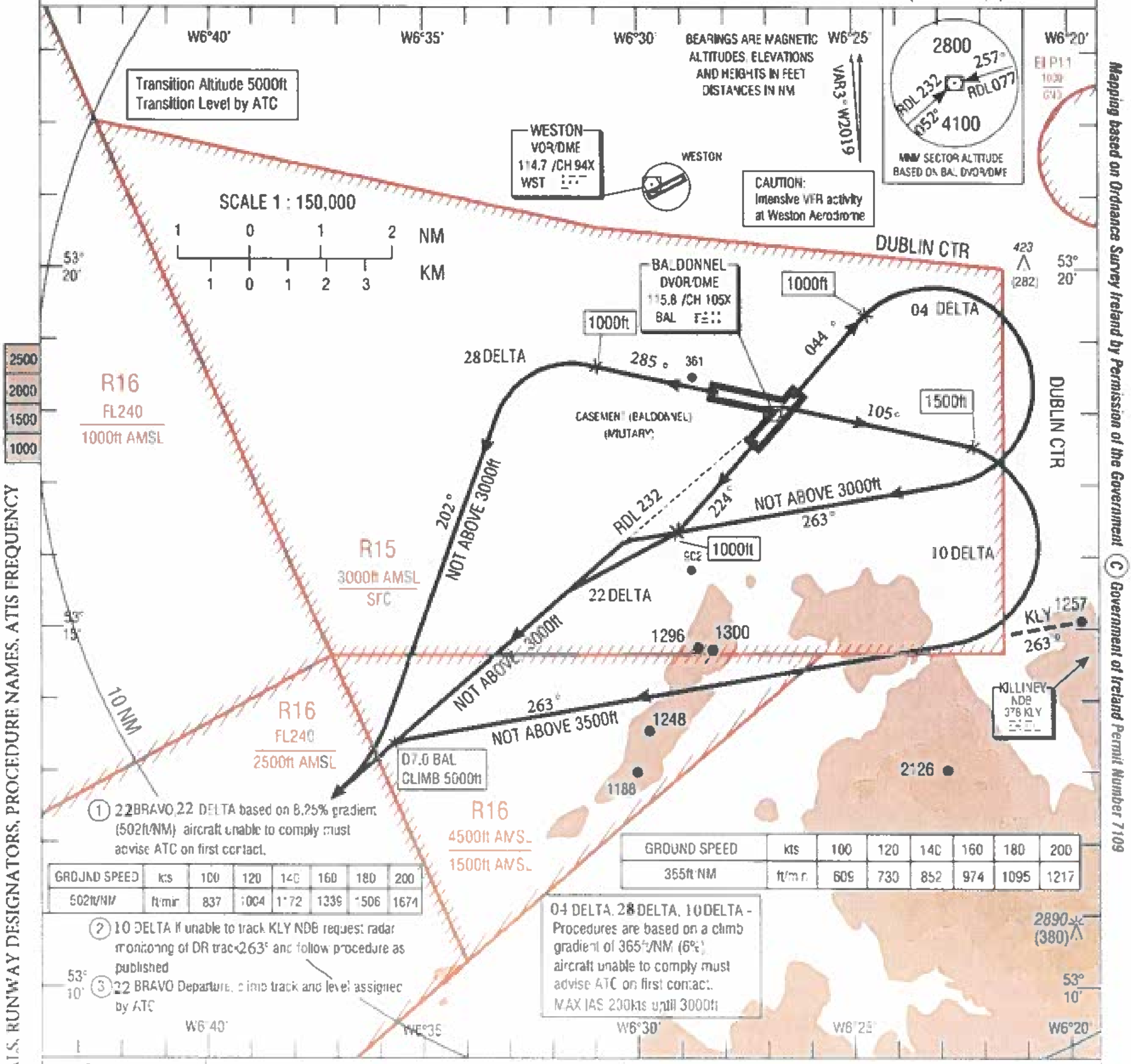
INSTRUMENT DEPARTURE CHART - ICAO	AERODROME ELEV 319 ft HEIGHTS RELATED TO AERODROME ELEVATION	TWR 123.500 BAL RADAR 122.000 ATIS 122.805	CONSULT NOTAM FOR LATEST INFORMATION	BALDONNEL/CASEMENT (MIL) DEPARTURES RWYs 28, 10, 22, 04 ①②③ (ACFT CAT A, B)



Departure	Routing	Climb Instruction
04 ALPHA	Climb on runway track, at 1000ft or D2.0 BAL DME, whichever is later, turn right inbound to BAL VOR, from BAL track RDL 232	Climb 3000ft Passing D7.0 BAL outbound on RDL 232 continue climb to 5000ft Maintain 6% climb gradient until 2800ft
28 ALPHA	Climb on runway track, at 1000ft turn left to track 202° to intercept RDL 232 BAL outbound	Climb 3000ft Passing D7.0 BAL outbound on RDL 232 continue climb to 5000ft Maintain 6% climb gradient until 2800ft
10 ALPHA	Climb on runway track, at 1300ft turn right to track 263° to intercept RDL 232 BAL outbound	Climb 3000ft Passing D7.0 BAL outbound on RDL 232 continue climb to 5000ft Maintain 6% climb gradient until 2800ft
22 ALPHA	Climb on runway track, at 1000ft turn right to intercept RDL 232 BAL outbound	Climb 3000ft Passing D7.0 BAL outbound on RDL 232 continue climb to 5000ft Maintain 8.25% climb gradient until 2800ft
22 BRAVO	Climb on track 239°, at 1000ft turn right to track assigned by ATC	Climb to assigned level Maintain 8.25% climb gradient until initial assigned level

CHANGE: MAGVAR, TRACKS AND RADIALS, RUNWAY DESIGNATORS, PROCEDURE NAMES, ATIS FREQUENCY

INSTRUMENT DEPARTURE CHART - ICAO	AERODROME ELEV 319 ft HEIGHTS RELATED TO AERODROME ELEVATION	TWR 123.500 BAL RADAR 122.000 ATIS 122.805	CONSULT NOTAM FOR LATEST INFORMATION	BALDONNEL/CASEMENT (MIL) DEPARTURES RWYs 28, 10, 22, 04 ①②③ (ACFT CAT C, D)

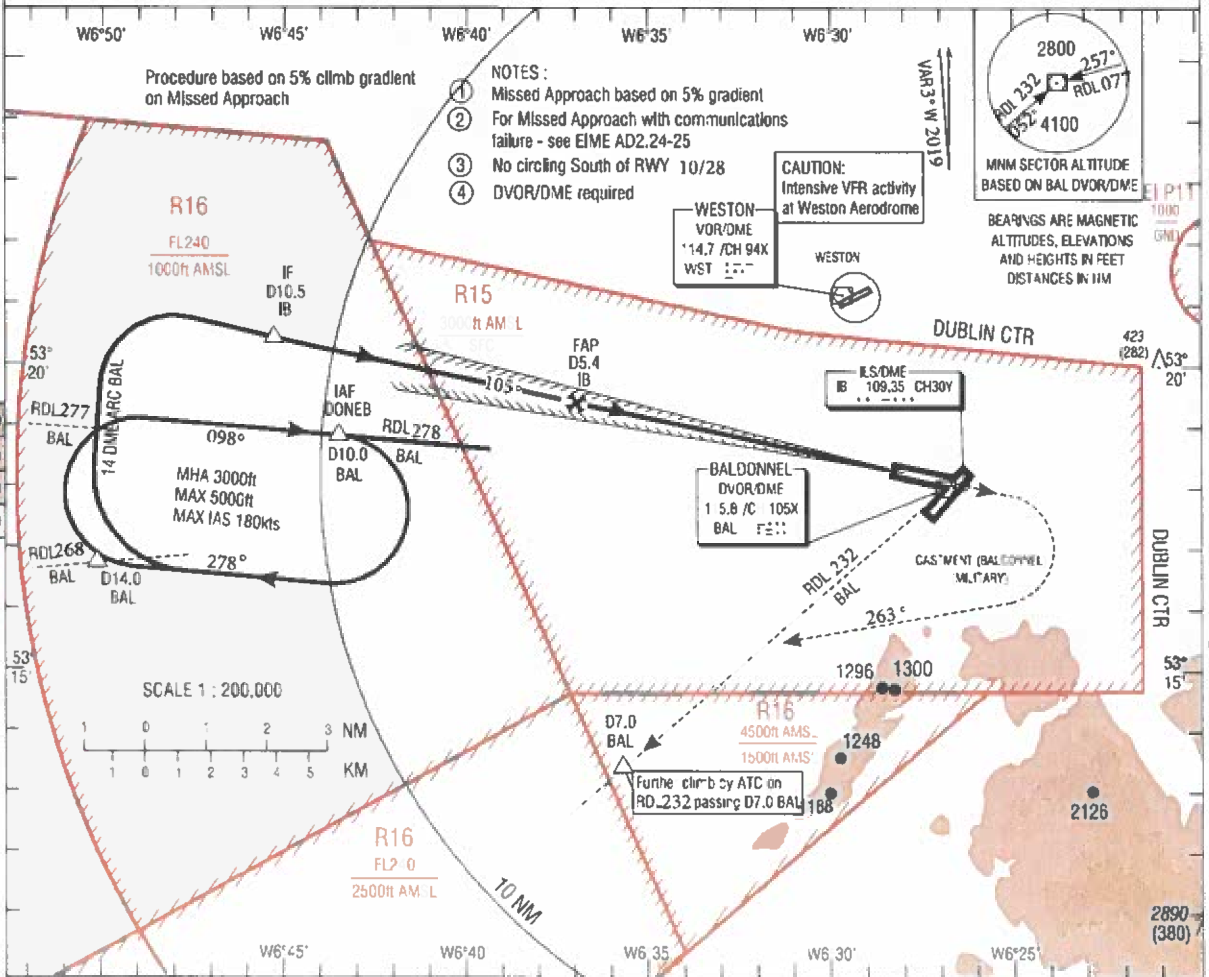


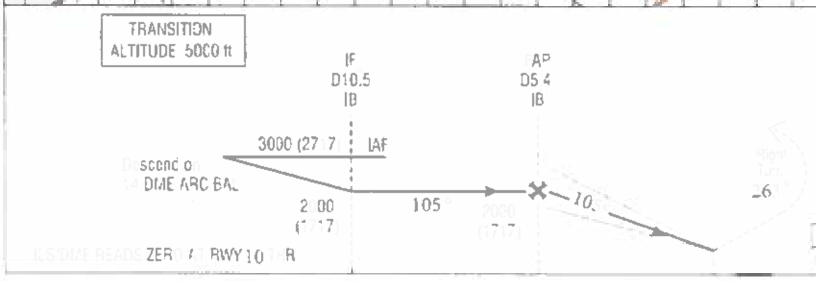
Departure	Routeing	Climb Instruction
04 DELTA	Climb on runway track, at 1000ft turn right TO TRACK 263° to intercept RDL 232 BAL outbound	Climb 3000ft Passing D7.0 BAL outbound on RDL 232 continue climb to 5000ft Maintain 6% climb gradient until 2600ft
28DELTA	Climb on runway track, at 1000ft turn left to track 202° to intercept RDL 232 BAL outbound	Climb 3000ft Passing D7.0 BAL outbound on RDL 232 continue climb to 5000ft Maintain 6% climb gradient until 2600ft
10 DELTA ②	Climb on runway track, at 1500ft turn right to intercept bearing263° from KLY to intercept RDL 232 BAL outbound	Climb 3500ft Passing D7.0 BAL outbound on RDL 232 continue climb to 5000ft Maintain 6% climb gradient until 3100ft
22 DELTA	Climb on runway track, at 1000ft turn right to intercept RDL 232BAL outbound	Climb 3000ft Passing D7.0 BAL outbound on RDL 232continue climb to 5000ft Maintain 8.25% climb gradient until 2800ft
22 BRAVO ③	Climb on track239°, at 1000ft turn right onto track assigned by ATC	Climb to assigned level Maintain 8.25% gradient until initial assigned level

Approved by GOC Air Corps

31 DEC 2020

INSTRUMENT APPROACH CHART - ICAO	AERODROME ELEV 319 ft HEIGHTS RELATED TO THR RWY 10 - ELEV 283 ft	TWR 123.500 BAL RADAR 122.000 ATIS 122.805	CONSULT NOTAM FOR LATEST INFORMATION	BALDONNEL/CASEMENT (MIL) ILS z RWY 10 ①②③④ (ACFT CAT A, B)





MISSED APPROACH:
Initial climb 3000ft
Climb on track 105° at 1300ft
ZERO DME IB whichever is later climbing
to 3000ft turn right onto track 263
to intercept BAL RDL 232. Contact ATC.
Maintain 5% climb gradient until 2800ft.

GROUND SPEED	kts	60	80	100	120	140	150
Rate of climb gradient 5%	ft/min	304	405	506	608	709	760

STRAIGHT IN LANDING RWY 10				
	OCA(H)	CEILING	RVR VIS	ALS OUT
A	436 (156)	200	800m	1200m
B	446 (163)	200	800m	1200m
OCAs based on 2.5% Missed Approach climb gradient				
A	870 (587)	600	1000m	1400m
B	960 (677)	700	1000m	1400m

LIGHTING	IDEAL ALTITUDE (HEIGHT) ON FINAL APPROACH						
PAPI 3° REIL RWY 11 SALS	NM	5.3	5.0	4.0	3.0	2.0	1.0
	ALT (HT)	2000 (1717)	1880 (1597)	1560 (1277)	1240 (957)	920 (637)	600 (317)

GROUND SPEED	kts	60	80	100	120	140	150
Rate of descent gradient 3°	ft/min	318	424	530	636	742	795

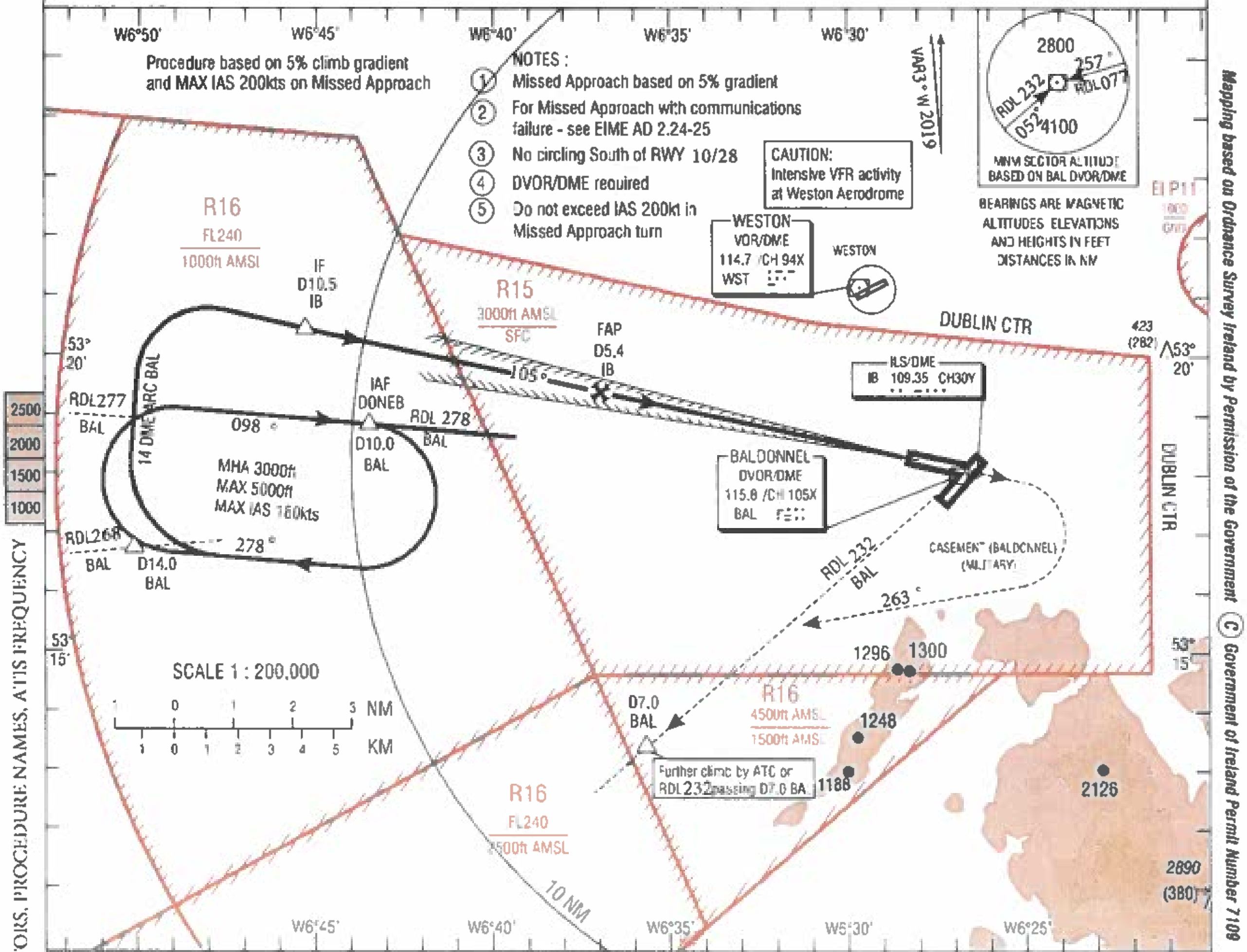
CIRCLE TO LAND (heights AAL)			
	OCA (H)	CEILING	VIS
A	720 (401)	500	2000m
B	820 (501)	600	2000m

