

Final Report Rev.2

Reflectivity Report for Stage 2
State Significant Development
Application (SSDA 6):

**SYDNEY INTERNATIONAL
CONVENTION, EXHIBITION AND
ENTERTAINMENT PRECINCT
(SICEEP): ICC HOTEL**

Sydney, Australia

CPP Project 7006

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EXECUTIVE SUMMARY

Cermak Peterka Petersen Pty. Ltd. has been engaged by Lend Lease Project Management & Construction (Australia) Pty. Limited (Lend Lease) to assess the proposed ICC Hotel of Sydney International Convention Centre, Exhibition and Entertainment Precinct (SICEEP) in terms of Solar Reflectivity. This report supports a State Significant Development Application (SSDA) submitted to the Minister for Planning and Infrastructure pursuant to Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act).

This report makes reference to the Sydney Development Control Plan 2012, Section 3 General Provisions – Section 3.2.7 Reflectivity. Specifically, Section 3.2.7 states that “A Reflectivity Report that analyses potential solar glare from the proposed building design may be required for tall buildings”.

This assessment report quantifies the potential impact for solar reflectivity glare upon motorist using roadways intersecting and surrounding the SICEEP ICC Hotel. CPP use, in part, the methodology developed by Hassall (1991) and the concept of veiling glare and contrast when quantifying the potential for hazard rogue reflections to be cast onto surrounding motorway receiver locations. Pedestrian and waterway impacts are assessed more broadly in this report in terms of amenity and usability of the site. This report does not assess solar glare impact onto surrounding buildings, nor glare from artificial lighting.

In summary, with the measures adopted by the designers as described in this report regarding choice of façade materials with reflectivity coefficient in the range 10%-13%, the proposed SICEEP ICC Hotel development does not present a driver hazard in terms of solar glare and will meet the Sydney Development Control Plan 2012 controls for reflectivity.

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1. INTRODUCTION

Cermak Peterka Petersen Pty. Ltd. has been engaged by Lend Lease to assess the proposed ICC Hotel of Sydney International Convention Centre, Exhibition and Entertainment Precinct (SICEEP) in terms of Solar Reflectivity. This report supports a State Significant Development Application (SSDA) submitted to the Minister for Planning and Infrastructure pursuant to Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act).

This report makes reference to the Sydney Development Control Plan 2012, Section 3 General Provisions – Section 3.2.7 Reflectivity. Specifically, Section 3.2.7 states that “A Reflectivity Report that analyses potential solar glare from the proposed building design may be required for tall buildings”.

2. CLIENT PROVIDED INFORMATION

2.1. Introduction

This report supports a State Significant Development Application (SSDA) submitted to the Minister for Planning and Infrastructure pursuant to Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act).

The Application (referred to as SSDA6) seeks approval for construction of the International Convention Centre (ICC) Hotel component of the Sydney International Convention, Exhibition and Entertainment Precinct (SICEEP) at Darling Harbour.

This SSDA follows SSDA1, which seeks approval for the core convention, exhibition and entertainment facilities of the SICEEP Project; SSDA2, a staged application that sets out a Concept Proposal for a new mixed-use neighbourhood at Darling Harbour known as 'The Haymarket'; and a number of detailed proposals (SSDA3, SSDA4, and SSDA5) for use of development plots within The Haymarket. SSDAs 1 and 2 were submitted to the Department of Planning and Infrastructure (DoPI) in March 2013, and the SSDAs 3-5 were submitted in May 2013.

The ICC Hotel forms part of the SICEEP Project, which will deliver Australia's global city with new world class convention, exhibition and entertainment facilities and support the NSW Government's goal to "make NSW number one again".

2.2. Overview of Proposed Development

The proposal relates to a SSDA for the ICC Hotel component of the SICEEP Project. The hotel is located at the northern end of the precinct and comprises a single building with up to 656 keys. The hotel is being developed by Lend Lease and is consistent with Darling Harbour Live's Preferred Precinct Plan.

More specifically, this SSDA seeks approval for the following components of the development:

- demolition of existing site improvements;
- associated tree removal and replanting;
- construction and use of a single hotel tower providing for up to 656 keys and including guest facilities, restaurant and ballroom;
- public domain improvements including integration with existing / proposed works; and
- extension, realignment and augmentation of physical infrastructure / utilities as required.

