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GLARE AND ARTIFICIAL LIGHT REFLECTIVITY ANALISYS

FOR

GOLF LANE DEVELOPMENT

Project Reference:	J587
Revision Ref:	A
Date Prepared:	18 th June 2020
Date Issued:	16th December 2020
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CONTENTS

1. INTRODUCTION

Bowbeck DAC, seek planning permission for a strategic housing development on a site at Golf Lane, Carrickmines, Dublin 18. The site has an area of c. 2.56 hectares and is bound to the north by the M50 motorway, to the east by Golf Lane, to the west by Glenamuck Road, and to the south by existing residential development.

The proposed development comprises a residential development of 482 no. units (all apartments), along with ancillary residential amenities, and provision of a childcare facility, gym, and local shop. The proposed residential units comprise 31 no. studio units, 183 no. 1-bedroom units, 229 no. 2-bedroom units, and 39 no. 3-bedroom units (including 2 no. duplex type units).

The proposed development is set out in 7 no. blocks which comprise the following:

- Block A1 comprises 62. no, apartments within a part four, part six storey building, including 10 no. studio units, 7 no. 1-bedroom units, 41 no. 2 bedroom units, and 4 no. 3-bedroom units. An ESB substation is provided at ground floor level.
- Block A2 comprises 85 no. apartments within a part four, part eight storey building, including 25 no. 1-bedroom units, 45 no. 2-bedroom units, and 15 no. 3-bedroom units.
- Block A3 comprises 79 no. apartments within a part four, part twelve storey building, including 21 no. studio units, 19 no. 1-bedroom units, 28 no. 2-bedroom units, and 11 no. 3-bedroom units.
- Block B0 comprises 150 no. apartments and resident's amenities within a part four, part eighteen, part twenty-one and part twenty-two storey building. The apartments include 76 no. 1-bedroom units, 68 no. 2-bedroom units, and 6 no. 3-bedroom units (including 2 no. duplex type units). An ESB substation, resident's concierge area and amenity space (171 sq.m sq.m) are provided at ground floor level. A further resident's amenity / event space is provided at the twentieth and twenty-first floor levels (83 sq.m).
- Block B1 comprises 8 no. apartments and is four storeys in height, directly abutting Block B. The apartments include 4 no. 1-bedroom units, and 4 no. 2-bedroom units.
- Block C comprises 42 no. apartments and a local shop within a part five, part seven storey building. The apartments include 30 no. 1-bedroom units, 9 no. 2-bedroom units, and 3 no. 3-bedroom units. A local shop (154 sq.m) and an ESB substation are provided at ground floor level.
- Block D comprises 56 no. apartments, a commercial gym, resident's concierge area, resident's lounge, and a childcare facility in a part four, part seven storey building. The apartments include 22 no. 1-bedroom units, and 34 no. 2-bedroom units. The resident's concierge area (99 sq.m), commercial gym (340 sq.m), and childcare facility (300 sq.m) units are located at ground floor level. The resident's lounge (292 sq.m) is located at first floor level.

Two basement levels are proposed, providing car parking spaces (299 no.), bin stores, plant rooms, bicycle parking (1,000 no. spaces), and circulation areas. A further 240 no. bicycle parking spaces and 4 no. car parking spaces are provided at ground level. The proposed development includes landscaping, boundary treatments, public, private and communal open space (including roof terraces), two cycle / pedestrian crossings over the stream at the western side of the site, along with a new pedestrian and cycle crossing of Glenamuck Road South at the west of the site, cycle and pedestrian facilities, play facilities, and lighting. The proposed buildings include the provision of private open space in the form of balconies and winter gardens to all elevations of the proposed buildings. The development also includes vehicular, pedestrian, and cycle accesses, drop off areas, boundary treatments, services, and all associated ancillary and site development works.

2. EXECUTIVE SUMMARY

The purpose of this report is to demonstrate that the proposed development, would satisfy the criteria of the local council as outlined below.

JAK have been retained by the Applicant to carry out a Night-time Glare and Solar Light Reflectivity Analysis for the proposed residential development in Golf Lane, Carrickmines.

The calculations were carried out using the 'IES Virtual Environment' software (Radiance module) and based on the layout drawings prepared by Henry J Lyons Architecture.

Glare is detected by the software when, the average luminance level on the façade is 7 times of the glare threshold value which is calculated by the Radiance module of IES VE software. This was done for 4 eye positions at critical road junctions adjoining the site at different times throughout the year.

The proposed dwellings within the building were analysed by using the unified glare rating (UGR). UGR is a measure of the glare in a given environment, proposed by Sorensen and adopted by the International Commission on Illumination (CIE). The Radiance module Evalglare was created to generate these metrics from a Radiance luminance image.

The results of this study indicate that the subject development will not cause adverse solar/artificial lighting glare to pedestrians and motorists in the adjoining roads and junctions.

