Melbourne City Council CH_2

Artificial Lighting Study

Prepared for:
Melbourne City Council

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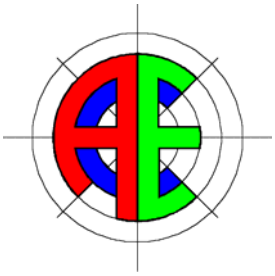

design advice

passive systems

design analysis

low energy services

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EXECUTIVE SUMMARY

The objective of this study is to determine the suitability of various options for the artificial ambient lighting designs for the Melbourne City Council CH2 development.

The study includes the simulation of three options, developed at meetings for the CH_2 building. The aim of each lighting design was to achieve a minimum ambient artificial lighting level of 150 lux on the floor as uniformly as possible. A second aim of each design was to minimise any potential glare impacts from that lighting.

Of the three options investigated, only one was able to satisfy the minimum 150 lux requirements of the design. Option 3, incorporating mounted column lights, linear pendants off the chilled ceiling elements and recessed T5 lamps at the low points of the waved ceiling satisfied this requirement. However with regard to uniformity, it is noted that the brightest areas of the floor were around the column-mounted lights, where up to 285 lux was obtained.

During investigations into glare, it was observed that the column-mounted up-lights represented a significant possible glare source (particularly at night – the condition used in the simulation), with the reflected light off the ceiling from the linear pendants also presenting itself as a potential source of glare. This may be overcome by considering different types of fittings or re-directing the upwards component of the light towards the centre of the ceiling.

There are a number of possible solutions for dealing with these issues. A strategy of dimming different lights at different times may solve some of the issues. For example, the lux levels show that, for option 3, the wall-mounted lights could be dimmed at times of no external light without reducing the light levels on the floor below the 150 lux benchmark. By dimming these lights at these times, the glare risk from the reflected light from these fittings will also be reduced.

At times of bright outdoor light conditions, the wall-mounted fittings may be needed to reduce the glare from the glazed portions of the façade, particularly where no additional glare controlling features are put in place.

The other recommended change would be to ensure that the linear pendant light fittings used at the top of the chilled ceiling elements are ones with slightly different upward photometrics. These fittings would be more effective if the upward component of the light was aimed towards the crest of the curved ceiling, thereby spreading the light evenly across the whole ceiling and reducing the potential glare risk. It should also be noted that during times where natural light levels are higher, this glare risk will be significantly reduced, particularly if the luminaires are controlled by daylight sensors.

In summary, the third option presented provides a good stepping stone for refinement of the lighting design. It provides a sufficient level of ambient lighting for the entire floor plate, but potentially has some uniformity and glare risks associated with it. Through some reasonably small design changes, it may be possible to reduce these risks without jeopardising the level of ambient lighting or energy minimisation aspired to.

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1 INTRODUCTION

This report summarises the outcomes of a radiance study into the suitability of three artificial ambient lighting options. The report is mainly concerned with investigating the uniformity and quality of lux levels on the floor, but also discusses potential sources of glare.

The report includes a brief discussion about the options selected, provides a summary of the results and makes some recommendations as to how the best design might be improved.

1.1 Considerations

The study includes the simulation of three options, developed at meetings for the CH_2 building. The aim of each lighting design was to achieve a minimum ambient artificial lighting level of 150 lux on the floor as uniformly as possible. A second aim of each design was to minimise any potential glare impacts from that lighting.

The light fittings used in each design were nominated by Lincolne Scott and Vision design in Melbourne and are based on Selux products. Selux provided the IES files, which were used to simulate the photometrics of the luminaires.

1.2 Limitations

The results of this study are valid only for the conditions stated below:

- The lighting levels shown assume no daylight or other significant sources of external light.
- The lighting levels are only valid for the options shown. These results should not be used to predict light levels from other designs.
- The ceiling and carpet are assumed to be rough, and of a fairly low reflectivity (average 0.4 for the ceiling, 0.5 for the carpet). Significant changes in the colour and characteristics of these (and other) surfaces may change the overall lux and glare levels.
- Level 5 is the only level for which results are obtained. It can be expected that there will be slight, but insignificant differences in results between each level due to the variation in the façade and glazing areas over each floor.