2.3. Background

The NSW Government considers that a precinct-wide renewal and expansion of the existing convention, exhibition and entertainment centre facilities at Darling Harbour is required, and is committed to Sydney reclaiming its position on centre stage for hosting world-class events with the creation of the Sydney International Convention, Exhibition and Entertainment Precinct.

Following an extensive and rigorous Expressions of Interest and Request for Proposals process, a consortium comprising AEG Ogden, Lend Lease, Capella Capital, and Spotless was announced by the NSW Government in December 2012 as the preferred proponent to transform Darling Harbour and create SICEEP.

Key features of the Preferred Precinct Plan include:

- Delivering world-class convention, exhibition and entertainment facilities, including:
 - up to 40,000 m² exhibition space;
 - over 8,000 m² of meeting rooms space, across 40 rooms;
 - overall convention space capacity for more than 12,000 people;
 - a ballroom capable of accommodating 2,000 people; and
 - a premium, red-carpet entertainment facility with a capacity of 8,000 persons.
- Providing a hotel complex at the northern end of the precinct, immediately adjacent to the new International Convention Centre.
- A vibrant and authentic new neighbourhood at the southern end of the precinct, called 'The Haymarket', including apartments, student accommodation, community facilities, shops, cafes, and restaurants.
- Renewed and upgraded public domain that has been increased by a hectare, including an outdoor event space for up to 27,000 people at an expanded Tumbalong Park.
- Improved pedestrian connections linking to the proposed Goods Line (formerly Ultimo Pedestrian Network) drawing people between Central, Chinatown, and Cockle Bay Wharf, as well as east-west between Ultimo/Pymont and the City.

2.4. Site Description

The SICEEP Site is located within Darling Harbour. Darling Harbour is a 60 hectare waterfront precinct on the south-western edge of the Sydney Central Business District that provides a mix of functions including recreational, tourist, entertainment, and business.

With an area of approximately 20 hectares, the SICEEP Site is generally bound by the Light Rail Line to the west, Harbourside shopping centre and Cockle Bay to the north, Darling Quarter, the Chinese Garden and Harbour Street to the east, and Hay Street to the south. The SICEEP Site has been divided into three redevelopment areas – Bayside, Darling Central and The Haymarket.

The ICC Hotel Site (refer to Figure 1):

- is located within the northern end of the Bayside precinct;
- is bound by Harbourside Shopping Centre to the north and east, the International Convention Centre to the south, and Darling Drive to the west; and
- occupies an area of approximately 3,730 m².



Figure 1: Aerial photograph of the SICEEP site and redevelopment areas

2.5. Planning Approvals Strategy

The SICEEP Project will result in the lodgement of numerous SSDAs for the various components of the redevelopment project. SSDAs have already been lodged for the PPP component of the SICEEP Project (comprising the convention centre, exhibition centre, entertainment facility and ancillary commercial premises and associated public domain upgrades), the Stage 1 Concept Proposal for The Haymarket, and the Stage 2 detailed proposals for three of the development plots within The Haymarket. Future applications will be lodged for the remaining development plots within The Haymarket Site.

This Application relates to a SSDA6 for the ICC Hotel component of the SICEEP Project and is consistent with Darling Harbour Live's Preferred Precinct Plan.

3. REFLECTIVITY IMPACT CONSIDERATIONS

To assess the impacts of the proposed development, this report considers the Sydney Development Control Plan 2012, Section 3 General Provisions – Section 3.2.7 Reflectivity, specifically:

- (1) A Reflectivity Report that analyses potential solar glare from the proposed building design may be required for tall buildings.
- (2) Generally, light reflectivity from building materials used on facades must not exceed 20%.
- (3) For buildings in the vicinity of arterial roads/major roads and Sydney Airport, proof of light reflectivity is required and is to demonstrate that light reflectivity does not exceed 20%.

As outlined under 3.2.7, Lend Lease will ensure all exterior façade elements used throughout the ICC Hotel development will limit light reflectivity to 20% or less. It is understood that the façade designers will adopt a glazing over the tower and podium with a reflectivity level of below 10%. For glazing producing specular type reflections this is defined as the percentage solar reflection when light strikes and reflects normal to the façade plane. When incident solar rays strike near parallel to the façade plane (large incident angle of typically greater than 70° also referred to as glancing reflections), it is known that the reflectivity of all glazing types increases dramatically towards the properties of a mirror, Figure 2.