Assessment of inward light from cars / motorway lighting on the proposed units also indicated no significant impact for the occupiers and is quantified by CIE Glare Index.

The methods and standards used to carry out the analysis of the entire proposed scheme are examined in detail in this report.

3. STATEMENT OF EXPERIENCE

The simulation and reporting is carried out by Martin Obst (Principal Modelling & Sustainability Engineer) and Jonathan Kirwan (Senior Consulting Engineer/ Managing Director). Martin has 5 years of experience using all modules of IES VE software and completed number of bespoke training sessions with IES VE focusing on areas covered in this report. Jonathan has 25 years of experience in building services consultancy.

JAK have vast experience of using the IES VE software and have In-depth knowledge & experience in understanding the significance of true modelling & its affects. As an experienced design & consultancy practice, we utilize & work with dedicated support to fully utilize functionality of the modelling programs we work with. We set our standards High & have a particularly good record in providing detailed reports for many state bodies, (inc. DOES, SEAI) and numerous successful planning applications for projects throughout Ireland & abroad.

4. METEOROLOGICAL & ATMOSPHERIC CONDITIONS

Glare can only occur when there is direct sunlight reaching the building facade. In overcast or rainy conditions, no glare will occur. Met Éireann, Ireland's National Meteorological Service, suggests that due to Ireland's position off the northwest of Europe we are kept in humid, cloudy airflows for much of the time. According to Met Éireann's statistics Irish skies are completely covered by cloud for well over fifty percent of the time.

5. RELEVANT GUIDANCE

Republic of Ireland
In the Republic of Ireland (ROI), there is currently no guidance, policy or recommendations in relation to the assessment of glare effects on aviation, road & rail users or residential buildings. Future Analytics in conjunction with the Sustainable Energy Authority of Ireland (SEAI) have produced planning and development guidance recommendations for utility scale solar photovoltaic schemes in Ireland which could be applied to buildings. While this is not formal guidance, it does set out recommended elements of the assessment based on international practice.

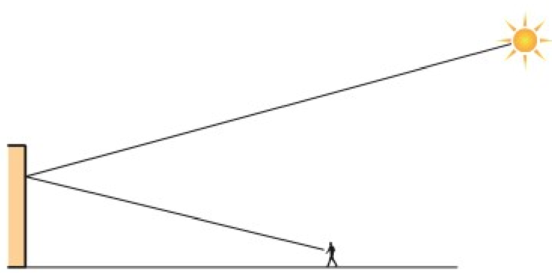
United Kingdom
In the United Kingdom (UK), certain studies have been carried out which help to establish an accepted best practice and planning guidance recommends the assessment of glint and glare effects. However, there is still no specific guidance by way of a prescriptive methodology document. In the absence of formal policy, the Civil Aviation Authority (CAA) have provided interim guidance in relation to the development of solar PV which could guide the approach to assessing of glazed facades. This guidance recommends that solar PV developers should "provide safety assurance documentation regarding the full potential impact of the SPV installation on aviation interests." The Building Research Establishment (BRE) have also issued several relevant papers, however neither the BRE nor the CAA have produced a methodology for assessing the effects of solar glare on aviation, road & rail users.

Germany
In Germany, glare is considered an emission not unlike noise, odour or vibration. "Licht-Leitlinie" or Light Guidelines produced by The Federal Ministry of the Environment defines acceptable levels of glare as being anything less than 30 minutes per day or 30 hours per year. The guidance also states that there is only additional impact to an observer as a result of glare if the angle between the source of the glare and the sun is greater than ten degrees.

6. DAYTIME GLARE ON BUILDING FACADE

Glare or dazzle can occur when sunlight reflected from a glazed façade or area of metal cladding. In this instance we are looking at possible effect to road users in the surrounding of the building. Reflected sunlight from the proposed building can be a problem to motorists when the sun is close to the horizon, allowing reflected glare to interfere with a driver's vision.

Glare impacts may occur during morning and early evening hours when the sun is near the horizon. In this chapter we have modelled locations and specific times when there is a possibility that certain sun altitudes can reflect to the ground.



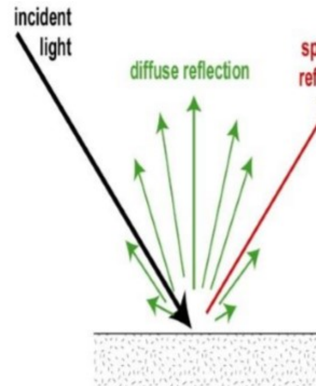


Fig. 1 Reflection of low angle sunlight from a vertical façade.   Fig. 2 Solar glare cause

The International Commission on Illumination (CIE) defines glare as:

Visual conditions in which there is excessive contrast or an inappropriate distribution of light sources that disturbs the observer or limits the ability to distinguish details and objects.