2 APPROACH

Three options were developed and assessed as part of this study. These options were as follows:

1 Column mounted wall up-lights (located at the perimeter only) with single T5 linear pendants suspended from the "top" of the wave in the ceiling to the height of the "base" of the wave, spaced 2m apart (see Figure 1)

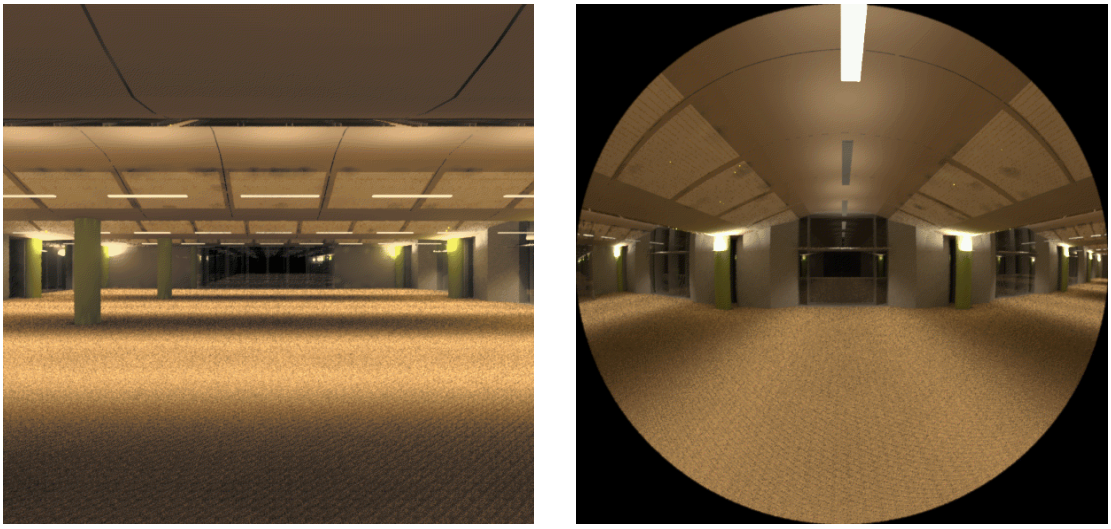

Figure 1: Representation of Option 1

2 Column mounted wall up-lights (located at the perimeter only) with single T5 linear pendants located at the "top" of each chilled ceiling element, spaced 2m apart (see Figure 2)