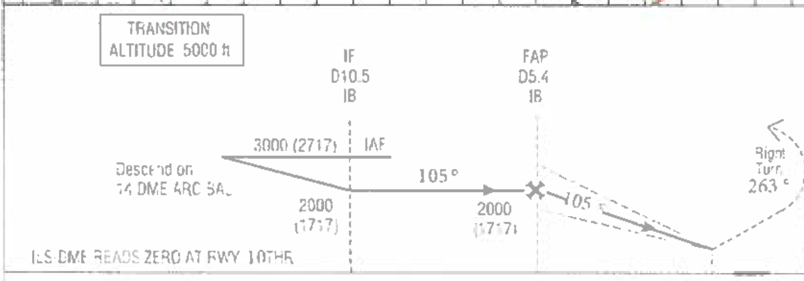
Rate of climb missed approach 2.5%							
GROUND SPEED	kts	60	80	100	120	140	150
Rate of climb gradient 2.5%	ft/min	152	203	254	304	355	380

CHANGE: MAG VAR, TRACKS AND RADIALS, RUNWAY DESIGNATORS, PROCEDURE NAMES, ATIS FREQUENCY

Approved by GOC Air Corps
31 DEC 2020

INSTRUMENT APPROACH CHART - ICAO	AERODROME ELEV 319 ft HEIGHTS RELATED TO THR RWY 10 - ELEV 283 ft	TWR 123.500 BAL RADAR 122.000 ATIS 122.805	CONSULT NOTAM FOR LATEST INFORMATION	BALDONNEL/CASEMENT (MIL) ILS y RWY 10 ①②③④⑤ (ACFT CAT C, D)





MISSED APPROACH:
Initial climb 3500ft
Climb on track 105°, at 2000ft, ZERO DME IB whichever is later, climbing to 3500ft turn right onto track 263° to intercept BAL RDL232. Contact ATC.
Maintain 5% climb gradient until 2800ft.
Do not exceed IAS 200kt in turn.
ELEV 283ft (THR RWY10)

GROUND SPEED	kts	100	120	140	160	180	200
Rate of climb gradient 5%	ft/min	506	608	709	811	912	1013

NM FROM THR RWY 10: 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 1 2 3 4

STRAIGHT IN LANDING RWY 10				
	OCA (H)	CEILING	RVR/VIS	ALS OUT
C	456 (173)	200	800m	1200m
D	467 (184)	200	800m	1200m
OCAs based on 2.5% Missed Approach climb gradient				
C	1030 (747)	800	4000m	4300m
D	1030 (747)	800	4400m	4500m

LIGHTING	IDEAL ALTITUDE (HEIGHT) ON FINAL APPROACH						
PAPI 3° RELS RWY Lts SALS	NM	5.3	5.0	4.0	3.0	2.0	1.0
	ALT (HT)	2000 (1717)	1880 (1597)	1560 (1277)	1240 (957)	920 (637)	600 (307)

GROUND SPEED	kts	100	120	140	160	180
Rate of descent gradient 3°	ft/min	530	636	743	849	955

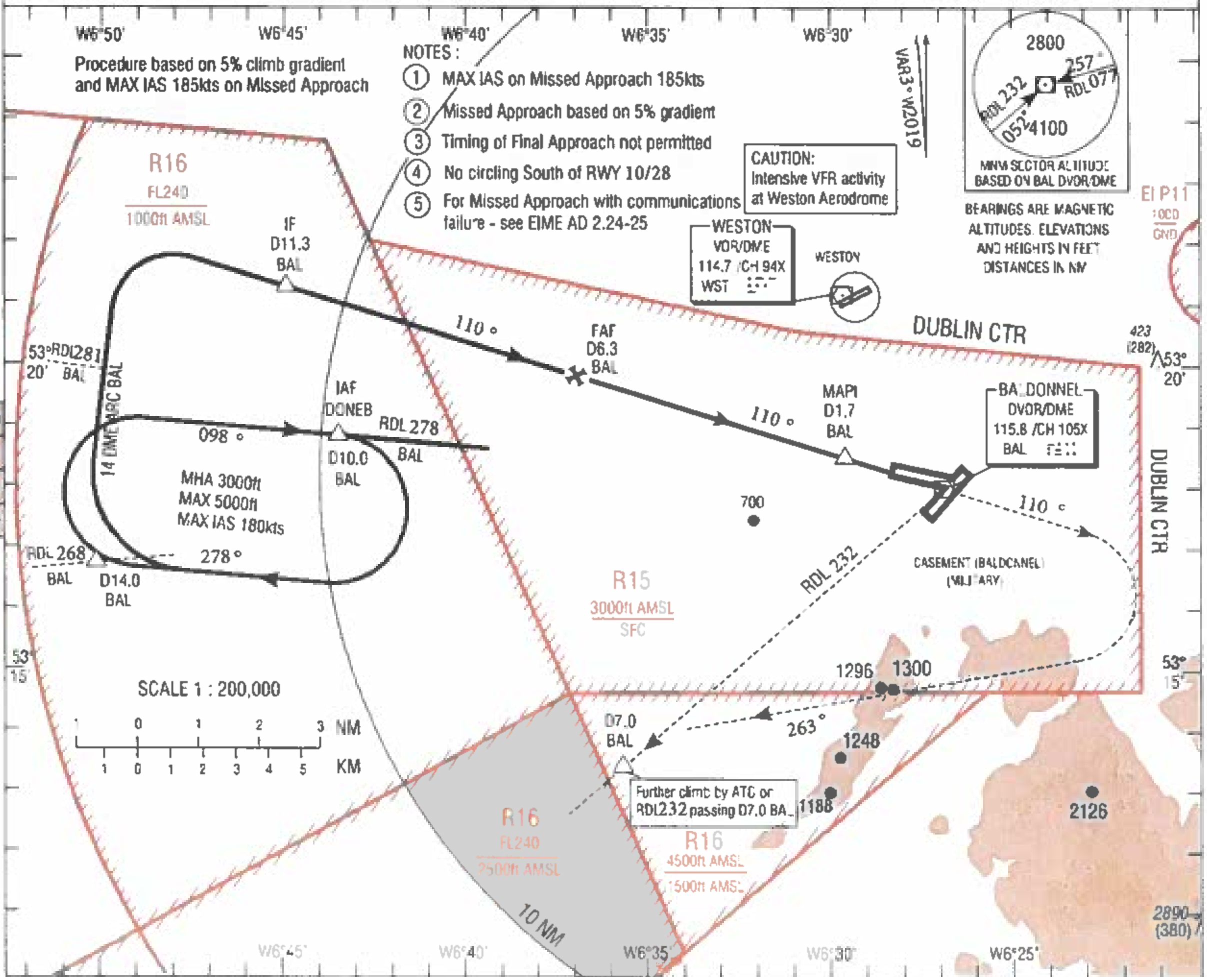
CIRCLE TO LAND (heights AAL)			
	OCA (H)	CEILING	VIS
C	910 (591)	600	2400m
D	1010 (691)	700	2800m

Rate of climb missed approach 2.5%							
GROUND SPEED	kts	100	120	140	160	180	200
Rate of climb gradient 2.5%	ft/min	254	304	355	406	456	507

CHANGE: MAGVAR, TRACKS AND RADIALS, RUNWAY DESIGNATORS, PROCEDURE NAMES, ATIS FREQUENCY

Approved by GOC Air Corps

INSTRUMENT APPROACH CHART - ICAO	AERODROME ELEV 319 ft HEIGHTS RELATED TO THR RWY 10 - ELEV 283ft	TWR 123.500 BAL RADAR 122.000 ATIS 122.805	CONSULT NOTAM FOR LATEST INFORMATION	BALDONNEL/CASEMENT (MIL) VOR/DME RWY 10 ①②③④⑤ (ACFT CAT A, B, C, D)



CHANGE: MAGVAR, TRACKS AND RADIALS, PROCEDURE NAME, ATIS FREQUENCY

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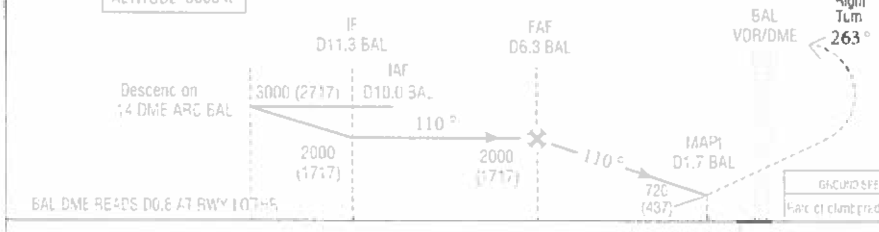
TRANSITION ALTITUDE 5000 ft



MISSED APPROACH:
Initial climb 3000ft
At D1.7 climb on track 110°, at 1500ft climbing to 3000ft turn right onto track 263° to intercept BAL RDL 232 Contact ATC.
Maintain 5% climb gradient until 2800ft.
Do not exceed IAS 185kts in turn.
ELEV 283ft (THR RWY 10)

GROUND SPEED	kts	60	80	100	120	140	160	180
Rate of climb gradient 5%	ft/min	304	405	506	608	709	810	911

NM FROM THR RWY 10: 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 1 2 3 4

	CAT	A	B	C	D
STRAIGHT IN LANDING RWY 10 OCA (H) 720 (437)	CEILING	500	500	500	500
	VIS	2000	2000	2400	2800
	ALS OUT	2400	2400	2800	3200
CIRCLE TO LAND (Heights AAL)	OCA (H)	720 (401)	820 (501)	910 (591)	1010 (691)
	CEILING	500	600	600	700
	VIS	2000	2000	2500	3600

LIGHTING
PAPI 3
REILS
RWY LTS
SALS

IDEAL ALTITUDE (HEIGHT) ON FINAL APPROACH

DME (BAL)	6.0	5.0	4.0	3.0	2.0
ALT (HT)	1910 (1627)	1610 (1327)	1300 (1017)	1000 (717)	700 (417)

GROUND SPEED	kts	60	80	100	120	140	160	180
Rate of descent gradient 5%	ft/min	304	405	506	608	709	810	911

OCAs based on 2.5% Missed Approach climb gradient

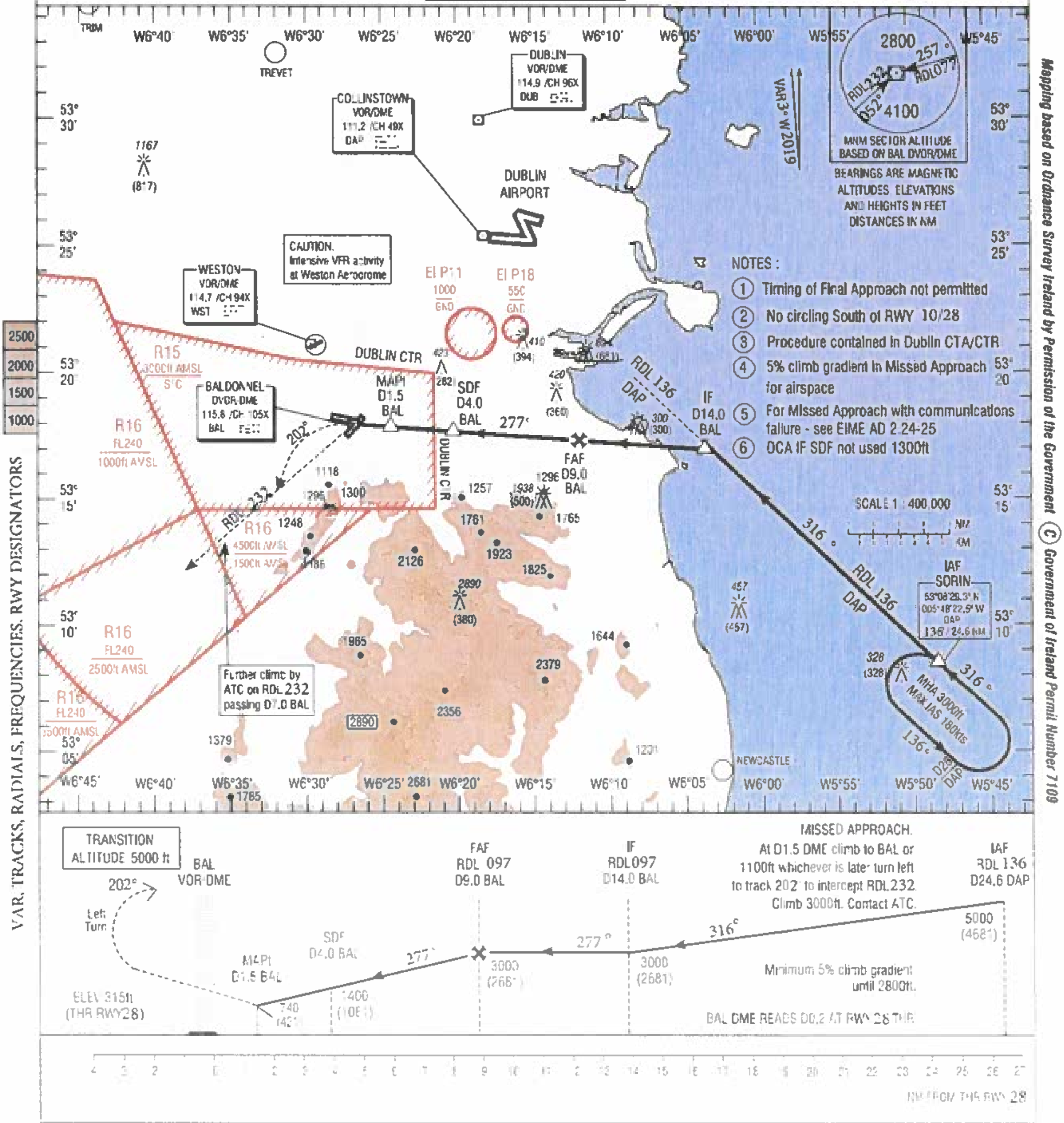
CAT	A	B	C	D
OCA	1000	1230	1400	1420

GROUND SPEED	kts	60	80	100	120	140	160	180
Rate of climb gradient 2.5%	ft/min	152	203	254	304	355	406	456