The CIE recommends the Unified glare rating (UGR) as a quantitative measure of glare however this is more suitable for indoor assessments which are included in the assessment of night-time glare from ongoing traffic.

Methodology

Discomfort glare is a unique problem that crosses boundaries between many fields of research; such as psychology, physiology, physics, engineering and architecture. Current guidance is lacking a common methodology to demonstrate glare from reflective facades. However, there are some methods recommended by CIE which can be used to estimate the glare sensation to passing motorists.

IES VE software uses sun-path algorithms for the selected times of the year (assuming 100% sunshine for all daylight hours). Relation between eye position and façade orientation determines times when reflections may occur at these selected receptors. If reflection is found to be geometrically possible from a location, further analysis is then carried out. This further analysis determines the significance of the glare that could potentially be experienced by an observer at that location. In certain cases, where glare is found to be significant and a likely source of hazard or nuisance, mitigation factors can then be discussed.

This assessment is carried out using the Radiance software within IES'S Virtual Environment Using the software at selected eye points we have calculated the average luminance from which the software calculates the glare threshold. The default glare threshold is calculated by the program to be 7 times the average luminance level.

Jakubiec & Reinhart (Department of Architecture, Massachusetts Institute of Technology, 2014) propose brightness of 30,000 cd/m2 as a threshold at which the probability of experiencing disability glare is likely.

The virtual environment model is based on architectural drawing and elevation. Large areas of glass are divided by low reflectivity precast concrete panels, cement board and aluminium rainscreen of dark colour.

Fig. 3Typical façade of tower bay

We have carried out 4 detailed eye position/focus positions and 24 simulations for daytime scenarios to quantify glare caused by sunlight. Times are based on relative sun positions to the eye position when glare would be possible. This would be when the sun is low on the sky behind the motorist.

Simulation times include mid-summer, the 21st June and mid-winter, the 21st December. These will give highest/ lowest sun position and maximum/ minimum levels of daylight.

Fig. 4 Keyplan of the site indicating proposed apartment blocks & locations of eye view assessed for glare

Sky Conditions

The Sunny sky is used to give the worst case scenario for glare analysis (luminance images). This is to give the highest illumination from the sky for the simulations of the glare.

Glare

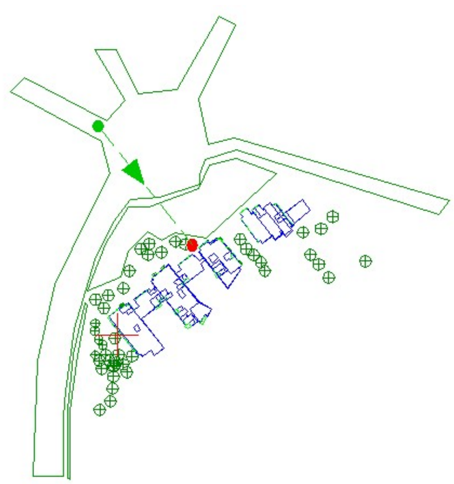
Solar glare can occur either when there are large areas of reflective glass or cladding on the façade so that high altitude sunlight can be reflected along the ground.

For motorists in particular, disability glare is most likely when the reflected sun is directly in the field of view and close to their direction of vision. Glare sources off to one side, or above the observer, are less likely to cause disability glare. Usually, glare sources at more than 25 degrees to the line of sight can be discounted. The worst problems occur when drivers are travelling directly towards the building, and sunlight can reflect off surfaces in the driver's direct line of sight. Usually this will be off the lower parts of the building. For glare, the visible light reflectance is important, rather than the total solar reflectance.

Receptor Eye 1

For eye 1 position 1.5m above ground is set to represent a motorist sitting in a car. Coordinates are set to location where the Ballyogan road meets the roundabout and motorist is looking towards the development.

On the pages overleaf we show when the simulation has shown occurrence of glare (indicated in red)



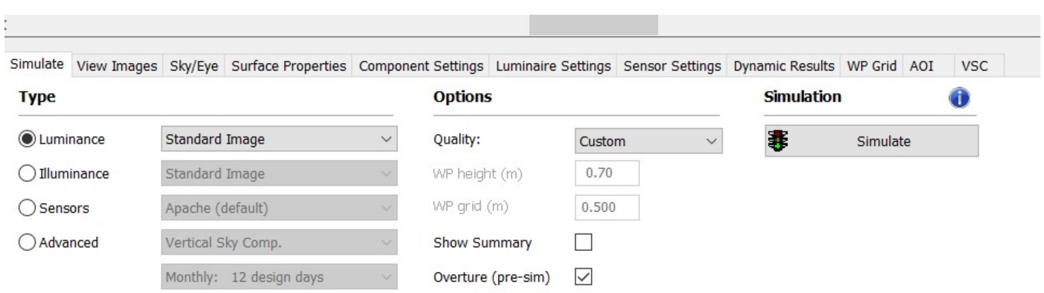


Fig. 5 Eye 1 setting for the assenment on the 21st of June

Fig. 6 Ballyogan road at the roundabout with subject site in the background

Fig. 7 Eye 1 on 21st of July 1900 – low levels of glare detected on A2 & A3

Fig. 8. Eye 1 on 21st of July 2130 – low levels of glare detected on A2 & A3

Results

Modelling has made it possible to determine of likely impact for this receptor. Glare was detected based on the Radiance IES threshold. The maximum detected glare is well below threshold brightness of 30,000 cd/m2 proposed by Jakubiec & Reinhart (2014) as illuminance at which the probability of experiencing disability glare is likely.