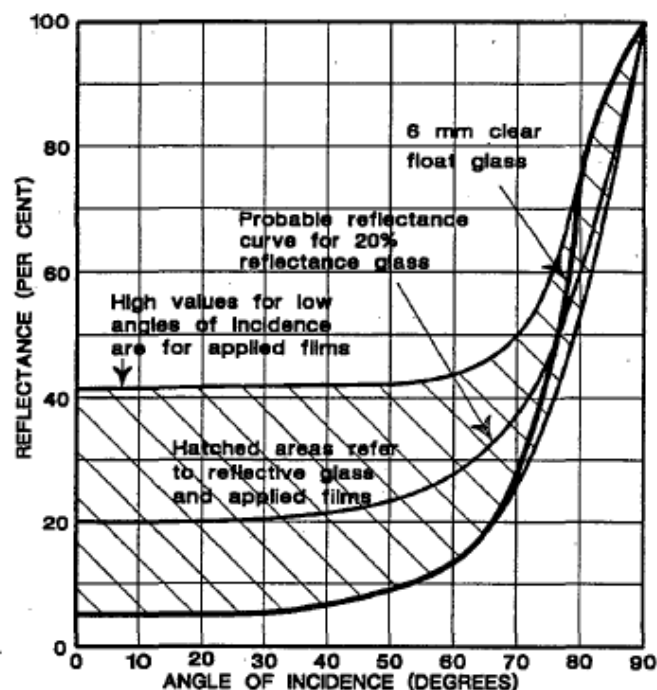


Figure 2: Façade reflectivity versus angle of incidence (Hassall, 1991)

Thus, even for glazing with low reflectivity coefficients, the potential for glare increases significantly when incoming solar rays can impact on a building close to parallel to the plane of the glazing, i.e. a glancing reflection. The following report quantifies potential for solar reflections of all incident angles on glazing to impact upon the surrounds taking into consideration:

- seasonal and diurnal solar paths (sun altitude and azimuth) at the ICC Hotel latitude and longitude and the relative angle between incident solar rays and façade orientation,
- reflectivity coefficients of the external glazing being used, and
- roadway receiver locations of interest; the alignment of adjoining public roads.

Where the combination of these factors suggests there is potential for hazardous rogue reflections to impact on surrounding areas, the potential magnitude of reflections can be quantified and compared with the acceptability criterion described below. This report quantifies the potential for solar reflectivity glare impact upon motorists using roadways intersecting and surrounding the ICC Hotel. CPP use, in part, the methodology developed by Hassall (1991) and the concept of veiling glare and contrast when quantifying the potential for hazard rogue reflections onto surrounding receiver locations. In many instances the potential for a façade to generate rogue reflections can be eliminated without the need for calculation by taking into account the above factors as well as shading offered by surrounding building massing.

Pedestrian impacts are less likely to be of safety concern and are assessed more broadly in this report in terms of general amenity and usability of the site. A pedestrian can more readily divert their viewing angle away from the glare source, or halt walking momentarily. It must be appreciated it is impractical to mitigate potential solar reflections at all potential pedestrian receiver locations across and surrounding the precinct.

Similarly, this report does not assess the impact of reflected solar glare onto surrounding building windows. Notwithstanding, designers have no glass sloping toward the sky in order to minimise solar reflections back onto surrounding multi-storey buildings, i.e. all glass is either aligned vertically, or sloping downward toward the ground.

4. GLARE ACCEPTABILITY CRITERION

Consider an object that is just visible in the absence of glare. The object will no longer be visible when glare is introduced and it will be necessary to increase the contrast to make the object visible again. Threshold Increment (TI) is the percentage by which the contrast must be increased to make the object just visible and is the parameter calculated in this study to assess the acceptability or otherwise of potential reflectivity glare events.

TI is a parameter used in the design of Road Lighting, e.g. AS/NZS 1158.1.1:2005 where a maximum TI value of 20% is used for all roadway lighting categories and is the TI acceptability criterion adopted in this study for assessing solar glare impact on passing traffic.

Where high TI values are identified, it is useful to investigate the angular limits of façade reflections relative to the motorist observer using a glare protractor (Hassall 1991). The glare protractor comprises a series of loops indicating whether a glare source will be above a predetermined veiling glare limit for the resultant per cent level of cladding reflectivity.