Approved by GOC Air Corps

31 DEC 2020

INSTRUMENT APPROACH CHART - ICAO	AERODROME ELEV 319 ft HEIGHTS RELATED TO AERODROME ELEVATION	TWR 123.500 BAL RADAR 122.000 ATIS 122.805 DUBLIN LOWER SOUTH 120.755 DUBLIN LOWER NORTH 132.580	CONSULT NOTAM FOR LATEST INFORMATION	BALDONNEL/CASEMENT (MIL) VOR/DME RWY 28 ① ② ③ ④ ⑤ ⑥ (ACFT CAT A, B, C, D)



STRAIGHT IN LANDING RWY28 OCA (H) 740 (421)	CAT	A	B	C	D
	CEILING	500	500	500	600
	VIS	2000	2000	2400	2800
	ALS OUT	2400	2400	2800	3200
CIRCLE TO LAND (Heights AAL)	OCA (H)	740 (421)	820 (501)	910 (591)	1010 (691)
	CEILING	500	600	600	700
	VIS	2000	2000	2800	3600

IDEAL ALTITUDE (HEIGHT) ON FINAL APPROACH

DME (BAL)	9.0	8.0	7.0	6.0	5.0	4.0	3.0	2.0
ALT (HT)	3000 (2681)	2710 (2391)	2410 (2091)	2120 (1801)	1820 (1501)	1530 (1211)	1230 (911)	950 ([illegible])

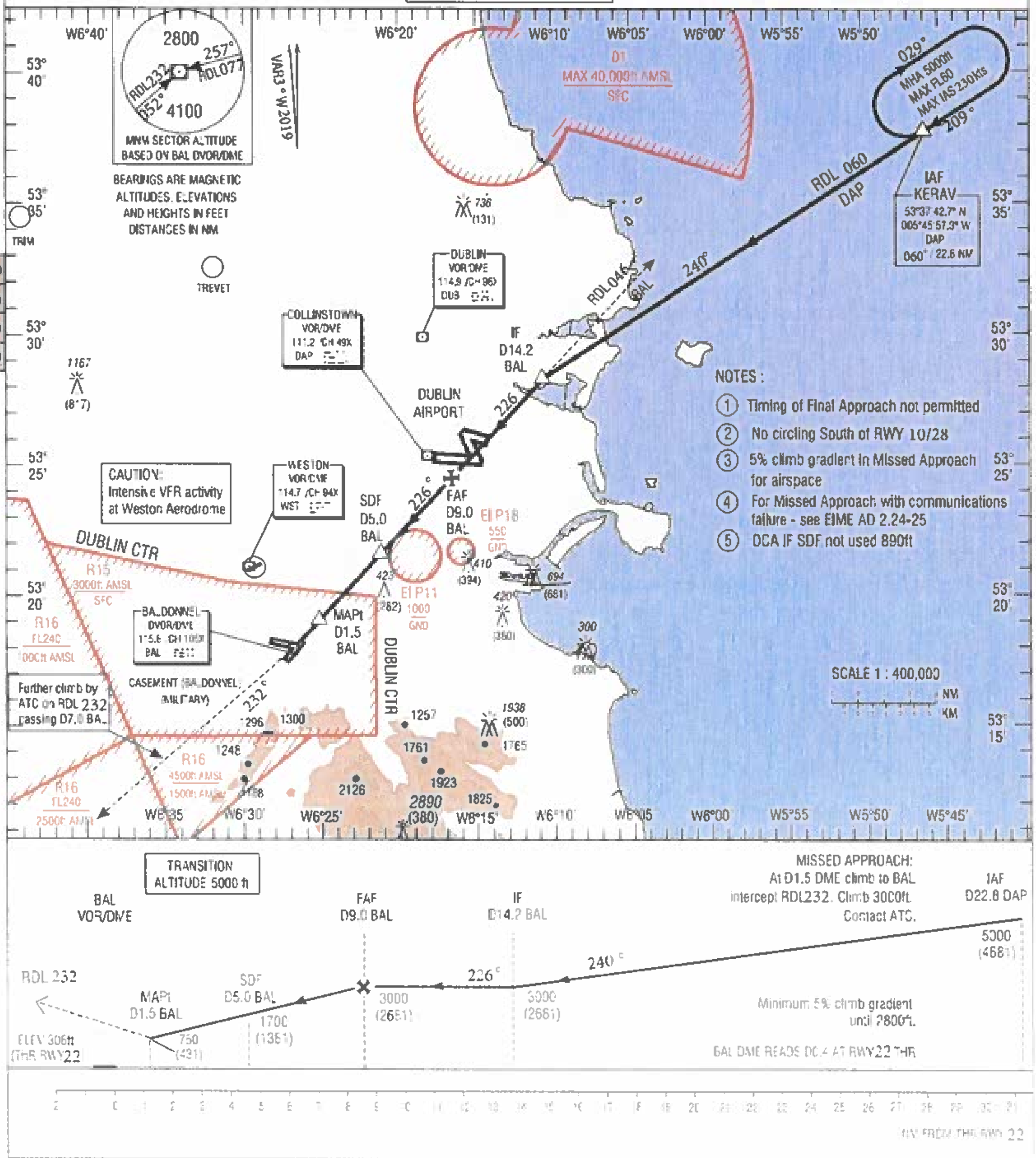
GROUND SPEED	kts	60	80	100	120	140	160	180
Rate of descent gradient 4.68%	ft min	297	395	494	593	692	791	890

LIGHTING
PAPI 3°
REIL
RWY LTs
SALS

Approved by GOC Air Corps

31 DEC 2020

INSTRUMENT APPROACH CHART - ICAO	AERODROME ELEV 319 ft HEIGHTS RELATED TO AERODROME ELEVATION	TWR 123.500 BAL RADAR 122.000 ATIS 122.805 DUBLIN LOWER SOUTH 120.755 DUBLIN LOWER NORTH 132.580	CONSULT NOTAM FOR LATEST INFORMATION	BALDONNEL/CASEMENT (MIL) VOR/DME RWY 22 ① ② ③ ④ ⑤ (ACFT CAT A, B, C, D)



		A	B	C	D
STRAIGHT IN LANDING RWY 22 OCA (H) 750 (431)	CEILING	500	500	500	500
	VIS	2000	2000	2400	2800
	ALS OUT	2400	2400	2800	3200
CIRCLE TO LAND (Heights AAL)	OCA (H)	750 (431)	820 (501)	910 (591)	1010 (691)
	CEILING	500	600	600	700
	VIS	2000	2000	2800	3600

IDEAL ALTITUDE (HEIGHT) ON FINAL APPROACH

DME (BAL)	9.0	8.0	7.0	6.0	5.0	4.0	3.0	2.0
ALT (H)	3000 (2681)	2690 (23[illegible])	2390 (20[illegible])	2090 (1771)	1780 (1461)	1480 (1161)	1180 (861)	870 ([illegible])

LIGHTING
PAPI 3°
REIL
RWY LTs
SALS

GROUND SPEED	kts	60	80	100	120	140	160	180
Rate of descent gradient 5%	ft/min	304	405	506	608	709	810	9[illegible]

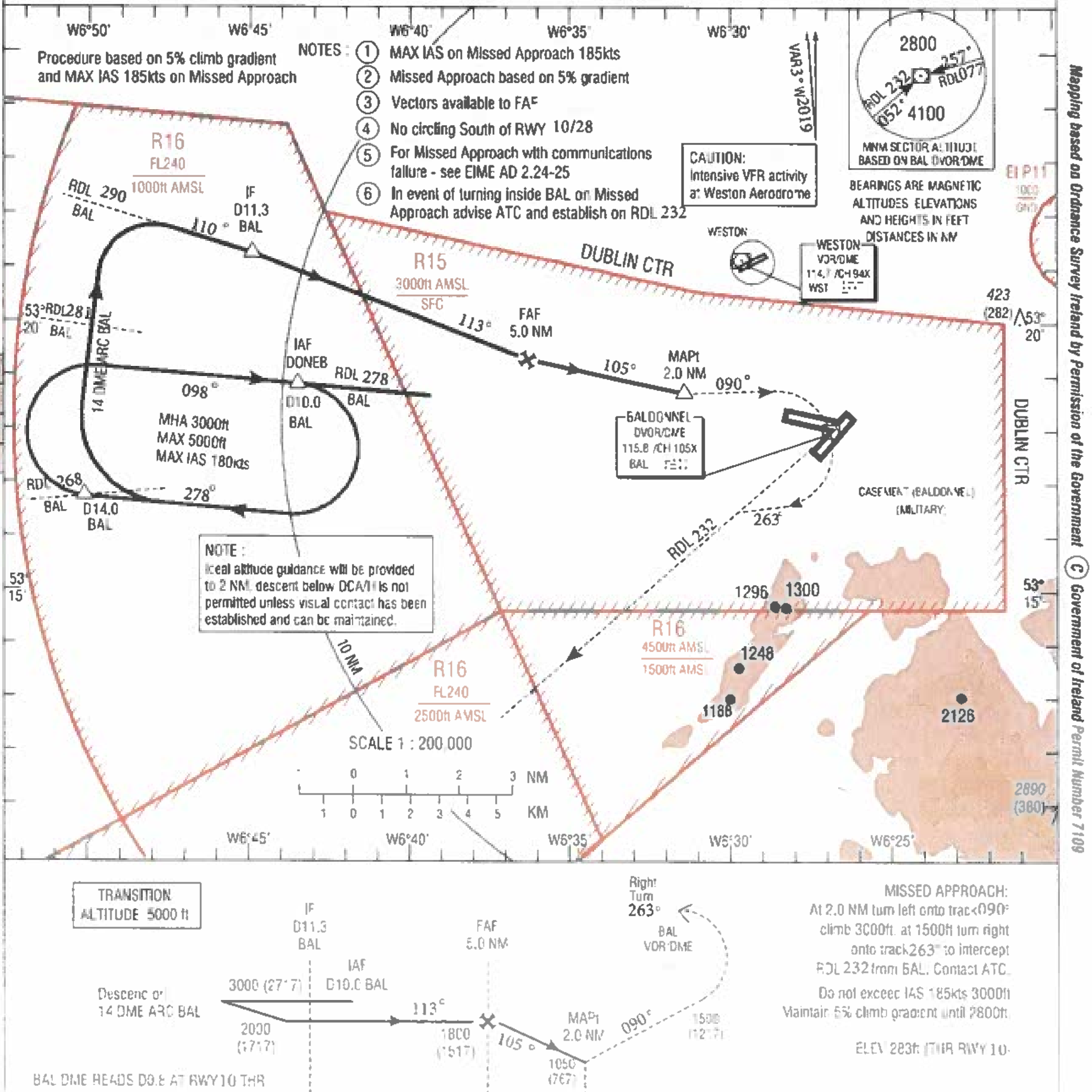
INSTRUMENT APPROACH CHART - ICAO

AERODROME ELEV 319 ft
HEIGHTS RELATED TO THR RWY 10 - ELEV 283ft

TWR BAL	123.500
RADAR	122.000
ATIS	122.805

CONSULT NOTAM FOR LATEST INFORMATION

BALDONNEL/CASEMENT (MIL)
SRA RWY 10 ① ② ③ ④ ⑤ ⑥
(ACFT CAT A, B, C)



	CAT	A	B	C
STRAIGHT IN LANDING RWY 10 OCA (H) 1050 (767)	CEILING	800	800	800
	VIS	2000	2000	3600
	ALS OUT	2400	2400	4000
CIRCLE TO LAND (Heights AAL)	OCA (H)	1050 (731)	1050 (731)	1050 (731)
	CEILING	800	800	800
	VIS	2000	2000	3600

OCAs based on 2.5% Missed Approach climb gradient

CAT	A	B	C
OCA	1130	1280	1460

LIGHTING
PAPI 3°
REIL
RWY LTs
SALS

IDEAL ALTITUDE (HEIGHT) ON FINAL APPROACH

Distance (NM)[1]	5.0	4.0	3.0	2.0
ALT (HT)	1800 (1517)	1500 (1217)	1200 (917)	935 ([illegible])

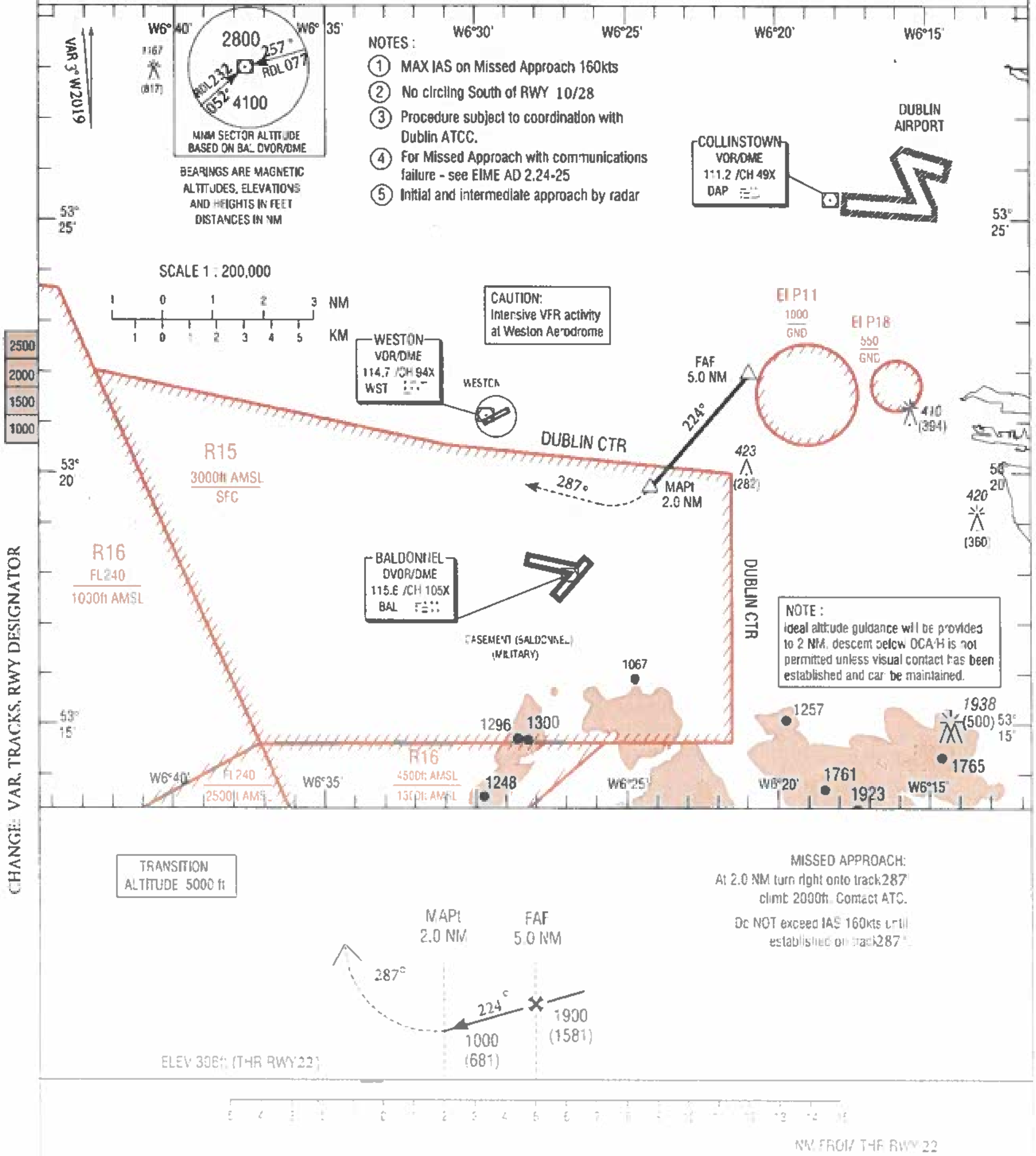
GROUND SPEED	kts	60	80	100	120	140	160	180
Rate of descent gradient 5%	ft/min	304	405	506	608	709	810	911