Table 1. Eye 1 Results summary

Block	AM Glare	PM Glare	Max level (cd/m2)	Max glare time/date	Glare detected	Disabling glare
A1	-	-	-	-	-	-
A2	-	Y	3320	2100; 21/6	y	n
A3	-	Y	2753	2100; 21/6	y	n
B1	-	Y	1353	2130; 21/6	y	n
C	-	-	-	-	-	-
D	-	-	-	-	-	-

Receptor Eye 2

For eye 2 position 1.5m above ground is set to represent a motorist sitting in a car. Coordinates are set to location where the Glenamuck Road North meets the roundabout and the motorist is looking towards the development. Morning glare would not be geometrically possible. Detailed modelling of the afternoon hours is indicating discomforting glare being reflected to the junction represented by Eye 2. The results confirm that there is no danger of disabling glare for the motorist as detailed in the results in table 2.

Fig. 9 Glenamuck Road North bridge meets the roundabout (Eye 2 position)

On the following pages we show when the simulation has shown occurrence of glare (indicated in red). The selected images indicate maximum glare detected.

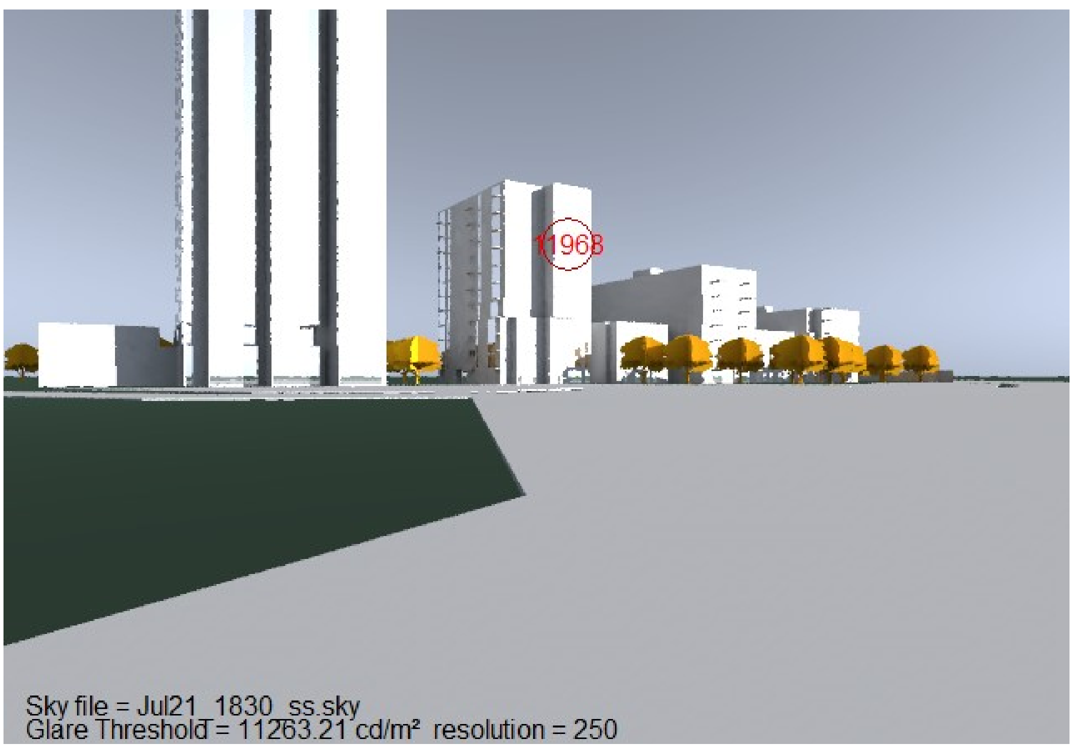


Fig. 10 Eye 2 receptor glare

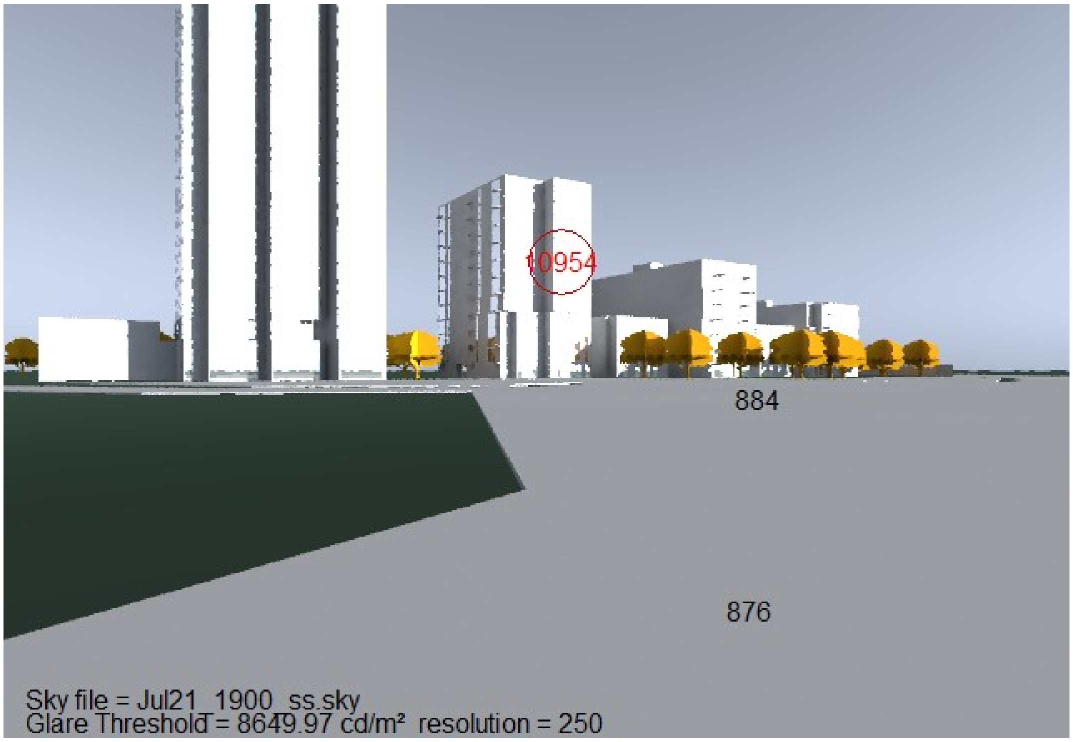