Calculations in this report assume specular type reflective façade surfaces, where the reflected ray angle is equal to the incident solar ray angle. This assumption is valid for most smooth surface glazing materials. Other building materials including surface fritted glazing, masonry, brickwork, tiles, and metal deck roofing produce diffuse components of reflection that are not directly quantified by the methodology adopted in this report. By definition, diffuse reflections have a greater scatter of reflected angles with lower concentration of reflected light in any given direction and are generally less likely to cast hazardous distant glare reflections than glazing.

5. REFLECTIVITY IMPACT RESULTS

The ICC Hotel is tall relative to surrounding roadways, so reflections from the facades are able to extend significant distances; especially early morning and late afternoon events when the solar altitude angle is low. Also important is the solar shading available from surrounding and proposed developments and the overall massing of the Sydney CBD.

Darling Drive, Allen Street and the M4 Western Distributor Freeway were considered most at risk to solar glare from the development and were assessed for reflectivity impact in this report. Pedestrian and waterway impacts are assessed more broadly in this report in terms of amenity and usability of the site.

With reference to the Holladay formula (Hassall, 1991); the greatest potential for glare impact upon drivers is when the angle between the centre of the glare source and line of sight is small. Therefore the greatest potential for glare impacts is for motorists travelling *towards* the ICC Hotel site.

Darling Drive travelling north toward the site

The greatest potential for the proposed SICEEP ICC Hotel development to generate reflections onto motorists on Darling Drive is solar interaction with the western tower façade reflecting onto northbound motorists. With reference to Figure 3, the highest TI values calculated for this facade were caused by late afternoon low altitude solar rays during the winter months striking lower levels of the tower west facade with reflections towards the south along Darling Drive.

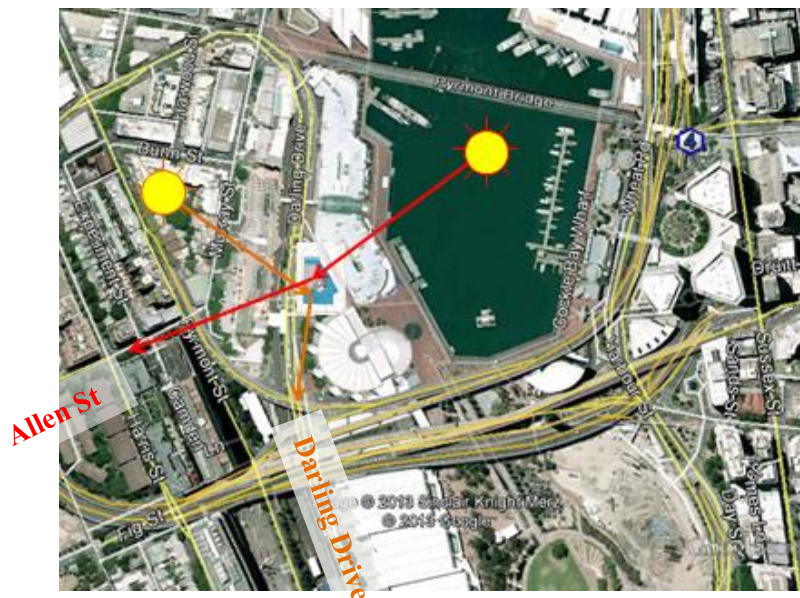


Figure 3: Solar reflections off the ICC Hotel tower facades (google earth).

An example of this reflection condition is on May 9th, which is illustrated in Figure 4 as viewed by an approaching motorist from the south. Reflections are off the west facade of the tower (highlighted yellow) and the impact point is on Darling Drive beneath the M4 Western Distributor Freeway deck looking northward.

| | | |
|-------------------|---------|---------|
| reflections start | 4:05 pm | TI = 20 |
| reflections max | 4:15 pm | TI = 21 |
| reflections cease | 4:55 pm | TI = 4 |

The highest TI levels are marginally in excess of the criterion assuming a 20% glazing reflectivity coefficient. It is noted that higher TI values were calculated but for later lower altitude sun angles, however these will be blocked by the existing Novotel Darling Harbour building to the west.

To further assess the suitability of the location, a Hassall glare protractor was used to investigate potential solar glare impacts on the northbound motorist. With reference to Figure 4, it is evident that reflections from the western tower facade fall outside the sensitive vision zone.