GROUND SPEED	kts	60	80	100	120	140	160	180
Rate of climb gradient 2.5%	ft/min	152	203	254	304	355	406	456

Approved by GOC Air Corps

31 DEC 2020

INSTRUMENT APPROACH CHART - ICAO	AERODROME ELEV 319 ft HEIGHTS RELATED TO AERODROME ELEVATION	TWR 123.500 BAL RADAR 122.000 ATIS 122.805	CONSULT NOTAM FOR LATEST INFORMATION	BALDONNEL/CASEMENT (MIL) SRA RWY 22 ① ② ③ ④ ⑤ (ACFT CAT A, B, C)



CHANGE: VAR, TRACKS, RWY DESIGNATOR

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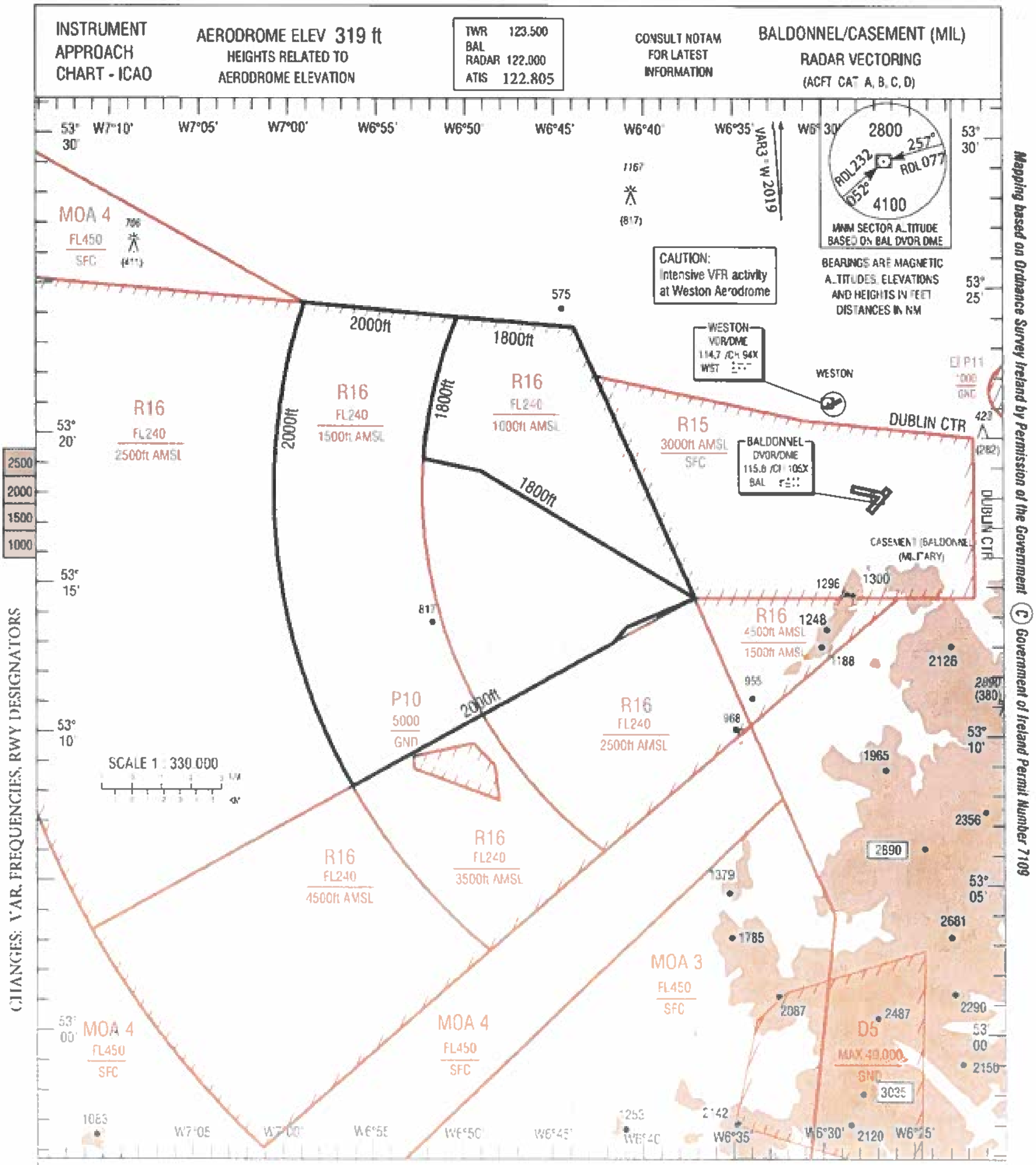
	CAT	A	B	C
STRAIGHT IN LANDING RWY 22 OCA (H) 1000 (681)	CEILING	700	700	700
	VIS	2000	2000	3600
	ALS OUT	2400	2400	4000
CIRCLE TO LAND (Heights AAL)	OCA (H)	1000 (681)	1000 (681)	1000 (681)
	CEILING	700	700	700
	VIS	2000	2000	3600

LIGHTING	IDEAL ALTITUDE (HEIGHT) ON FINAL APPROACH								
PAPI 3° REIL RWY LTs SALS	Distance (NM)		5.0		4.0		3.0		2.0
	ALT (FT)		1900 (1581)		1590 (1271)		1280 (961)		970 (651)
	GROUND SPEED	kts	60	80	100	120	140	160	180
	Rate of descent gradient 5%	ft/min	304	405	506	608	709	810	911

Approved by GOC Air Corps

31 DEC 2020



NOTES:

1. RADAR service normally available MON to FRI 0900 - 1630 (1)
2. Vectors available to establish on Final Approach for all instrument procedures
3. SRAs to RWY 10 and RWY 22 on request

Approved by GOC Air Corps

31 DEC 2020

IRISH AIR CORPS

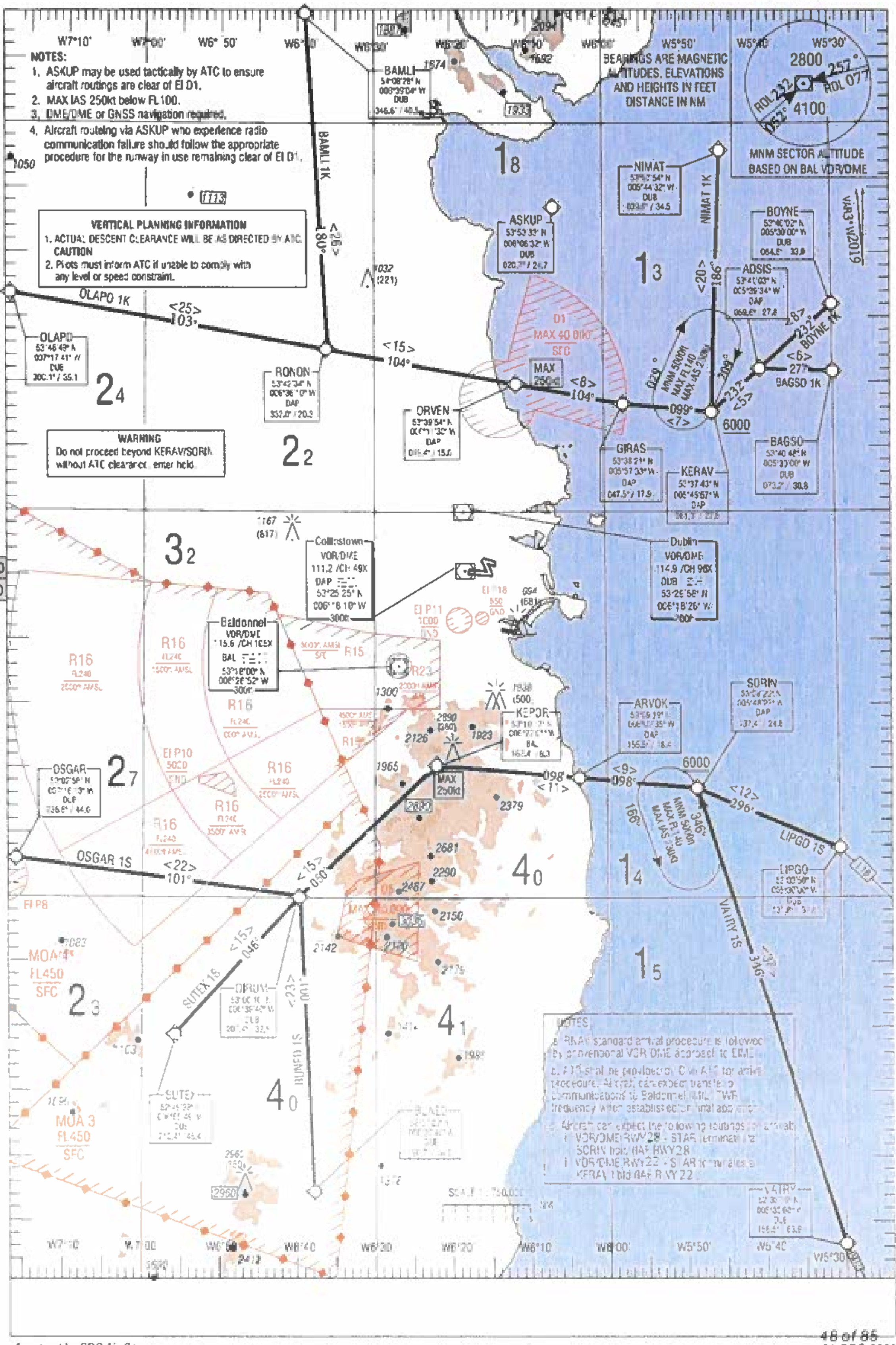
RNAV STANDARD ARRIVAL CHART INSTRUMENT (STAR) - ICAO

TRANS ALT 5000ft
TRANS LEVEL by ATC

TWR	123.500
BAL RADAR	122.000
ATIS	122.805
DUBLIN LOWER SOUTH	120.755
DUBLIN LOWER NORTH	132.580

BALDONNEL/CASEMENT (MIL)
RWY 22/28

NIMAT 1K, BOYNE 1K, BAGSO 1K, LIPGO 1S, VATRY 1S, RUNFI 1S, SUTEX 1S, OSGAR 1S, OLAPO 1K, BAMLI 1K.



ELEVATION PROFILE BETWEEN PROPOSED DEVELOPMENT AND DUBLIN AIRPORT ATCT OLD TOWER

High Point

Dublin Airport ATCT old tower

Proposed Development

ELEVATION PROFILE BETWEEN PROPOSED DEVELOPMENT AND DUBLIN AIRPORT ATCT NEW TOWER

High Point

Dublin Airport ATCT New tower

Proposed Development

FORGESOLAR GLARE ANALYSIS

Project: **Lidl Fortunestown Lane**
Site configuration: **LIDL Fortunestown Lane**

Client: Lidl Ireland GMBH

Created 18 Aug, 2022
Updated 29 Aug, 2022
Time-step 1 minute
Timezone offset UTC0
Site ID 74302.13111
Category 100 to 500 kW
DNI peaks at 1,000.0 W/m^2
Ocular transmission coefficient 0.5
Pupil diameter 0.002 m
Eye focal length 0.017 m
Sun subtended angle 9.3 mrad
Methodology V2

Summary of Results

Glare with low potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV array 1	4.0	80.0	16,093	268.2	0	0.0	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
FP 01 Casement	0	0.0	0	0.0
FP 02 Casement	0	0.0	0	0.0
FP 03 Casement	0	0.0	0	0.0
Fp 04 Casement	568	9.5	0	0.0
Fp 05 Weston	0	0.0	0	0.0
Fp 06 Weston	0	0.0	0	0.0
FP 07 Dublin	0	0.0	0	0.0
FP 08 Dublin	428	7.1	0	0.0
FP 09 Dublin	0	0.0	0	0.0
FP 10 Dublin	563	[illegible]	0	0.0
FP 11 Dublin	0	0.0	0	0.0
FP 12 Dublin	0	0.0	0	0.0
FP 13 Tallaght	3,584	59.7	0	0.0
FP 14 Tallaght	2,521	42.0	0	0.0
FP 15 Tallaght	1,020	17.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
FP 16 Tallaght	3,927	65.5	0	0.0
FP 17 Tallaght	0	0.0	0	0.0
FP 18 Tallaght	0	0.0	0	0.0
FP 19 Tallaght	2,466	41.1	0	0.0
FP 20 Tallaght	0	0.0	0	0.0
1-ATCT	453	7.5	0	0.0
2-ATCT	463	7.7	0	0.0
3-ATCT	0	0.0	0	0.0
4-ATCT	0	0.0	0	0.0

Component Data

PV Arrays

Name: PV array 1
Axis tracking: Fixed (no rotation)
Tilt: 4.0°
Orientation: 80.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.285925	-6.418237	117.00	6.98	123.98
2	53.285951	-6.417998	117.00	5.76	122.76
3	53.285492	-6.417864	117.00	5.76	122.76
4	53.285463	-6.418098	117.00	6.98	123.98

Flight Path Receptors

Name: FP 01 Casement
Description:
Threshold height: 15 m
Direction: 42.8°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.293640	-6.453752	97.98	15.24	113.22
Two-mile	53.272426	-6.486655	149.63	132.27	281.90

Name: FP 02 Casement
Description:
Threshold height: 15 m
Direction: 104.9°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.304690	-6.468754	86.14	15.24	101.38
Two-mile	53.312130	-6.515564	71.41	198.65	270.07

Name: FP 03 Casement
Description:
Threshold height: 15 m
Direction: 223.1°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.303472	-6.439537	93.10	15.24	108.34
Two-mile	53.324587	-6.406446	63.96	213.06	277.02

Name: Fp 04 Casement
Description:
Threshold height: 15 m
Direction: 282.3°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.301646	-6.444699	96.06	15.24	111.30
Two-mile	53.295492	-6.397371	106.16	173.82	279.98

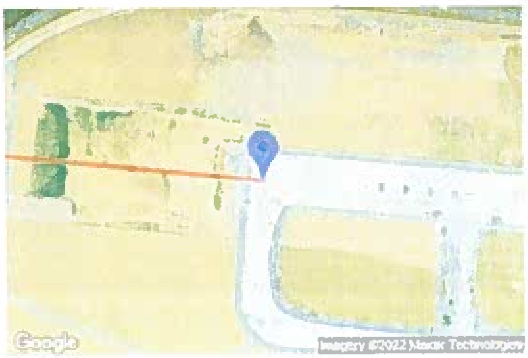
Name: Fp 05 Weston
Description:
Threshold height: 15 m
Direction: 244.1°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.354181	-6.482160	46.73	15.24	61.97
Two-mile	53.366805	-6.438530	28.64	202.02	230.66

Name: Fp 06 Weston
Description:
Threshold height: 15 m
Direction: 63.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.350448	-6.494423	47.63	15.24	62.87
Two-mile	53.337322	-6.537630	50.76	180.80	231.56

Name: FP 07 Dublin
Description
Threshold height: 15 m
Direction: 95.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.437361	-6.284594	72.91	15.24	88.15
Two-mile	53.440188	-6.332953	77.82	179.01	256.83

Name: FP 08 Dublin
Description:
Threshold height: 15 m
Direction: 275.3°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.434817	-6.238454	67.69	15.24	82.93
Two-mile	53.432166	-6.190069	31.98	219.63	251.61

Name: FP 09 Dublin
Description:
Threshold height: 15 m
Direction: 95.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.422436	-6.289965	74.08	15.24	89.32
Two-mile	53.424968	-6.338353	80.26	177.75	258.01