Fig. 11 Eye 2 receptor glare

Fig. 12 Eye 2 receptor glare

Fig. 13 Eye 2 receptor glare

Fig. 14 Eye 2 receptor glare

Fig. 15 Eye 2 receptor glare

Results

Modelling has made it possible to determine of likely impact for this receptor. Glare was detected based on the Radiance IES threshold. The maximum detected glare is well below threshold brightness of 30,000 cd/m2 proposed by Jakubiec & Reinhart (2014) as illuminance at which the probability of experiencing disability glare is likely.

Table 2. Eye 2 Results summary

Block	AM Glare	PM Glare	Max level (cd/m2)	Max glare time/date	Glare detected	Disabling glare
A1	N	N	-	-	-	-
A2	N	Y	3320	2100; 21/6	y	n
A3	N	Y	11968	2100; 21/6	y	n
B1	N	Y	1353	2130; 21/6	y	n
C	N	N	-	-	-	-
D	N	N	-	-	-	-

Receptor Eye 3

For eye 3 position 1.5m above ground is set to represent a motorist sitting in a car. Coordinates are set on the exit no. 15 slipway off the northbound M50.

We have reviewed the sun paths troughout the year to determine most likely occurences for glare would be early mornings of march and september. The simulation did not detect glare in these pereiods for the selected receptors.