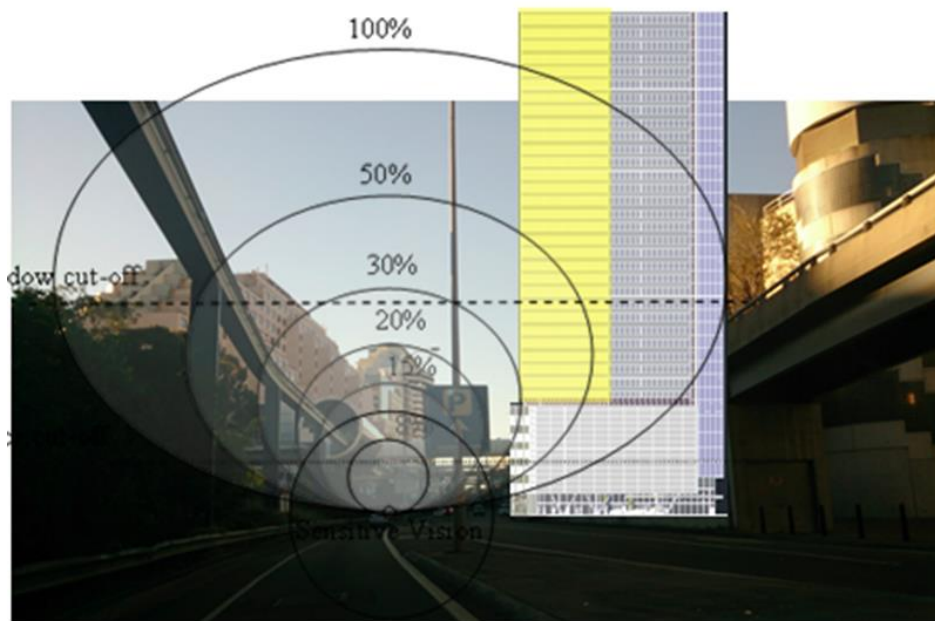


Figure 4: Glare protractor on Darling Drive approaching ICC Hotel, northward view.

For the reflection condition in Figure 4, incident and reflected angles are relatively large and a lowering of the glass reflectivity coefficient will be effective in reducing the impact on motorists. For the hotel tower, glazing designers have adopted glass with a reflectivity coefficient in the range 10%-13%, which is below the 20% level required under the Sydney Development Control Plan 2012. It is recommended that all other glazing on the tower façades should have a reflectivity coefficient in this range or lower to minimise reflections onto the surrounding precinct, which will be also of benefit to pedestrian users of the precinct as discussed below.

Allen Street travelling east toward the site

The greatest potential for the proposed SICEEP ICC Hotel development to generate reflections onto motorists on Allen Street is solar interaction with the north tower façade reflecting onto eastbound motorists. The highest TI values calculated for this facade were caused by morning low altitude solar rays during the winter months striking lower levels of the tower north facade with reflections towards the west along Allen Street.

The highest TI levels are approaching the criterion levels. To further assess the suitability of the location, a Hassall glare protractor was used to investigate potential solar glare impacts on the eastbound motorist. With reference to Figure 5, the greatest potential impact is over the lower third of the north façade but outside the sensitive vision range.