Name: FP 10 Dublin
Description:
Threshold height: 15 m
Direction: 275.3°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.420311	-6.251005	61.98	15.24	77.22
Two-mile	53.417625	-6.202643	41.28	204.53	245.81

Name: FP 11 Dublin
Description:
Threshold height: 15 m
Direction: 339.8°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.420011	-6.249632	62.25	15.24	77.49
Two-mile	53.392882	-6.232836	51.17	195.01	246.17

Name: FP 12 Dublin
Description:
Threshold height: 15 m
Direction: 157.6°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.435682	-6.261042	66.05	15.24	81.29
Two-mile	53.462421	-6.279527	68.26	181.72	249.98

Name: FP 13 Tallaght
Description:
Threshold height: 15 m
Direction: 180.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.289506	-6.376775	103.74	15.24	118.98
Two-mile	53.318418	-6.376775	80.39	207.28	287.67

Name: FP 14 Tallaght
Description:
Threshold height: 15 m
Direction: 225.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.289508	-6.376776	103.74	15.24	118.98
Two-mile	53.309952	-6.342535	66.97	220.70	287.67

Name: FP 15 Tallaght
Description:
Threshold height: 15 m
Direction: 270.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.289507	-6.376774	103.74	15.24	118.98
Two-mile	53.289507	-6.328350	68.03	219.64	287.67

Name: FP 16 Tallaght
Description:
Threshold height: 15 m
Direction: 315.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: [illegible]

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.289506	-6.376778	103.74	15.24	118.98
Two-mile	53.269061	-6.342527	100.15	187.52	287.67

Name: FP 17 Tallaght
Description:
Threshold height: 15 m
Direction: 0.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.289504	-6.376775	103.75	15.24	118.99
Two-mile	53.260591	-6.376775	161.86	125.82	287.68

Name: FP 18 Tallaght
Description:
Threshold height: 15 m
Direction: 45.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.289505	-6.376774	103.75	15.24	118.99
Two-mile	53.269060	-6.411015	207.32	80.36	287.68

Name: FP 19 Tallaght
Description:
Threshold height: 15 m
Direction: 90.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.289506	-6.376778	103.74	15.24	118.98
Two-mile	53.289506	-6.425202	110.05	177.62	287.67

Name: FP 20 Tallaght
Description:
Threshold height: 15 m
Direction: 135.0°
Glide slope: 3.0°
Pilot view restricted? Yes
Vertical view: 30.0°
Azimuthal view: 50.0°

Point	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
Threshold	53.289506	-6.376778	103.74	15.24	118.98
Two-mile	53.309951	-6.411019	80.98	206.69	287.67

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
1-ATCT	1	53.429083	-6.264286	65.41	87.00
2-ATCT	2	53.428547	-6.262177	65.68	22.00
3-ATCT	3	53.355626	-6.489512	49.51	15.00
4-ATCT	4	53.305511	-6.441794	93.49	15.00

Map image of 1-ATCT

Map image of 2-ATCT

Map image of 3-ATCT

Map image of 4-ATCT

Glare Analysis Results

Summary of Results

Glare with low potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV array 1	4.0	80.0	16,093	268.2	0	0.0	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
FP 01 Casement	0	0.0	0	0.0
FP 02 Casement	0	0.0	0	0.0
FP 03 Casement	0	0.0	0	0.0
Fp 04 Casement	568	9.5	0	0.0
Fp 05 Weston	0	0.0	0	0.0
Fp 06 Weston	0	0.0	0	0.0
FP 07 Dublin	0	0.0	0	0.0
FP 08 Dublin	428	7.1	0	0.0
FP 09 Dublin	0	0.0	0	0.0
FP 10 Dublin	663	11.1	0	0.0
FP 11 Dublin	0	0.0	0	0.0
FP 12 Dublin	0	0.0	0	0.0
FP 13 Tallaght	3,584	59.7	0	0.0
FP 14 Tallaght	2,521	42.0	0	0.0
FP 15 Tallaght	1,020	17.0	0	0.0
FP 16 Tallaght	3,927	65.5	0	0.0
FP 17 Tallaght	0	0.0	0	0.0
FP 18 Tallaght	0	0.0	0	0.0
FP 19 Tallaght	2,466	41.1	0	0.0
FP 20 Tallaght	0	0.0	0	0.0
1-ATCT	453	7.5	0	0.0
2-ATCT	463	7.7	0	0.0
3-ATCT	0	0.0	0	0.0
4-ATCT	0	0.0	0	0.0

PV: PV array 1 low potential for temporary after-image

Receptor results ordered by category of glare

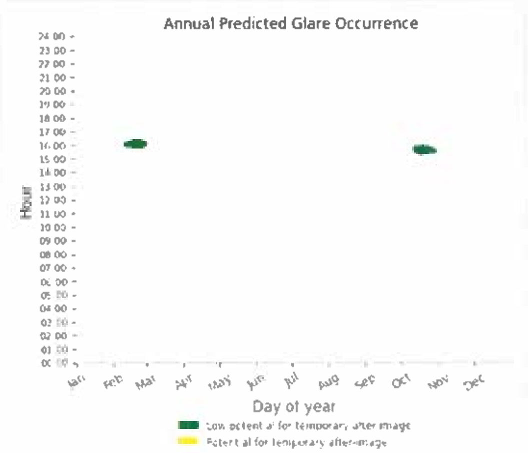
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Fp 04 Casement	568	9.5	0	0.0
FP 08 Dublin	428	7.1	0	0.0
FP 10 Dublin	663	11.1	0	0.0
FP 13 Tallaght	3,584	59.7	0	0.0
FP 14 Tallaght	2,521	42.0	0	0.0
FP 15 Tallaght	1,020	17.0	0	0.0
FP 16 Tallaght	3,927	65.5	0	0.0
FP 19 Tallaght	2,466	41.1	0	0.0
FP 01 Casement	0	0.0	0	0.0
FP 02 Casement	0	0.0	0	0.0
FP 03 Casement	0	0.0	0	0.0
Fp 05 Weston	0	0.0	0	0.0
Fp 06 Weston	0	0.0	0	0.0
FP 07 Dublin	0	0.0	0	0.0
FP 09 Dublin	0	0.0	0	0.0
FP 11 Dublin	0	0.0	0	0.0
FP 12 Dublin	0	0.0	0	0.0
FP 17 Tallaght	0	0.0	0	0.0
FP 18 Tallaght	0	0.0	0	0.0
FP 20 Tallaght	0	0.0	0	0.0
1-ATCT	453	7.5	0	0.0
2-ATCT	463	7.7	0	0.0
3-ATCT	0	0.0	0	0.0
4-ATCT	0	0.0	0	0.0