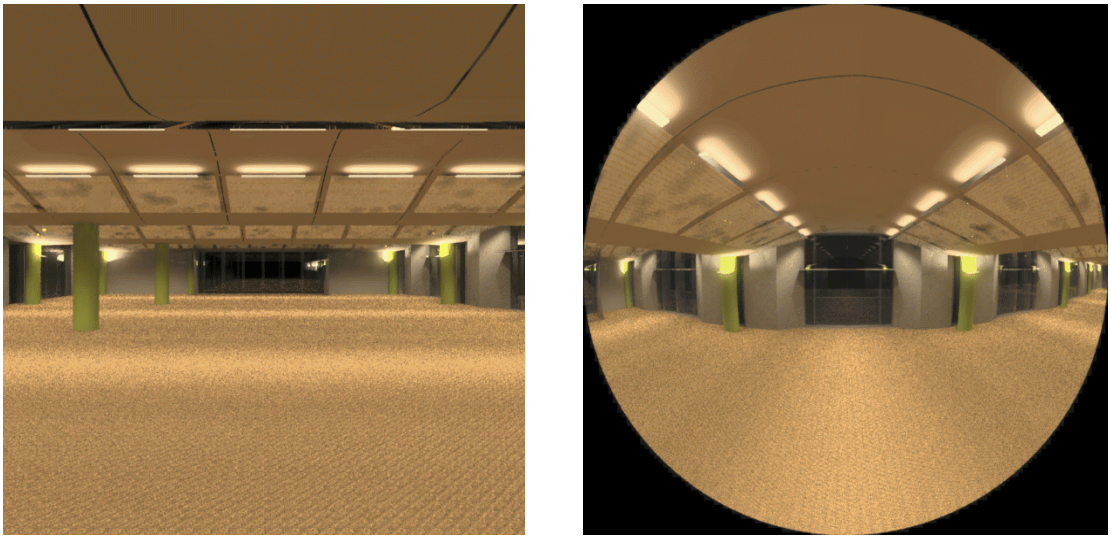

Figure 2: Representation of Option 2

3 Column mounted wall up-lights (located at the perimeter only) with single T5 linear pendants located at the "top" of each chilled ceiling element, spaced 2m apart with an additional recessed single T5 fitting located at the "base" of the wave of the ceiling, also spaced 2m apart.

Each option was built into a radiance model, with level 5 the only floor of the building simulated. Three views were created for each option:

- a horizontal section of the building showing the floor plate for level 5 (to show uniformity and lux levels);
- a 180° hemispherical view of the façade (for investigating glare); and
- a view looking across the interior of the office (to provide a visual simulation of the layout).

3 RESULTS

The primary consideration of this report is to investigate lux levels and the uniformity of each design option investigated. A secondary consideration is to identify areas which are potential glare sources. These findings are discussed below.

3.1 Illuminance and Uniformity

The primary objective of the lighting design is to achieve ambient artificial light levels of no less than 150 lux in as uniform a manner as possible. It is expected that additional lighting required for individual occupants will be provided by individually controlled task lighting, hence the relatively low ambient lighting requirements.

Option 1 included the use of mounted column lighting and hanging single T5 pendants from the higher parts of the ceiling. The lux levels are shown in Figure 3. Note that there are very few areas on the floor plate that achieve the necessary target of 150 lux. The light levels are show a very low uniformity, with levels as high as 150 lux metres away from light levels of 30 lux.