Fig. 16 Exit no. 15 slipway off the northbound M50 – Eye 3

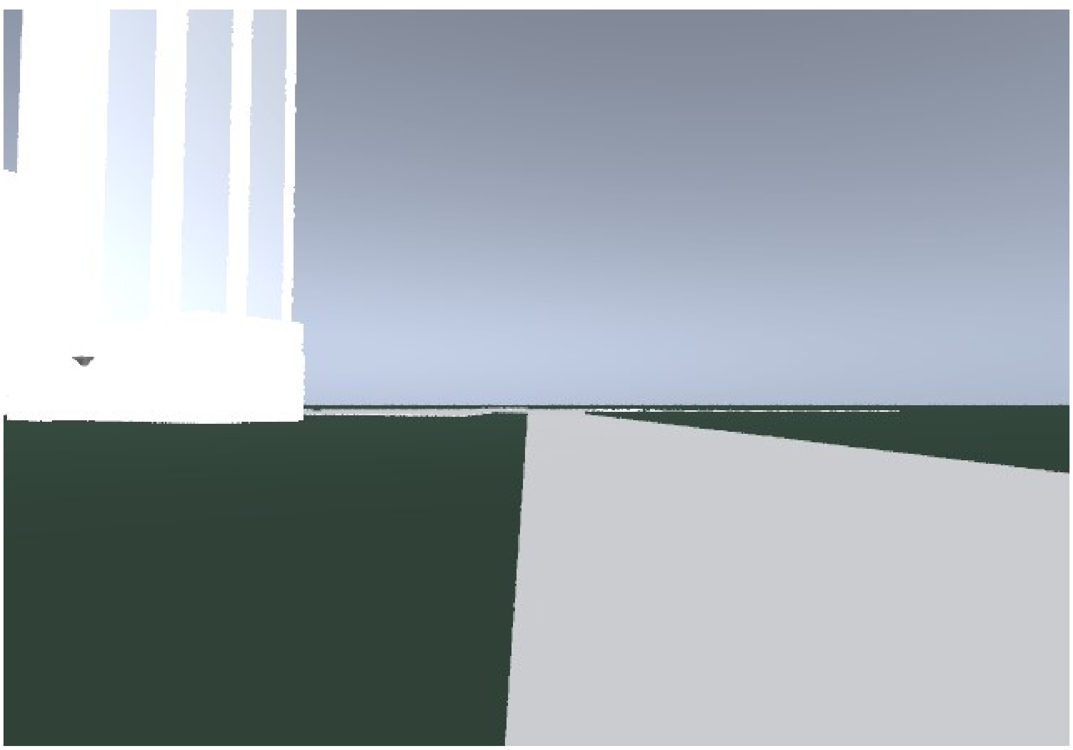


Fig. 17 Eye 3 position on 21st of march does not indicate glare

Results
The simulation did not detect glare in these pereiods for the selected receptors.

Receptor Eye 4

For eye 4 position 1.5m above ground is set to represent a motorist sitting in a car. Coordinates are set on the turn off Glenamuck road to The Park Carrickmines looking towards the Development.

Fig. 18 The Park Carrickmines turn meets glenamuck road – Eye 4

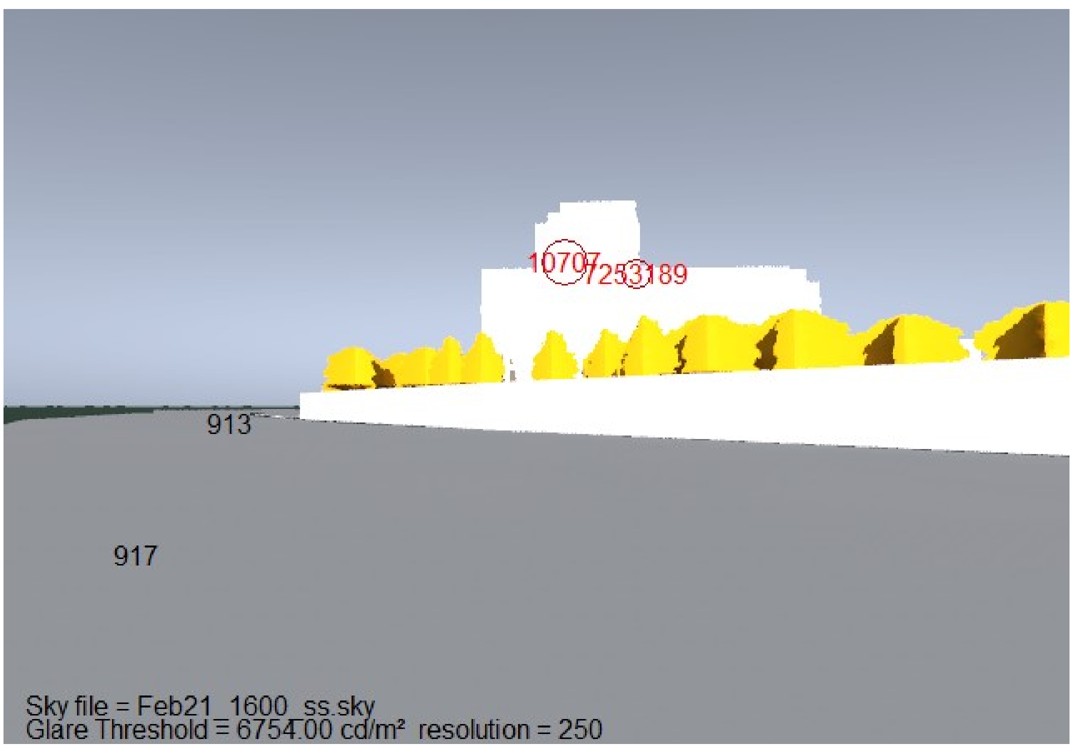


Fig. 19 Eye 4 receptor glare

Fig. 20 Eye 4 receptor glare

Fig. 21 Eye 4 receptor glare

Results

Modelling has made it possible to determine of likely impact for this receptor. Glare was detected based on the Radiance IES threshold. The maximum detected glare is well below threshold brightness of 30,000 cd/m2 proposed by Jakubiec & Reinhart (2014) as illuminance at which the probability of experiencing disability glare is likely.