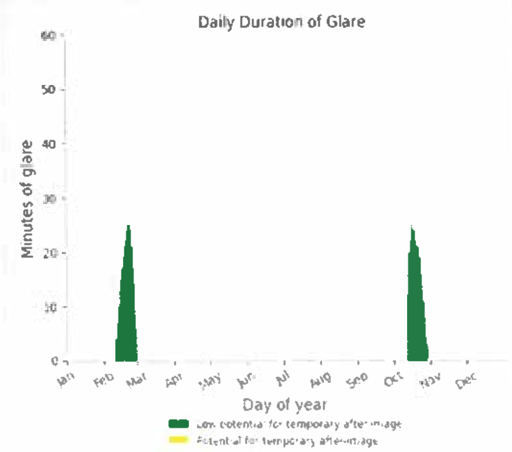
PV array 1 and Fp 04 Casement

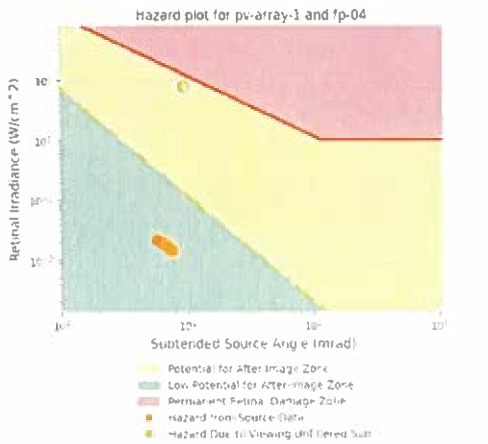
Receptor type: 2-mile Flight Path

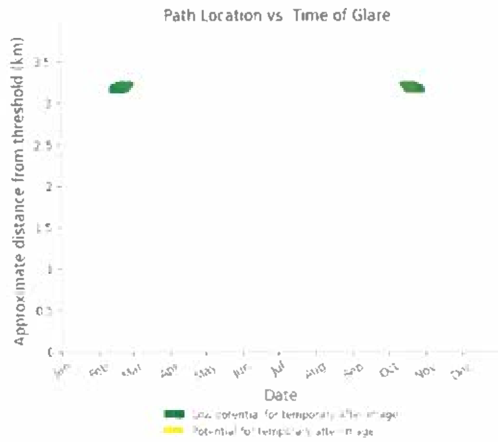
0 minutes of yellow glare

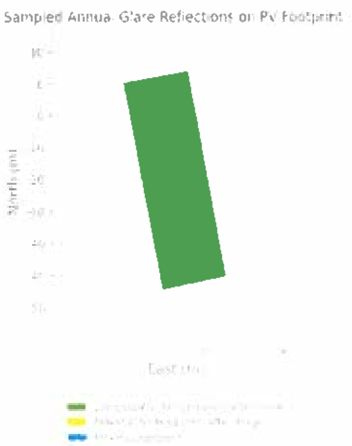
568 minutes of green glare

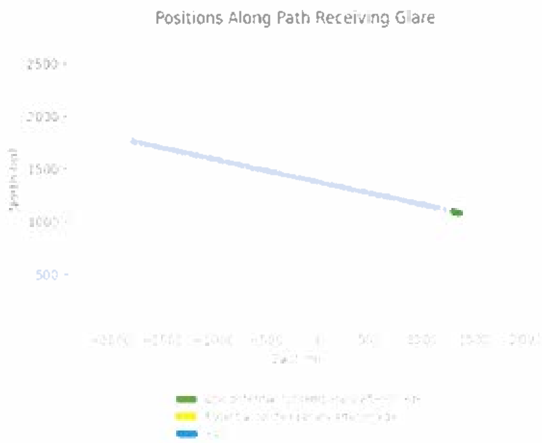










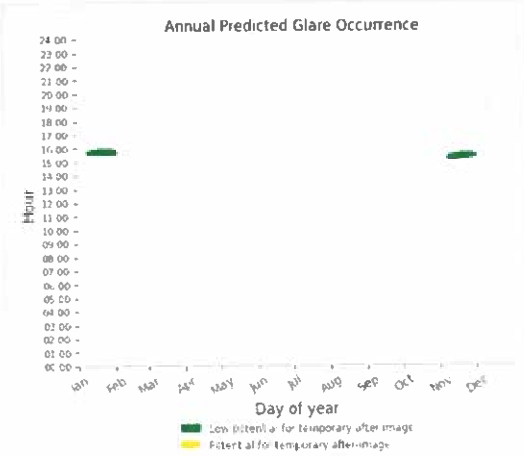


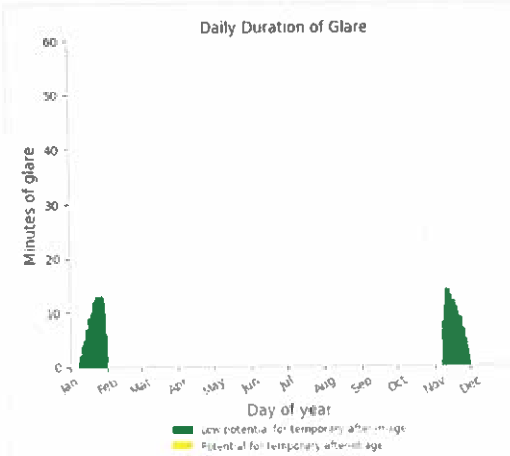
PV array 1 and FP 08 Dublin

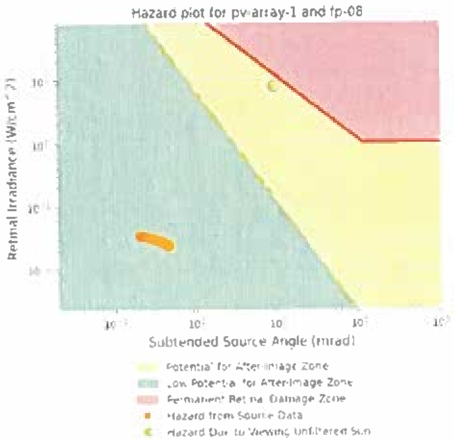
Receptor type: 2-mile Flight Path

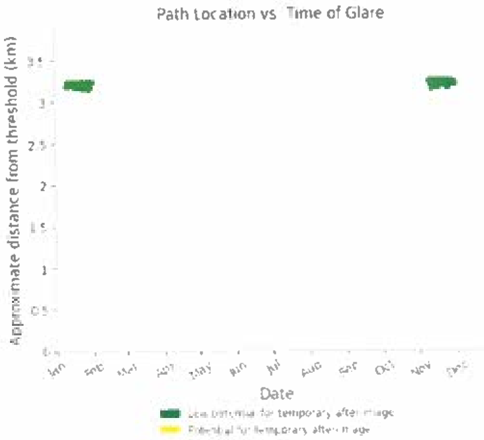
0 minutes of yellow glare

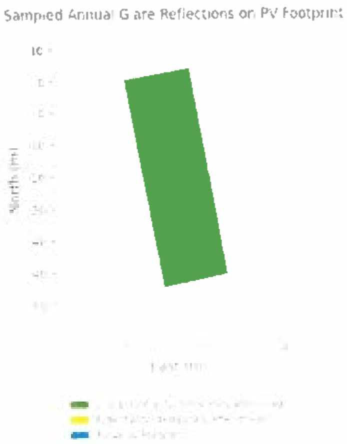
428 minutes of green glare

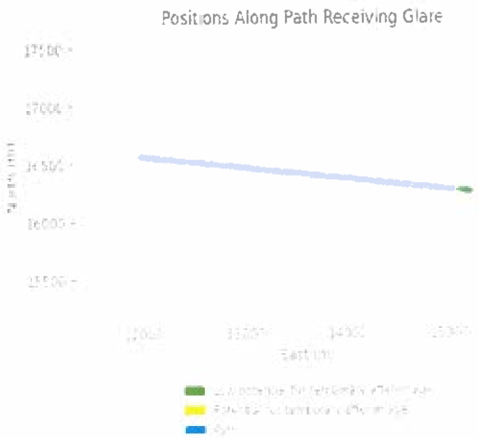






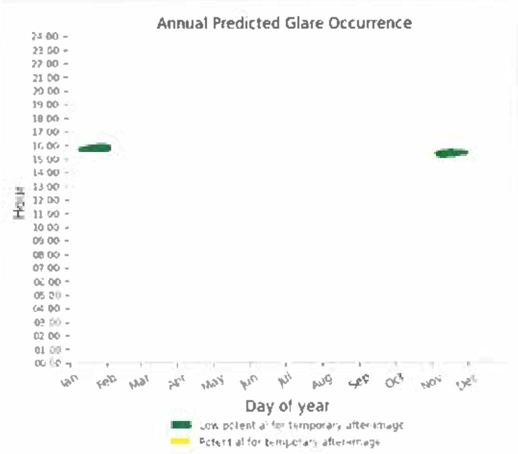


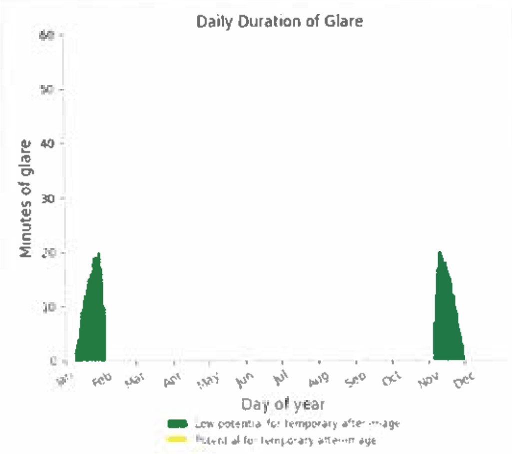


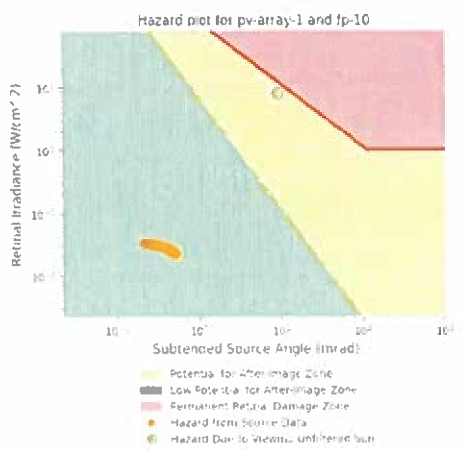


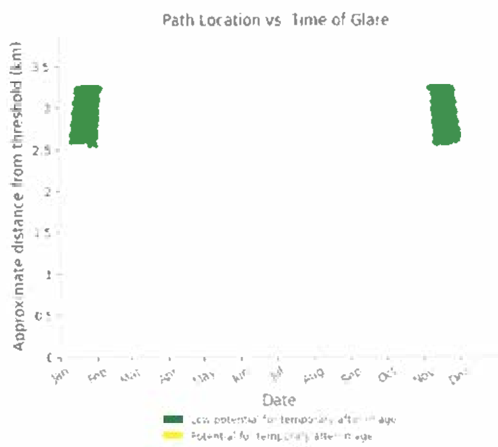
PV array 1 and FP 10 Dublin

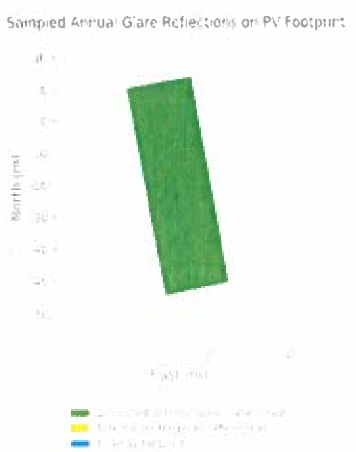
Receptor type: 2-mile Flight Path
0 minutes of yellow glare
663 minutes of green glare

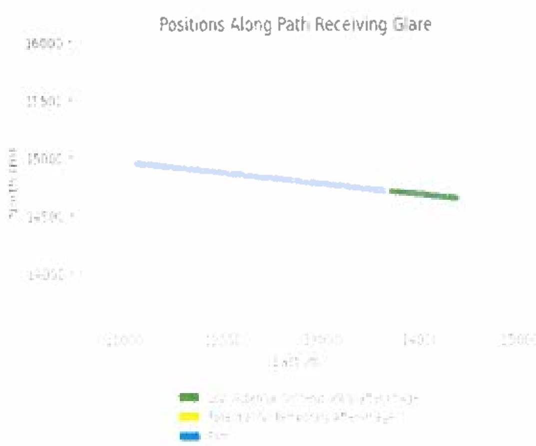










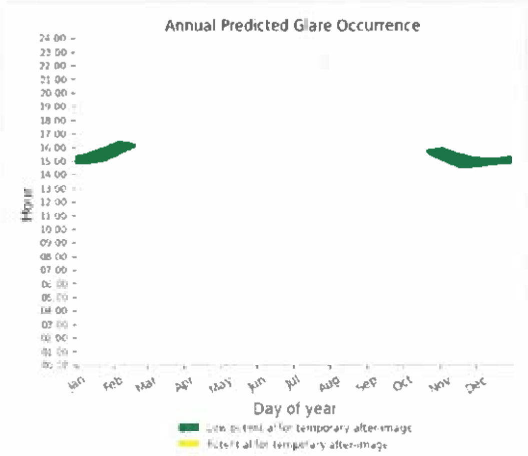


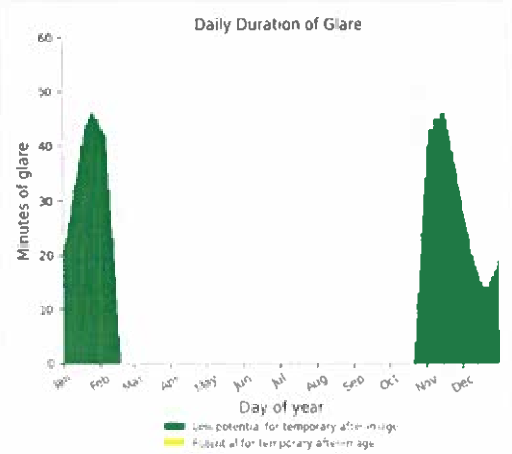
PV array 1 and FP 13 Tallaght

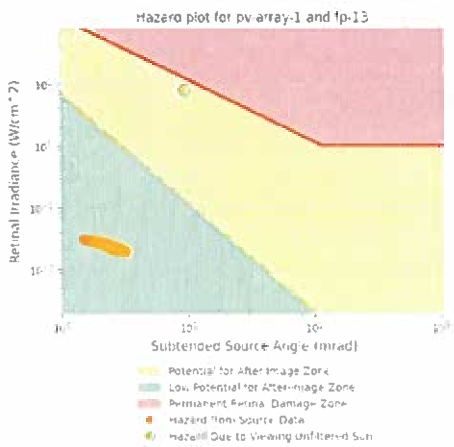
Receptor type: 2-mile Flight Path

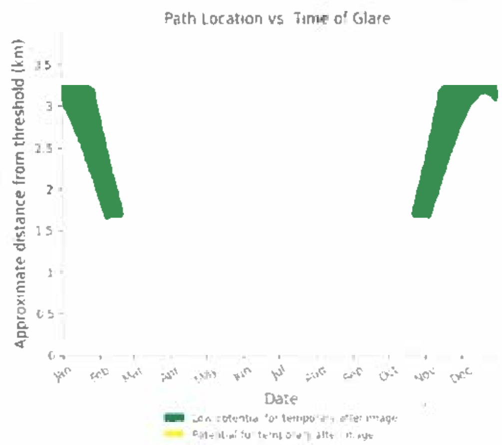
0 minutes of yellow glare

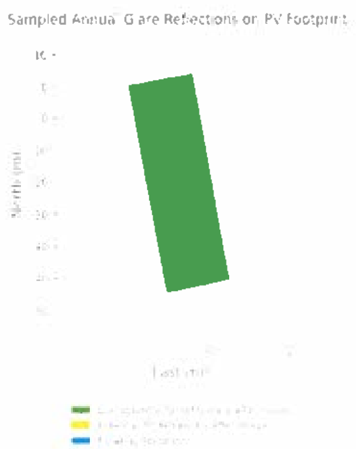
3,584 minutes of green glare

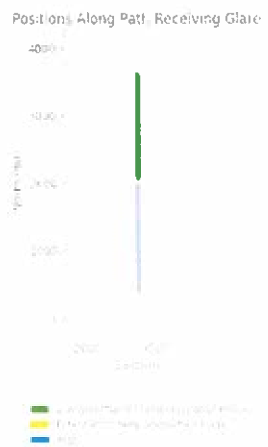










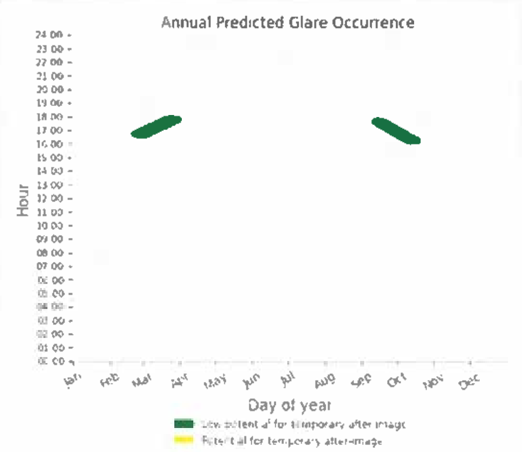


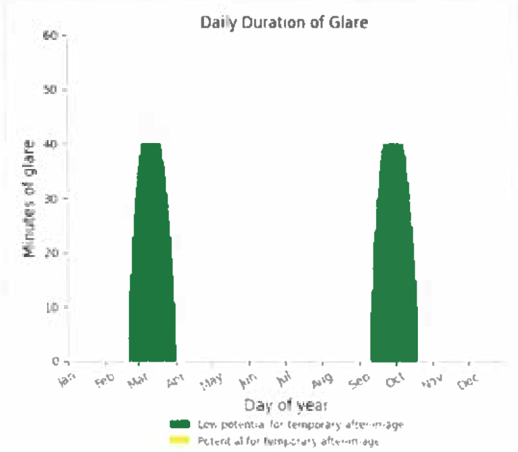
PV array 1 and FP 14 Tallaght

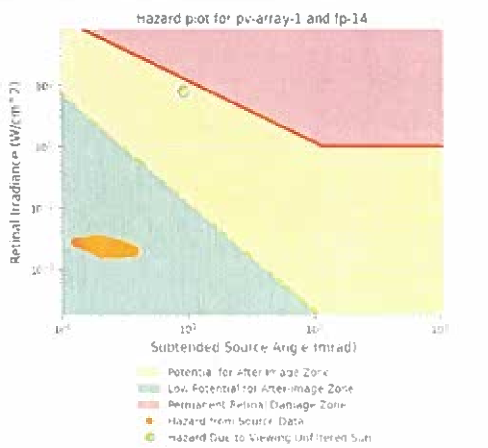
Receptor type: 2-mile Flight Path

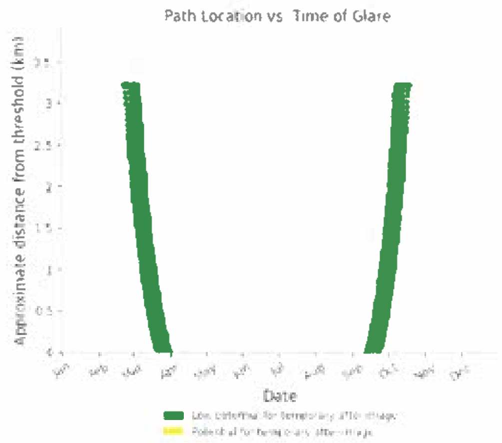
0 minutes of yellow glare

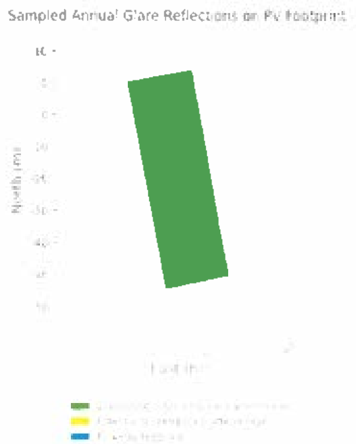
2,521 minutes of green glare

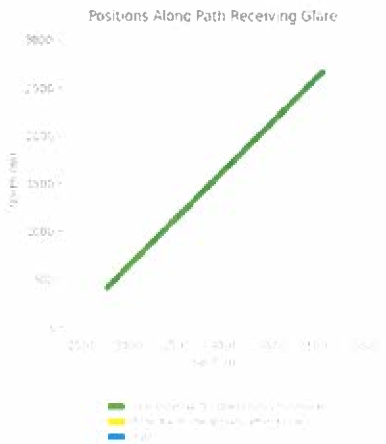






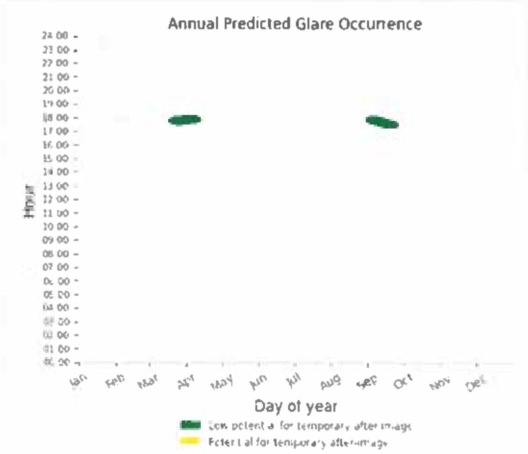


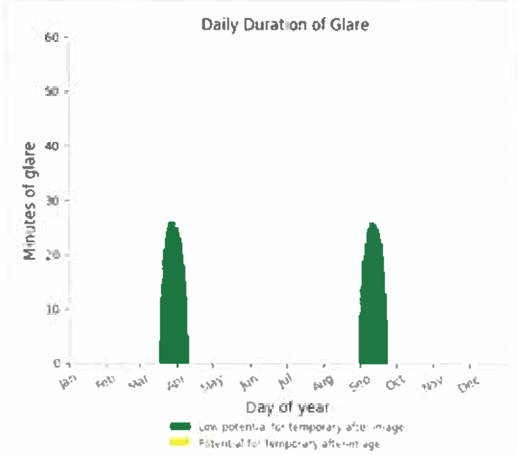


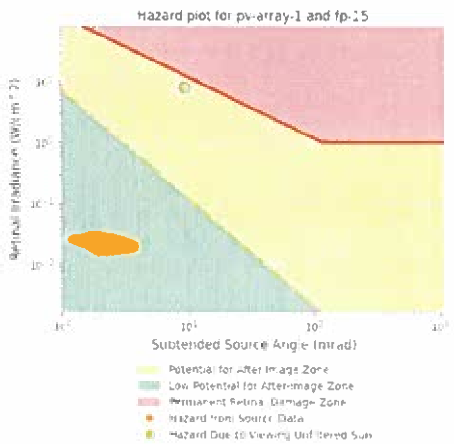


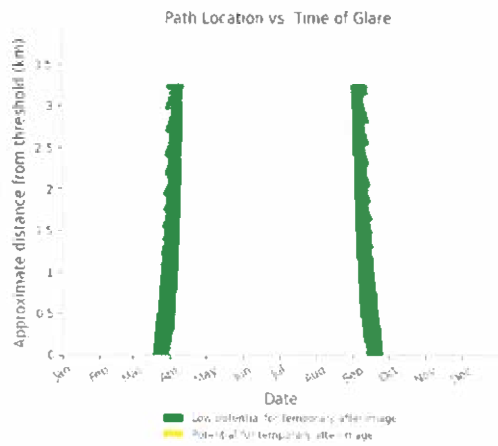
PV array 1 and FP 15 Tallaght

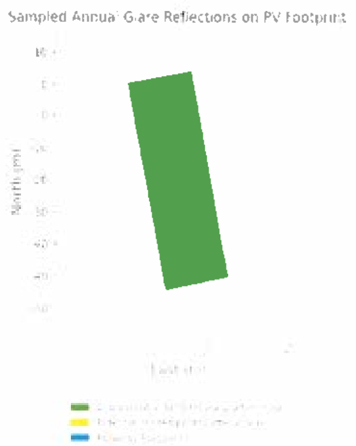
Receptor type: 2-mile Flight Path
0 minutes of yellow glare
1,020 minutes of green glare