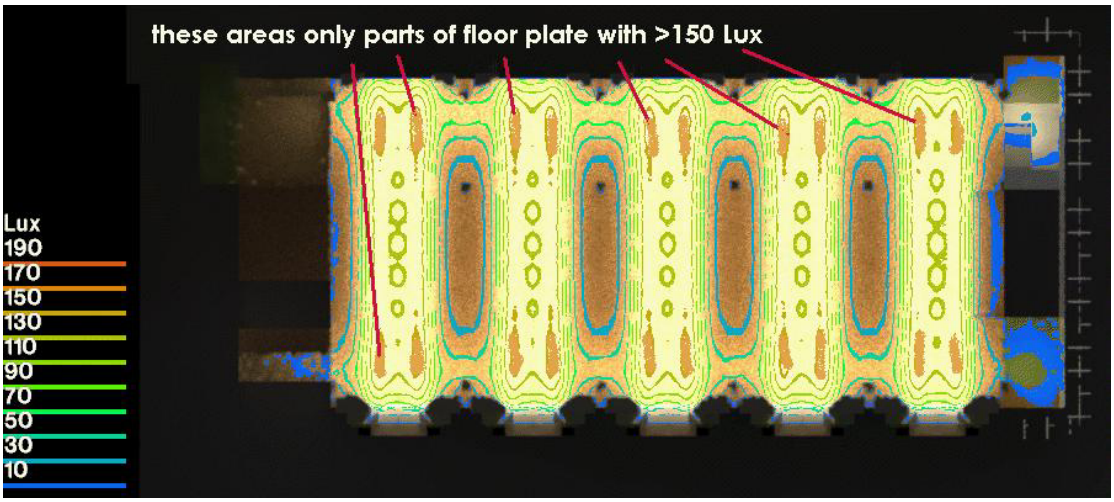

Figure 3: Lux levels on the floor for Option 1

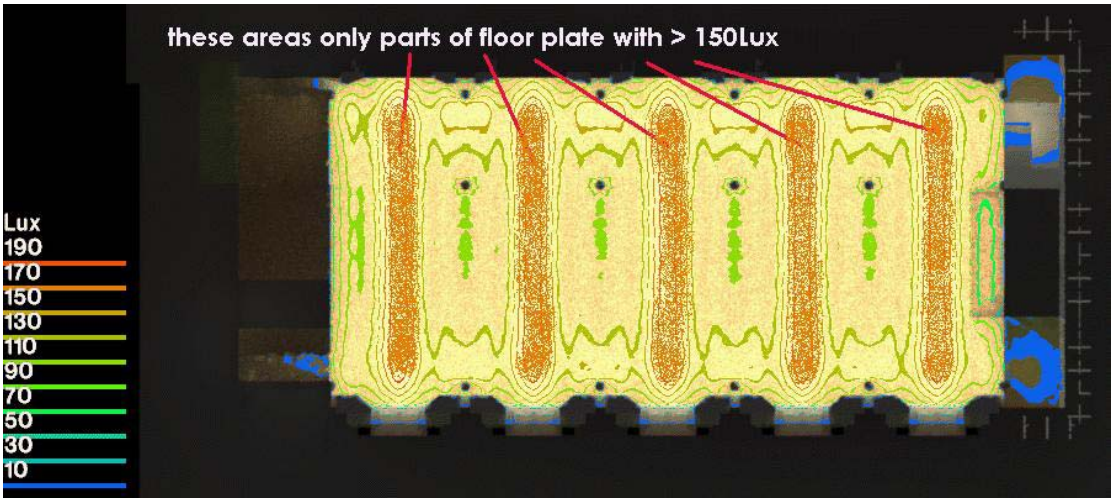

Figure 4: Lux levels on the floor for Option 2

The light levels shown for option 2 in Figure 4 are an improvement on option 1, but again fail to meet the requirements of 150 lux throughout. Indeed, only about 10-15% of the floor area is lit to the required level. In terms of uniformity, however, this option is preferable to option 1, and fairly large areas of reasonable uniformity are visible in this

option. It is also important to note that the difference between the lowest and the highest lux levels is smaller (minimum of 70-90 lux as opposed to 30 lux.)

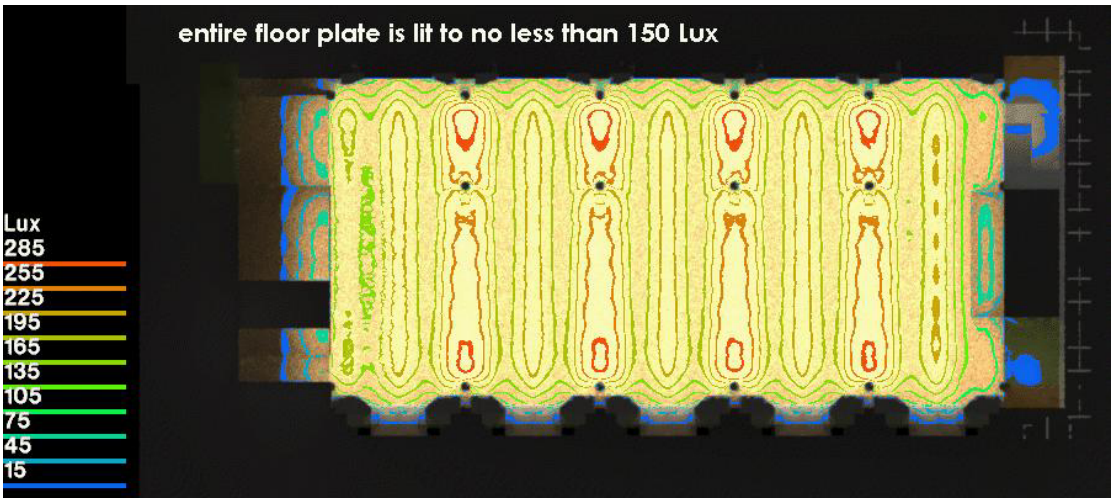

Figure 5: Lux levels on the floor for Option 3

The addition of the extra recessed T5 luminaires in option 3 significantly increases the lux levels on the floor to the extent at which almost the entire floor plate is lit to the required 150 lux (see Figure 5). The contribution of the wall-mounted lights becomes more evident in this option, with the brightest patches of light around the base of those luminaires. Indeed whilst this option provides the aspired light levels, the uniformity of the lighting provided is still relatively poor, with differences in 100 lux common between fairly proximate areas. As light levels in some areas are quite high for this option, a suitable degree of dimming may be required for certain fittings.