Table 3. Eye 1 Results summary

Block	AM Glare	PM Glare	Max level (cd/m2)	Max glare time/date	Glare detected	Disabling glare
A1	N	Y	7253	1600, 21/2	y	n
A2	N	N	-	-	-	-
A3	N	N	-	-	-	-
B1	N	Y	10707	1600, 21/2	y	n
C	N	N	-	-	-	-
D	N	N	-	-	-	-

7. ASSESSMENT OF INWARD LIGHT FROM CARS / MOTORWAY LIGHTING ON THE PROPOSED UNITS

Methodology

Radiance software within IES'S Virtual Environment Software uses standard methods to calculate glare. For our model we use the Unified glare rating (UGR) to check whether a design introduces glare to a defined observer located in the surrounding area of the proposed building.

Lighting Conditions

Luminance sources which exceed this threshold have been identified. We output the intensity, size and position of these glare sources. We analyse these results with respect to "unified glare rating" indices. This is done by taking fixed angles to the left and right of the centre of focus (by default at 10 degree intervals from –60 to +60 degrees), see figure below.

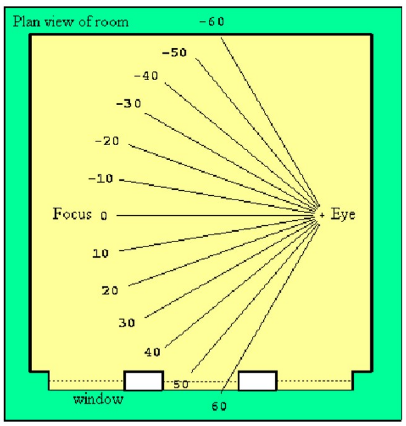


Fig. 22 Unified glare rating respective to windows

Modelled conditions

The source of artificial light for this assessment was coming from number of cars on the M50, the slipways and the existing public lighting. Assumptions were made on the output of these sources. The software does not allow moving light source and all cars are modelled as stationary. Existing public lighting in the simulation was based on the local council general specification document.

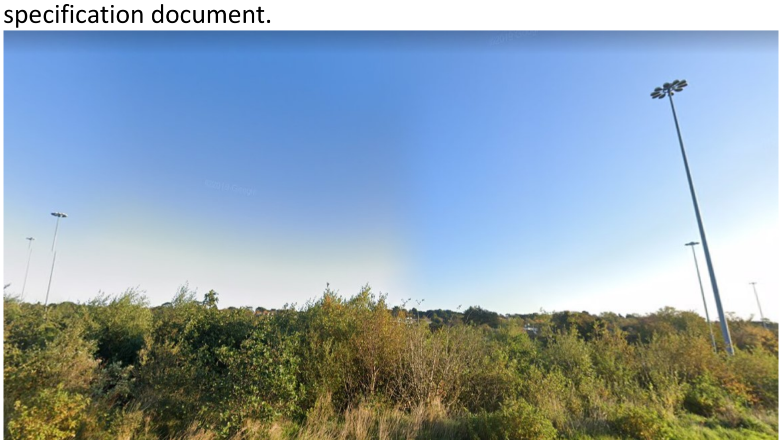


Fig. 23 Existing M50 exit public lighting

Fig. 24 Existing public lighting on the roundabout adjoining the site

Analysis Results

Data is presented by CIE Glare Index and the Unified glare rating (UGR).

Table 4. Analysis results

Apartment reference	Unified glare rating (UGR).
Ground Floor Living Room	
A2-022	3.8
A3-012	3.4
A3-041	3.8
B0-147	11.8
B0-144	10.4
Third Floor Living Room	
A2-036	4.2
A3-100	3.8
A3-042	4.0
B0-001	12.3
B0-003	11.2
Seventh Floor Living Room	
A2-089	2.4
A3-062	2.2
A3-068	2.6
B-040	8.4
B-034	7.2

Following values are used as basis of the assessment:

Table 5. Glare Indices

Degree of sensation	Unified glare rating (UGR).
Intolerable	**>28**
Disturbing	**22-28**
Perceptible	**13-22**
Imperceptible	**<13**

Conclusion

Glare from the light from cars / motorway lighting on the proposed units can be characterised as imperceptible. This is mainly from the design of the public lighting which is maintaining uniformity of outdoor lighting. The M50 is approx. 5m below the ground floor of the development and therefore the passing cars would not have impact on the proposed dwellings.

Overall, the glare based on the measured indices can be classified as imperceptible.

8. ASSESSMENT OF GLARE ON THE MOTORWAY FROM THE PROPOSED BUILDINGS

Night-time Glare

The proposed Development would change the land uses of the site and its night-time appearance. The public lighting adjoining to the area includes floodlights on 12m high poles which illuminate M50 exit no. 15 and roundabout at the Glenamuck road north bridge. Illumination from the public lighting would make very unlikely that night-time glare from the proposed building would occur.