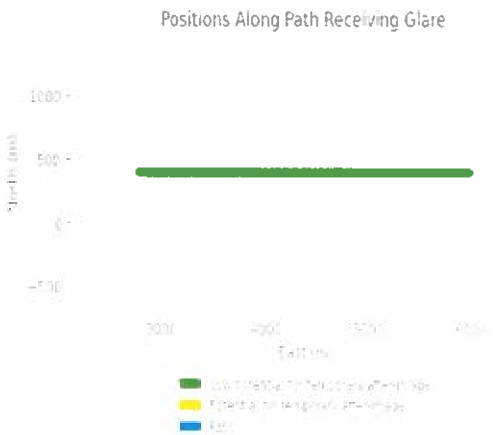










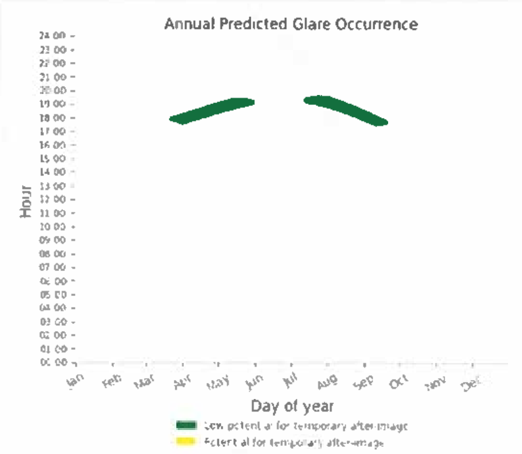


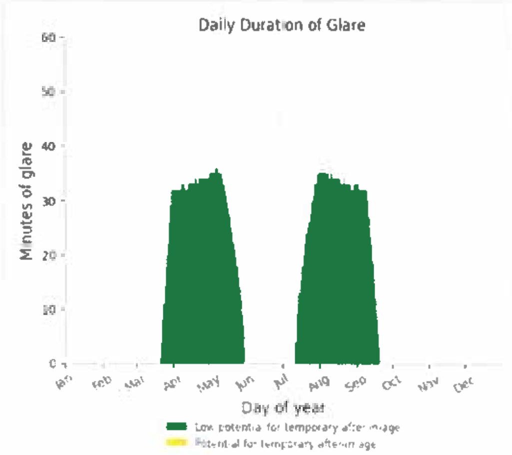
PV array 1 and FP 16 Tallaght

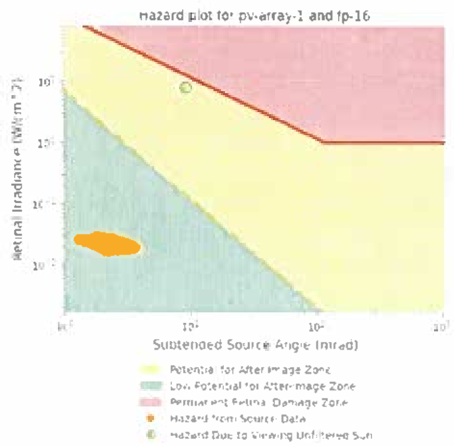
Receptor type: 2-mile Flight Path

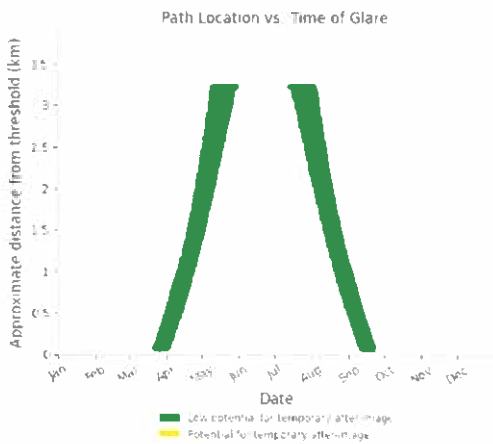
0 minutes of yellow glare

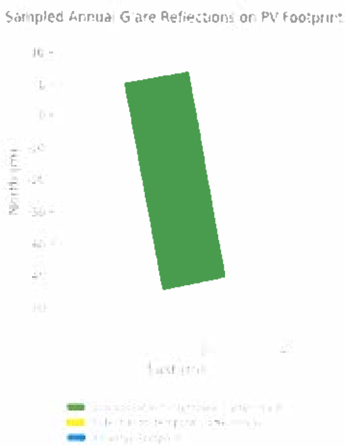
3,927 minutes of green glare

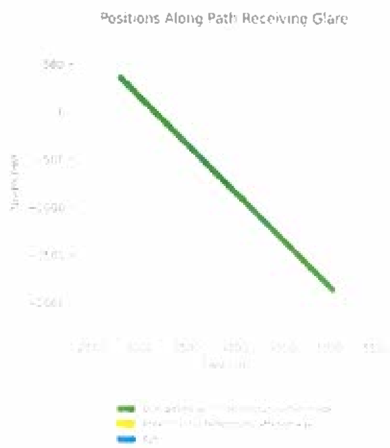






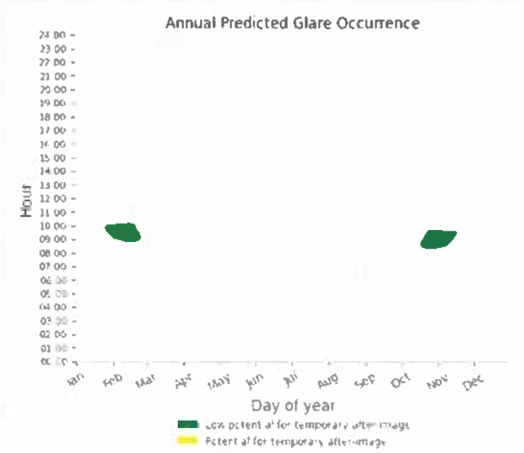


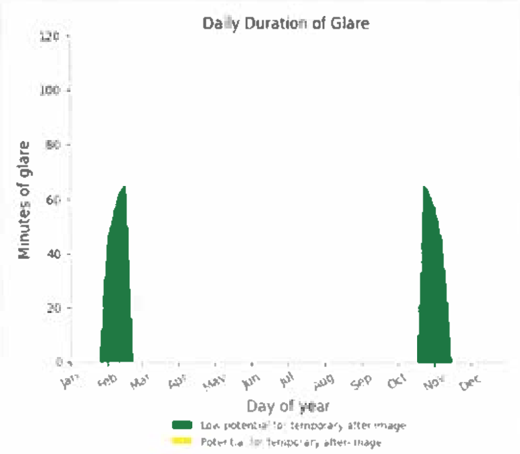


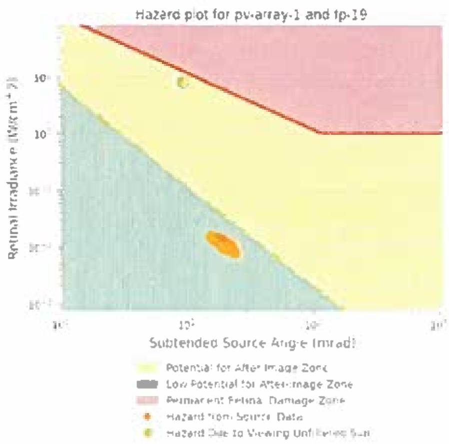


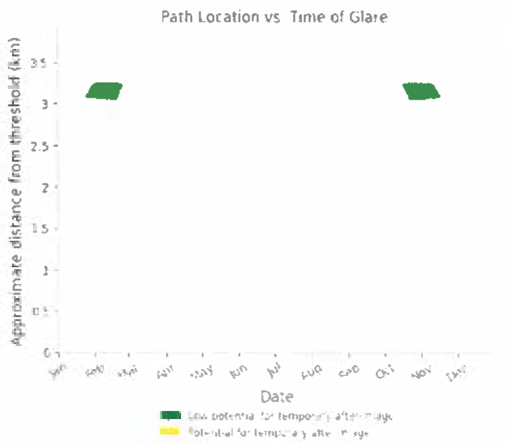
PV array 1 and FP 19 Tallaght

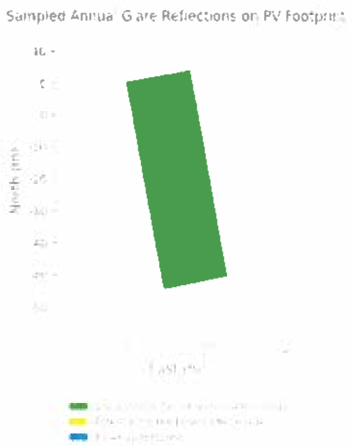
Receptor type: 2-mile Flight Path
0 minutes of yellow glare
2,466 minutes of green glare

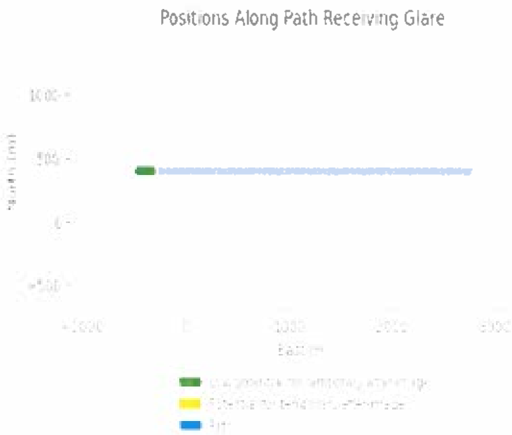












PV array 1 and FP 01 Casement

Receptor type: 2-mile Flight Path
No glare found

PV array 1 and FP 02 Casement

Receptor type: 2-mile Flight Path
No glare found

PV array 1 and FP 03 Casement

Receptor type: 2-mile Flight Path
No glare found

PV array 1 and Fp 05 Weston

Receptor type: 2-mile Flight Path
No glare found

PV array 1 and Fp 06 Weston

Receptor type: 2-mile Flight Path
No glare found

PV array 1 and FP 07 Dublin

Receptor type: 2-mile Flight Path
No glare found

PV array 1 and FP 09 Dublin

Receptor type: 2-mile Flight Path
No glare found

PV array 1 and FP 11 Dublin

Receptor type: 2-mile Flight Path
No glare found

PV array 1 and FP 12 Dublin

Receptor type: 2-mile Flight Path
No glare found

PV array 1 and FP 17 Tallaght

Receptor type: 2-mile Flight Path
No glare found

PV array 1 and FP 18 Tallaght

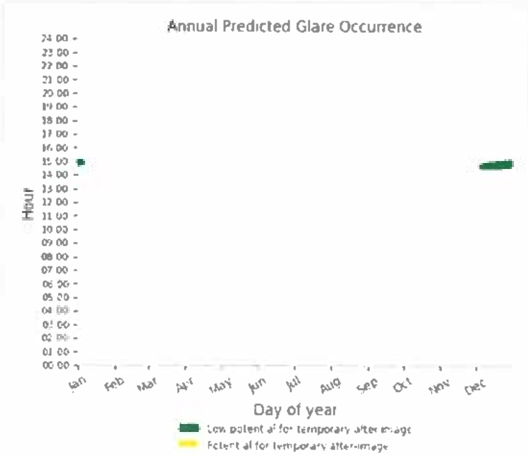
Receptor type: 2-mile Flight Path
No glare found

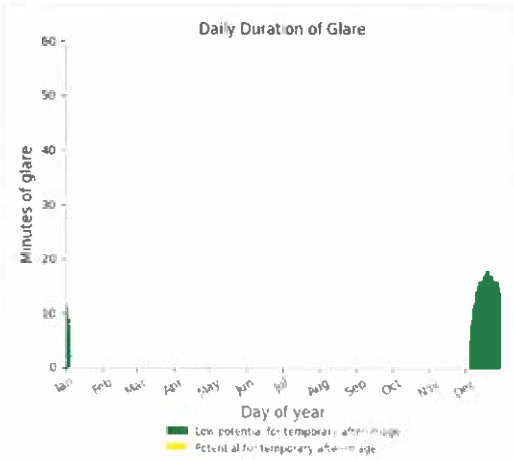
PV array 1 and FP 20 Tallaght

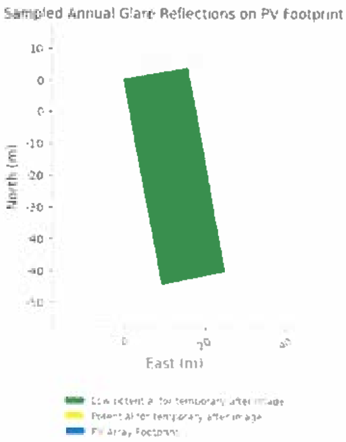
Receptor type: 2-mile Flight Path
No glare found

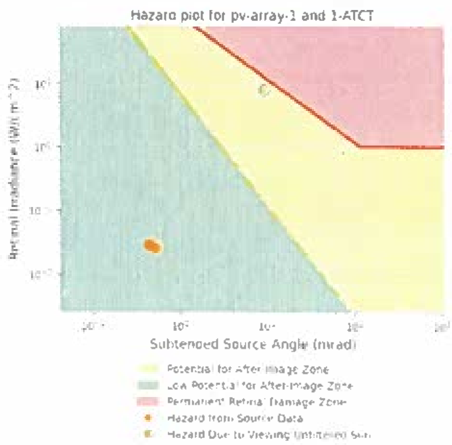
PV array 1 and 1-ATCT

Receptor type: Observation Point
0 minutes of yellow glare
453 minutes of green glare







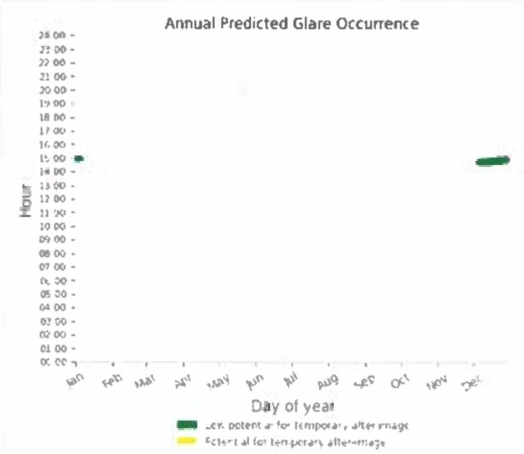


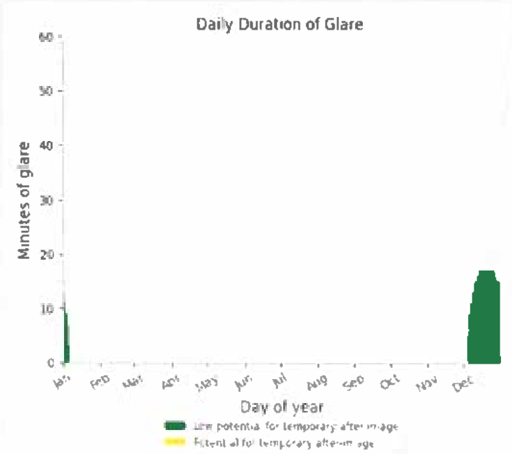
PV array 1 and 2-ATCT

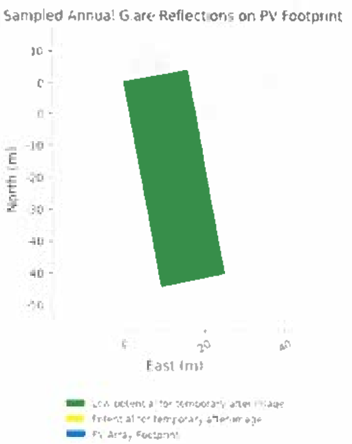
Receptor type: Observation Point

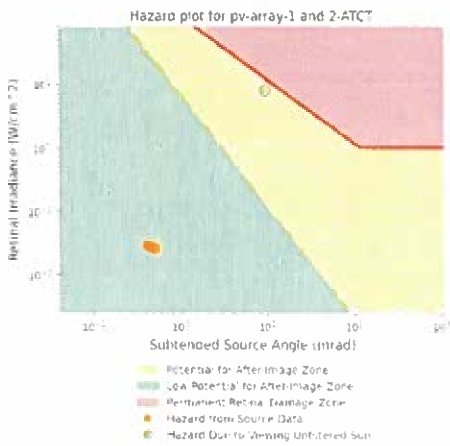
0 minutes of yellow glare

463 minutes of green glare









PV array 1 and 3-ATCT

Receptor type: Observation Point

No glare found

PV array 1 and 4-ATCT

Receptor type: Observation Point

No glare found

Assumptions

"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 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 modeling 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.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

FORGESOLAR GLARE ANALYSIS

Project: **Lidl Fortunestown Lane**
Site configuration: **LIDL Fortunestown Lane**

Client: Lidl Ireland GMBH

Created 18 Aug, 2022
Updated 29 Aug, 2022
Time-step 1 minute
Timezone offset UTC0
Site ID 74302.13111
DNI peaks at 1,000.0 W/m^2
Ocular transmission coefficient 0.5
Pupil diameter 0.002 m
Eye focal length 0.017 m
Sun subtended angle 9.3 mrad
Methodology V2

Glare Policy Adherence

The following table estimates the policy adherence of this glare analysis according to the 2021 U.S. Federal Aviation Administration Policy:

Review of Solar Energy System Projects on Federally-Obligated Airports

This policy may require the following criteria be met for solar energy systems on airport property:

- No glare of any kind for Air Traffic Control Tower(s) ("ATCT") at cab height.
- Default analysis and observer characteristics, including 1-minute time step.