3.2 Glare

Glare needs to be carefully considered in lighting design as glare sources have been found to decrease the comfort and productivity of building occupants. Glare sources in offices are typically where the luminance of a surface is 7 times higher than the luminance of other surrounding surfaces. Thus is it likely that glare will require more control in an environment where the ambient light levels are kept low.

Figure 6 shows the potential sources of glare when looking toward the façade. Note that the 180° view is used, because this is most typical of the field of vision for an average person. The image shows that the reflected light onto the columns from the wall mounted lights is the most likely source of glare, with the luminance on the columns up to 1600 lux above the fitting, and with an average 8 lux on the walls and column below the fitting. This is the sort of glare source that may be lessened during the day, with the windows also becoming a source of a relatively high luminance.

The other possible source of glare is the reflected light from the linear pendants off the ceiling. The radiance results show a luminance on the ceiling of up to 130 lux directly above the light fittings, whilst most of the ceiling has a luminance of approximately 7 lux. This may be reduced if a luminare with different photometrics (angled more towards the top of the ceiling) is employed to spread the upward component more evenly across the ceiling.

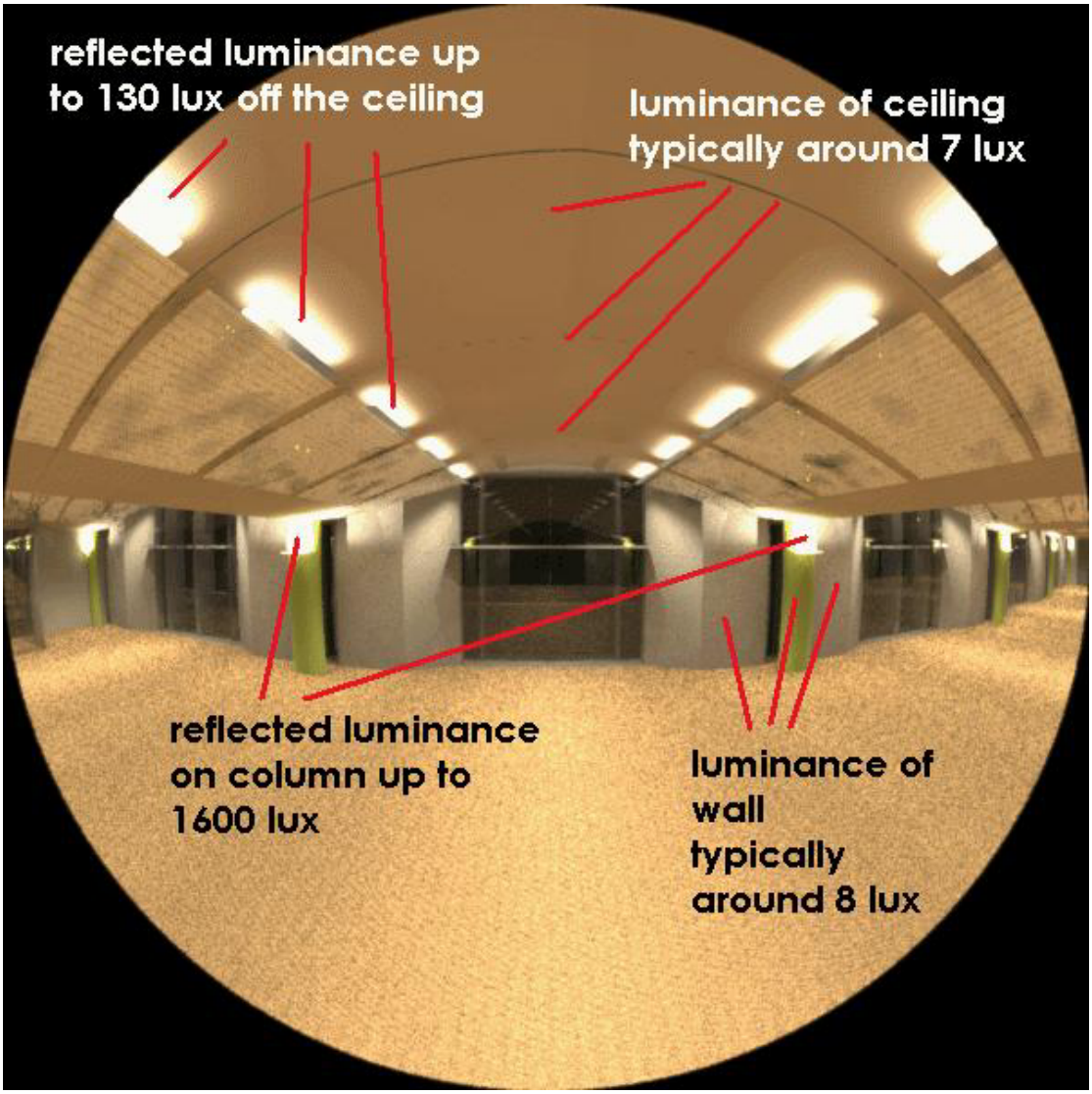

Figure 6: Potential sources of glare

In summary, these results show that, particularly given the low ambient light levels aspired to, glare will need to continue to be monitored as part of the design process.

4 RECOMMENDATIONS

The objective of this study was to determine the suitability of the proposed artificial ambient lighting designs for the Melbourne City Council CH2 development. The study sought to identify whether or not the options, devised by the design team, satisfied the minimum lux requirements, provided a good degree of uniformity whilst minimising the resultant glare.

Of the three options investigated, only one was able to satisfy the minimum 150 lux requirements of the design. Option 3, incorporating mounted column lights, linear pendants off the chilled ceiling elements and recessed T5 lamps at the low points of the waved ceiling satisfied this requirement, but lacked the sort of uniformity that might be looked for in the overall lighting design. It is noted that the brightest areas of the floor were around the column-mounted lights, where up to 285 lux was obtained.