Methodology

Current guidance is lacking a common methodology to demonstrate glare from the lighting in the dwellings to the road users. Based on the methodology used for daylight glare we will estimate the glare sensation to passing motorists.

This assessment is carried out using the Radiance software within IES'S Virtual Environment Using the software at selected eye points we have calculated the average luminance from which we can calculate the glare threshold.

The default glare threshold is calculated by the program to be 7 times the average luminance level.

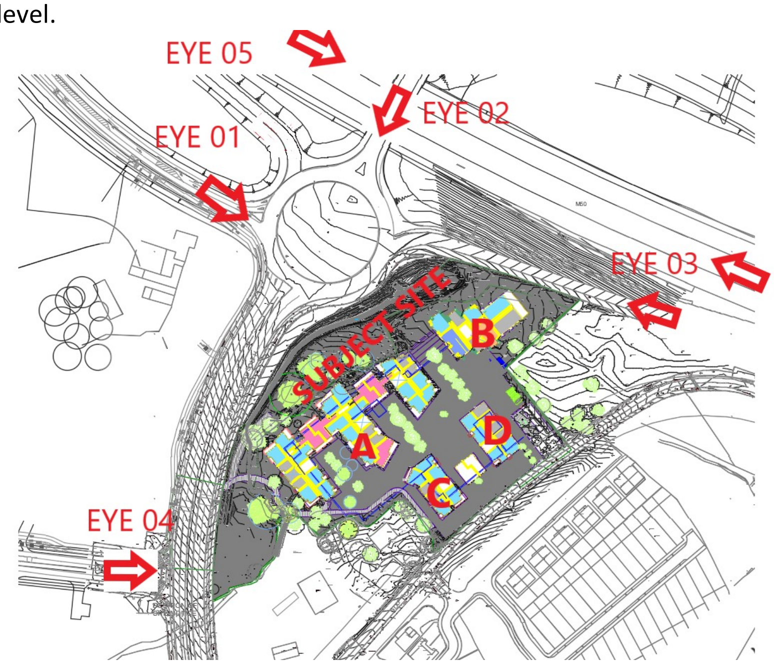


Fig. 25 Nighttime glare receptors

We have carried out assessment for 6 detailed eye position/focus positions as indicated on figure 25 to quantify glare caused by artificial lighting. We have used the same eye positions as in the daylight glare study with additional 2 receptors representing cars travelling on southbound and northbound directions of the M50.

Modelled conditions

Source of artificial light for this assessment was coming from 75% of the windows in the new development and the existing public lighting. Assumptions were made on the output of these sources. Internal fitting were selected to give 500 lux illuminance to the rooms in the development Existing public lighting in the simulation was based on the local council general specification d document.

Analysis Results

The software did not record any glare for the receptors. We note that the lighting off the building would be generally quite low. The glare threshold was not reached in the modelling which means no glare recorded by the software.

Table 3. Eye 1 Results summary

Receptor	Nighttime Glare	Max level (cd/m2)	Max glare time/date	Discomfoting glare	Disabling glare
Eye 1	N	-	-	N	N
Eye 2	N	-	-	N	N
Eye 3	N	-	-	N	N
Eye 4	N	-	-	N	N
Eye 5	N	-	-	N	N
Eye 6	N	-	-	N	N

Night-time Illumination Recommendation

Exterior lighting shall be designed to shield and direct illumination to the Project site, and/or areas which do not include light-sensitive uses.

The Project shall not install flashing, moving, strobe, or blinking outdoor lights along the western and southern boundaries of the Project site or on the south-facing exterior wall of the proposed building.

9. CONCLUSION

Daylight Glare

The analysis of the selected receptors has indicated that glare will occur in the instances as shown in the tables 1, 2 & 3. The maximum detected glare is well below threshold brightness of 30,000 cd/m2 proposed by Jakubiec & Reinhart (Department of Architecture, Massachusetts Institute of Technology, 2014). Glare can only occur when there is direct sunlight reaching the building facade. In overcast or rainy conditions, no glare will occur and according to Met Éireann's statistics Irish skies are completely covered by cloud for well over fifty percent of the time. This reduces probability of glare by half.

Glare from cars / motorway lighting on the proposed units

Glare from the light from cars / motorway lighting on the proposed units can be characterised as imperceptible. the existing public lighting is maintaining uniformity of outdoor lighting counteracting the impact of incoming illuminance from cars.

Glare on the motorway from the proposed buildings

The software did not record any glare for the receptors. We note that the lighting off the building would be generally quite low. The glare threshold was not reached in the modelling which means no glare recorded by the software.

Overall, the new development would not have adverse effects on the adjoining traffic and vice versa.