ForgeSolar is not affiliated with the U.S. FAA and does not represent or speak officially for the U.S. FAA. ForgeSolar cannot approve or deny projects - results are informational only. Contact the relevant airport and FAA district office for information on policy and requirements.

COMPONENT	STATUS	DESCRIPTION
Analysis parameters	PASS	Analysis time interval and eye characteristics used are acceptable
ATCT(s)	FAIL	Receptor(s) marked as ATCT receive green and/or yellow glare

The referenced policy can be read at https://www.federalregister.gov/d/2021-09862

Component Data

This report includes results for PV arrays and Observation Point ("OP") receptors marked as ATCTs. Components that are not pertinent to the policy, such as routes, flight paths, and vertical surfaces, are excluded.

PV Arrays

Name: PV array 1
Axis tracking: Fixed (no rotation)
Tilt: 4.0°
Orientation: 80.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	53.285925	-6.418237	117.00	6.98	123.98
2	53.285951	-6.417998	117.00	5.76	122.76
3	53.285492	-6.417864	117.00	5.76	122.76
4	53.285463	-6.418098	117.00	6.98	123.98

Observation Point ATCT Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
1-ATCT	1	53.429083	-6.264286	65.41	87.00
2-ATCT	2	53.428547	-6.262177	65.68	22.00
3-ATCT	3	53.355628	-6.489512	49.51	15.00
4-ATCT	4	53.305511	-6.441794	93.49	15.00

Map image of 1-ATCT

Map image of 2-ATCT

Map image of 3-ATCT

Map image of 4-ATCT

Glare Analysis Results

Summary of Results Glare with low potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV array 1	4.0	80.0	916	15.3	0	0.0	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces

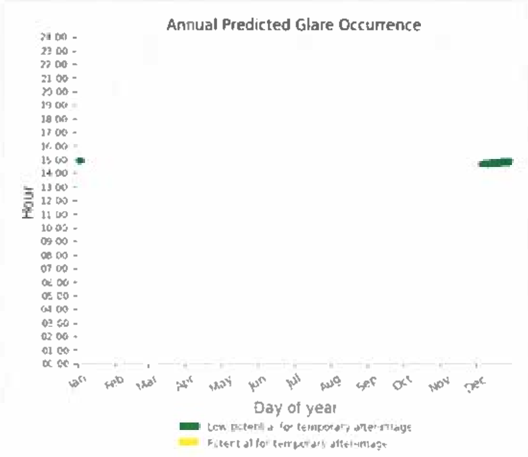
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
1-ATCT	453	7.5	0	0.0
2-ATCT	463	7.7	0	0.0
3-ATCT	0	0.0	0	0.0
4-ATCT	0	0.0	0	0.0

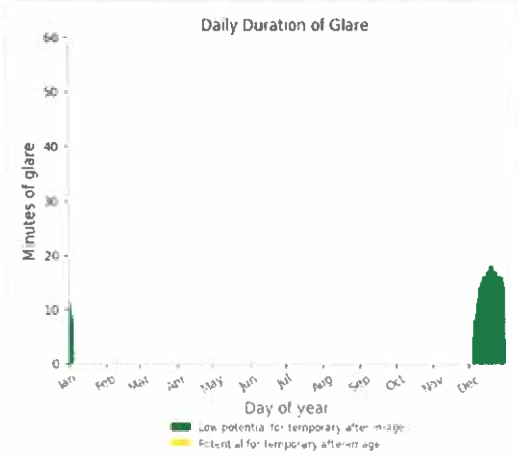
PV: PV array 1

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
1-ATCT	453	7.5	0	0.0
2-ATCT	463	7.7	0	0.0
3-ATCT	0	0.0	0	0.0
4-ATCT	0	0.0	0	0.0

PV array 1 and 1-ATCT

Receptor type: ATCT Observation Point
0 minutes of yellow glare
453 minutes of green glare





PV array 1 and 2-ATCT

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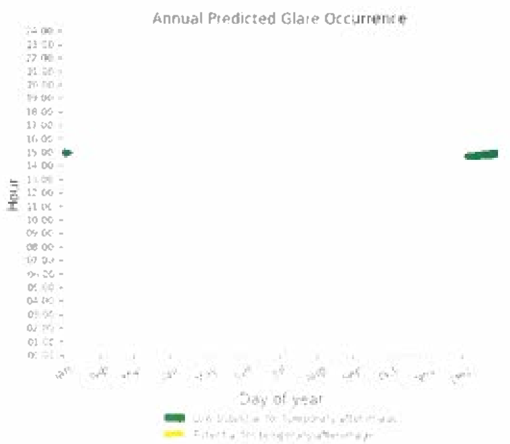
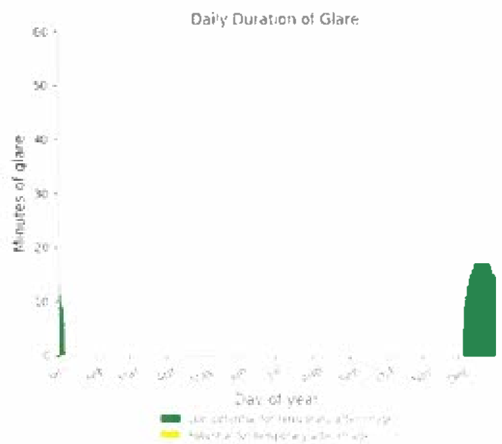
463 minutes of green glare





PV array 1 and 3-ATCT

Receptor type: ATCT Observation Point
No glare found

PV array 1 and 4-ATCT

Receptor type: ATCT Observation Point
No glare found

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Default glare analysis parameters and observer eye characteristics (for reference only):

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- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

Appendix D
Solar Module Glare and Reflectance Technical Memo

SUNPOWER

Technical Notification

TITLE: SunPower Solar Module Glare and Reflectance
AUTHORS: Technical Support
APPLICATION: Residential/ Commercial
SCOPE: SunPower Modules

SUMMARY:

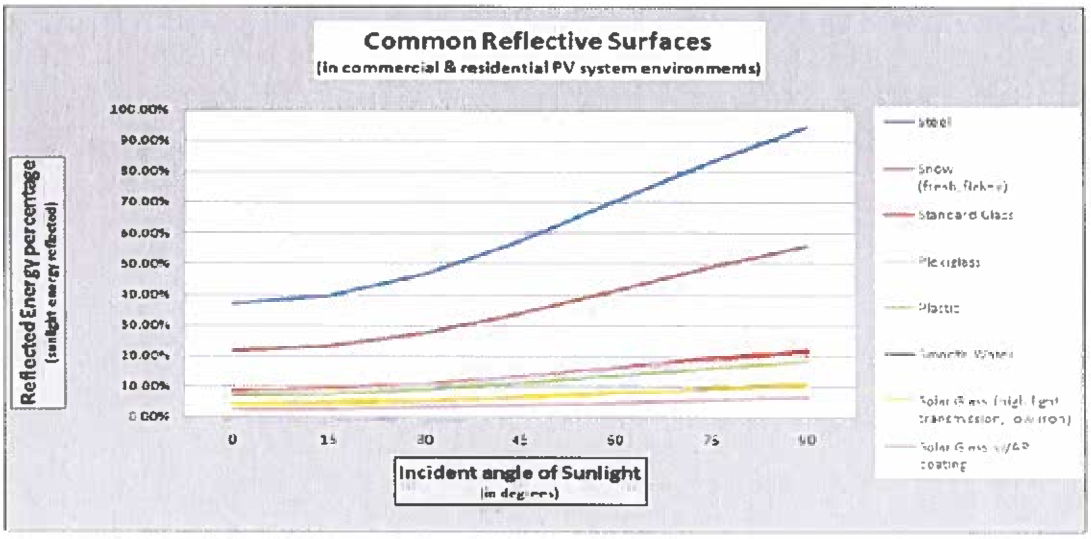
The objective of this document is to increase awareness concerning the possible glare and reflectance impact of PV Systems on their surrounding environment.

The glare and reflectance levels from a given PV system are decisively lower than the glare and reflectance generated by the standard glass and other common reflective surfaces in the environments surrounding the given PV system. Concerning random glare and reflectance observed from the air: SunPower has several large projects installed near airports or on air force bases. Each of these large projects has passed FAA or Air Force standards and all projects have been determined as "No Hazard to Air Navigation". Although the possible glare and reflectance from PV systems are at safe levels and are usually decisively lower than other standard residential and commercial reflective surfaces, SunPower suggests that customers and installers discuss any possible concerns with the neighbors/cohabitants near the planned PV system installation.

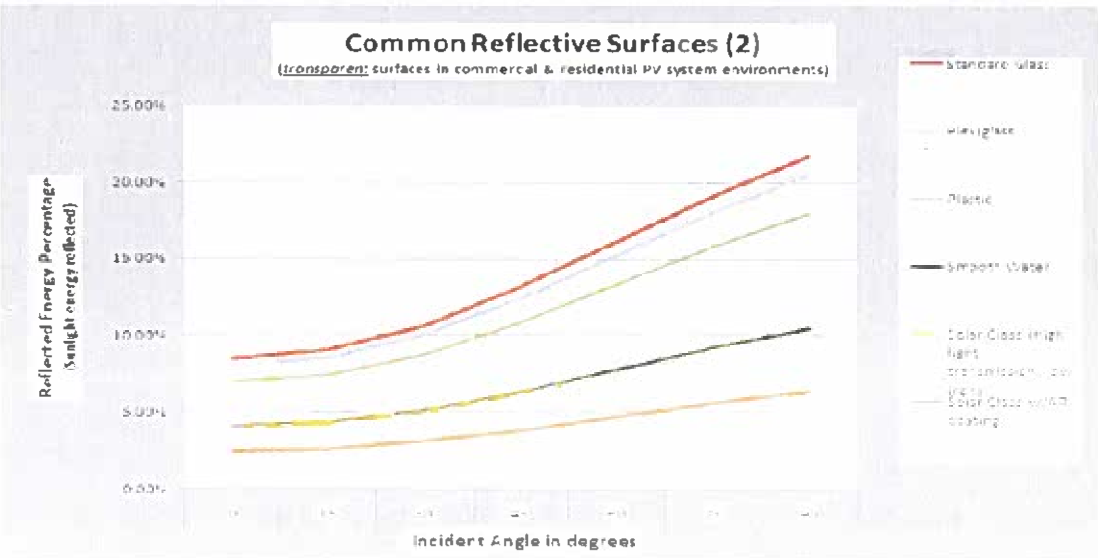
DETAILED EXPLANATION:

In general, since the whole concept of efficient solar power is to absorb as much light as possible while reflecting as little light as possible, standard solar module produces less glare and reflectance than standard window glass. This is pointed out very well in US Patent #6359212 which explains the differences in the refraction and reflection of solar module glass versus standard window glass. Solar modules use "high-transmission, low iron glass" which absorbs more light, producing small amounts of glare and reflectance than normal glass.

In the graph below, we show the reflected energy percentages of sunlight, of some common residential and commercial surfaces. The legend and the graph lists the items from top to bottom in order of the highest percentage of reflected energy.



It should be noted that the reflected energy percentage of Solar Glass is far below that of a standard glass and more on the level of smooth water. Also, below are the ratios of the common reflective surfaces:



Light beam physics resolves that the least amount of light is reflected when the beam is the normal, in other words, least light energy is reflected when the beam is at 0 degrees to the normal. The chart below is a result of light beam physics calculations:

Common Reflective Surfaces (in surrounding environments for PV systems)		Incident angle in degrees						
		0	15	30	45	60	75	90
Material Reflectivity (percent of incident light reflected)	Steel	36.73%	39.22%	46.34%	57.11%	70.02%	83.15%	94.40%
	Snow (fresh flakes)	21.65%	23.09%	27.29%	33.65%	41.23%	48.96%	55.59%
	Standard Glass	8.44%	9.01%	10.65%	13.12%	16.09%	19.10%	21.69%
	Plexiglass	8.00%	8.54%	10.00%	12.44%	15.25%	18.11%	20.56%
	Plastic	6.94%	7.44%	8.82%	10.87%	[illegible]	15.85%	17.47%
	Smooth Water	4.07%	4.35%	5.24%	6.33%	7.76%	9.22%	10.47%
	Solar Glass (high light transmission low iron)	3.99%	4.26%	5.05%	6.20%	7.61%	9.05%	10.26%
	Solar Glass w/AR coating	2.47%	2.64%	3.12%	3.84%	4.71%	5.59%	6.55%

(Note: Index of refraction values may vary slightly depending on suppliers and reference documentation. The values for the above calculations are averages or single values obtained from the list of references for this document).

Important reference – "Stipples glass": In addition to the superior refractive/reflective properties of solar glass versus standard glass, SunPower uses stippled solar glass for our modules. Stippled glass is used with high powered telescopes and powerful beacons and lights. The basic concept behind stippling is for the surfaces of the glass to be textured with small types of indentations. As a result, stippling allows more light energy to be channeled/ transmitted through the glass while diffusing the reflected light energy. This concept is why the reflection of off a SunPower solar module will look hazy and less-defined than the reflection from standard glass, this occurs because the stippled SunPower glass is transmitting a larger percentage of light to the solar cell while breaking up the intensity of the reflected light energy.

SUMMARY/ACTION REQUIRED:

The studies, data and light beam physics behind the charts and graphs prove beyond a reasonable doubt that solar glass has less glare and reflectance than standard glass. The figures also make it clear that the difference is very decisive between solar glass and other common residential/commercial glasses. In addition, not to be lost in the standard light/glass equations and calculations, the SunPower solar glass is stippled and has a very photon-absorbent solar cell attached to the back side, contributing two additional factors which results in even less light energy being reflected.

REGIONAL CONTACTS:

****

EU Toll Free number: SunPower Technical Support, **00800–SUNPOWER (00800–78676937)**

- **For inquiries by e-mail, please use:**
  - Spain: SunPower - Soporte Técnico España: soportetecnico@sunpowercorp.com
  - Germany: SunPower – Technischer Support: technischersupport@sunpowercorp.com
  - Italy: SunPower - Servizio Tecnico Italia: serviziotecnico@sunpowercorp.com
  - France: SunPower - Support Technique France: supporttechnique@sunpowercorp.com

USA Toll Free number: SunPower Technical Support, **1-800–SUNPOWER (786-76937)**

- **For inquiries by e-mail, please use:** Technicalsupport@Sunpowercorp.com

Australia (Sunpower Corporation Australia PTY LTD) contact number: +61-8-9477-5888.

Korea – SPK (SunPower Korea) contact number: (02) 3453-0941

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