Option 3 was then investigated for glare, in order to assess potential sources of glare for each option. It was observed that the column-mounted up-lights represented a significant possible glare source (particularly at night – the condition used in the simulation), with the reflected light off the ceiling from the linear pendants also presenting itself as a potential source of glare.

There are a number of possible solutions for dealing with these issues. A strategy of dimming different lights at different times may solve some of the issues. For example, the lux levels show that the wall-mounted lights could be dimmed at times of no external light without reducing the light levels on the floor below the 150 lux benchmark. By dimming these lights at these times, the glare risk from the reflected light from these fittings will also be reduced.

At times of bright outdoor light conditions, the wall-mounted fittings may be needed to reduce the glare from the glazed portions of the façade, particularly where no additional glare controlling features are put in place. Investigation into alternative column fittings may help to reduce this problem.

The other recommended change to option 3 would be to ensure that the linear pendant light fittings used at the top of the chilled ceiling elements are ones with slightly different upward photometrics. These fittings would be more effective if the upward component of the light was aimed towards the crest of the curved ceiling, thereby spreading the light evenly across the whole ceiling and reducing the potential glare risk. It should also be noted that during times where natural light levels are higher, this glare risk will be significantly reduced, particularly if the luminaires are controlled by daylight sensors.

In summary, the third option presented provides a good stepping stone for refinement of the lighting design. It provides a sufficient level of ambient lighting for the entire floor plate, but potentially has some uniformity and glare risks associated with it. Through some reasonably small design changes, it may be possible to reduce these risks without jeopardising the level of ambient lighting or energy minimisation aspired to.