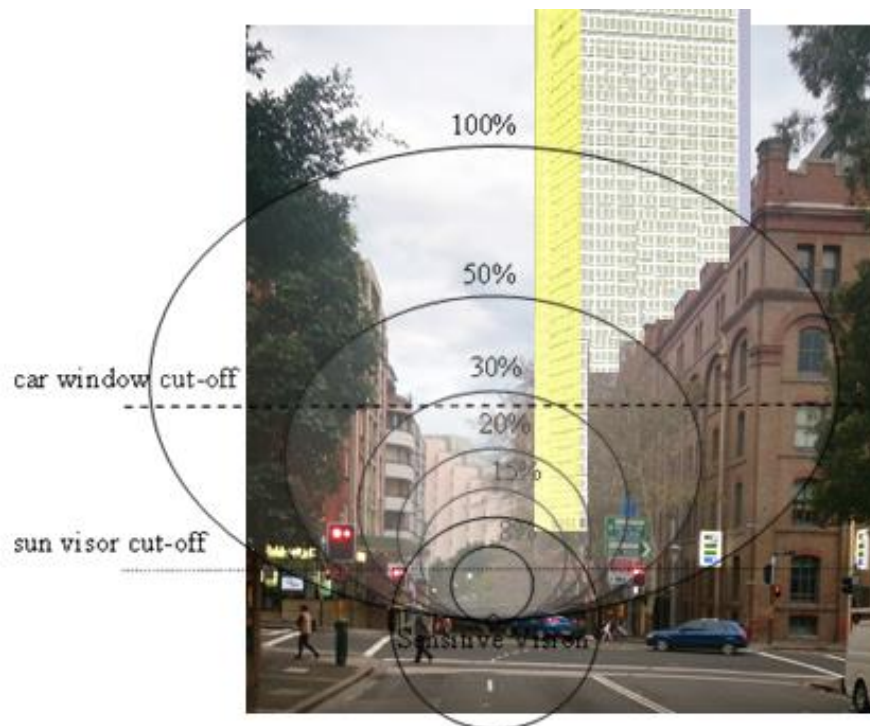


Figure 5: Glare protractor on Allen Street approaching ICC Hotel, eastward view.

Harbourside Place

Solar reflections off the tower and podium east facades of the proposed SICEEP ICC Hotel development can potentially reflect onto Harbourside Place at the southern base of the tower and the one way access lane on the south and east perimeters of the site respectively. These reflections will result from noon to early afternoon sun, with lowest incident angles during the winter months. Here it is noted that traffic is not planned to move northward on these roads, i.e. the one way lane travels southward and Harbourside Place traffic circulates clockwise.

For a driver looking directly forward as would normally be the case on these perimeter roadways, the glare source lies well outside the zone of sensitive vision and glare is not considered to be problematic with reference to the Holladay formula (Hassall, 1991). Notwithstanding, there is also pedestrian amenity to consider in the vicinity of the site and Convention Centre to the south and the designers have adopted glass with a reflectivity coefficient in the range 10%-13% on the podium facades as well as the tower.

Other Surrounding Roadways

With reference to the Holladay formula (Hassall, 1991); the greatest potential for glare impact upon drivers is when the angle between the centre of the glare source and line of sight is small. Apart from the roadways identified above, there is limited potential for reflections from the tower to align with the sensitive vision zone of a motorist using other surrounding motorways.

Cockle Bay Waterway and Surrounding Pedestrian Locations

The tower will be highly visible from Cockle Bay, Figure 4. On Cockle Bay and other surrounding pedestrian locations there are limited glancing reflections identified. As potential reflections are mostly of higher incident and reflected angles, a lowering of the glass reflectivity coefficient will be effective. It is understood that all glazing on the SICEEP ICC Hotel will have a reflectivity coefficient in the range 10%-13% to minimise reflections onto the surrounding precinct.



Figure 6: Cockle Bay, westward view late winter afternoon.

There is limited guidance in the literature to assess Threshold Increment in terms of pedestrian comfort and amenity. Notwithstanding, reflections off existing buildings surrounding Darling Harbour are known to occur and anecdotally appear to be accepted by users of the precinct. In Figure 6 a second reflection off another CBD building reflection is observed from the Ibis building – this condition is of interest but does not present a hazard.

Diffuse Reflections

Any façade ancillaries to be developed during detailed design should each be assessed for potential to generate nuisance reflections. Elements such as external louvers, metallic awnings, signage, blade walls, and masonry walls have potential to generate localised glare of both a diffuse and specular nature. Assessment of these is not made in the current study, but will be assessed during detailed design.

6. CONCLUSIONS

To meet the qualitative requirements of the Sydney Development Control Plan 2012, this reflectivity analysis has assessed the potential for the proposed developments to cause adverse glare events at surrounding locations. Lend Lease will ensure all exterior façade elements used throughout the development will limit light reflectivity by using glazing with a reflectivity coefficient in the order 10%-13%.

In summary, with the measures adopted by the designers as described in this report regarding choice of façade materials and façade alignment, the proposed SICEEP ICC Hotel development is not considered to present a driver hazard in terms of solar glare and will meet the Sydney Development Control Plan 2012 controls for reflectivity.

7. REFERENCES

Australia/New Zealand Standard AS/NZS 1158.1.1:2005 "Lighting for Roads and Public Spaces" Part 1.1: Vehicular Traffic (Category V) lighting – Performance and design requirements".

Hassall (1991) "Reflectivity, Dealing with Rogue Solar Reflections" Faculty of Architecture, University of NSW.

Architectural Drawings

Assessment of reflectivity in this report has been based upon development drawings prepared by Lend Lease dated July 2013.