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SOLVING GLARE IN LIGHTING APPLICATIONS

Contents

1. Introduction

The issue of glare has always been an issue where artificial lighting is provided. Any new lighting installation or change of lighting, the issue of glare need to be addressed. This short paper provides some background as to the subject and illustrates how the issue can be addressed.

2. Definition

The definition of glare in respect of vision is defined as follows: (Wikipedia)

Glare (vision) is difficulty seeing in the presence of very bright light

- **Glare** is difficulty seeing in the presence of bright light such as direct or reflected sunlight or artificial light such as car headlamps at night. Because of this, some cars include mirrors with automatic anti-glare functions.

- Glare is caused by a significant ratio of luminance between the task (that which is being looked at) and the glare source. Factors such as the **angle between the task and the glare source** and eye adaptation have significant impacts on the experience of glare.

3. Discomfort and disability glare

Glare can be generally divided into two types:

Discomfort glare and disability glare.

- Discomfort glare results in an instinctive desire to look away from a bright light source or difficulty in seeing a task.
- Disability glare impairs the vision of objects without necessarily causing discomfort.[1] This could arise for instance when driving westward at sunset.

Disability glare is often caused by the inter-reflection of light within the eyeball, reducing the contrast between task and glare source to the point where the task cannot be distinguished. When glare is so intense that vision is completely impaired, it is sometimes called **dazzle**.[2]

4. Measurement

Glare is typically measured with luminance meters or luminance cameras, both of which are able to determine the luminance of objects within small solid angles. The glare of a scene i.e. visual field of view, is then calculated from the luminance data of that scene.

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.[3][4]

The CIE recommends the *Unified glare rating* (UGR) as a quantitative measure of glare.[5][6] Other glare calculation methods include *CIBSE Glare Index*, *IES Glare Index* and the*Daylight Glare Index* (DGI).[7]

5. Unified glare rating[edit]

The unified glare rating (UGR) is a measure of the glare in a given environment, proposed by Sorensen in 1987 and adopted by the International Commission on Illumination(CIE). It is basically the logarithm of the glare of all visible lamps, divided by the background lumination L_b:

$$UGR = 8 \mathrm{Log} \frac{0.25}{L_b} \sum_n \left(L_n^2 \frac{w_n}{p_n} \right)$$

where Log is the common logarithm (base 10), L_n is the luminance of each light source numbered n, w_n is the solid angle of the light source seen from the observer and

P_n is the Guth position index, which depends on the distance from the line of sight of the viewer.

This is a very complex calculation but what is really says is the following:

- The more light from various sources the more glare.
- The more closely that the light source is in line with the line of sight, the more glare.
- The bigger the distance from the source the lower the glare.
- The more backlight lamination, the less glare.

To thus reduce glare is to increase illumination of the objects and reduce the amount of light shining closely to the directly of sight.

6. Implications

The real issue for application in commercial buildings in respect of glare would relate to both factors discomfort and Disability. In respect of Hi-Bay lights this would be heavily influenced by the angle at which the lights are shining into the eye and the brightness of the lights.

The brightness of the eye is influenced by the lighting level required in the ground and there is thus not much that can be done in this respect.

The factors that influence the angle at which the light hits the eye is affected by:

- the height at which the light is installed
- and the bean angle of the light source (LED)
- incorporating the impact of the lens or reflector.

7. Mitigation.

The amount of glare can thus be reduced by the following means:

- Increase the amount of background illumination. This is very difficult in most caes.
- Reducing the light output of the lights. This will reduce the light levels required and it thus not really an option.
- Increase the height of the lights which will increase the angle at which the light hits the eye. This is not always practice due to the height of the roof. It also means that the light level at any particular point would depend on light from many more lights which may not be possible due to the presence of obstacles.
- Decrease the able of radiation or beam angle. This can be done in 2 ways:
    - With a reflector which could be part of the actual fitting.
    - With a lens connected directly to the light.

  The problem with both these options is that it could create uneven illumination which in some cases may require:
    - the installation of more lights
    - or to increase the mounting height both of which
- Install an anti-glare lens. These lenses disperse the light and thus unfortunate reduces the light level required.

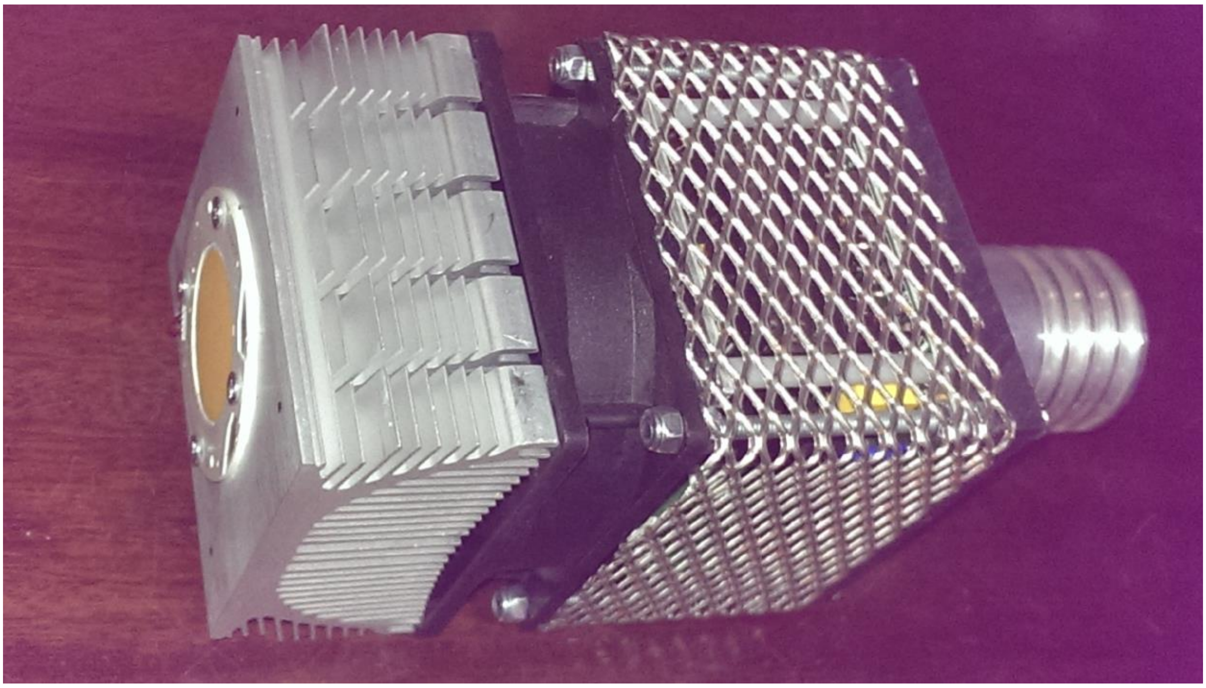
8. Elexpert solution.

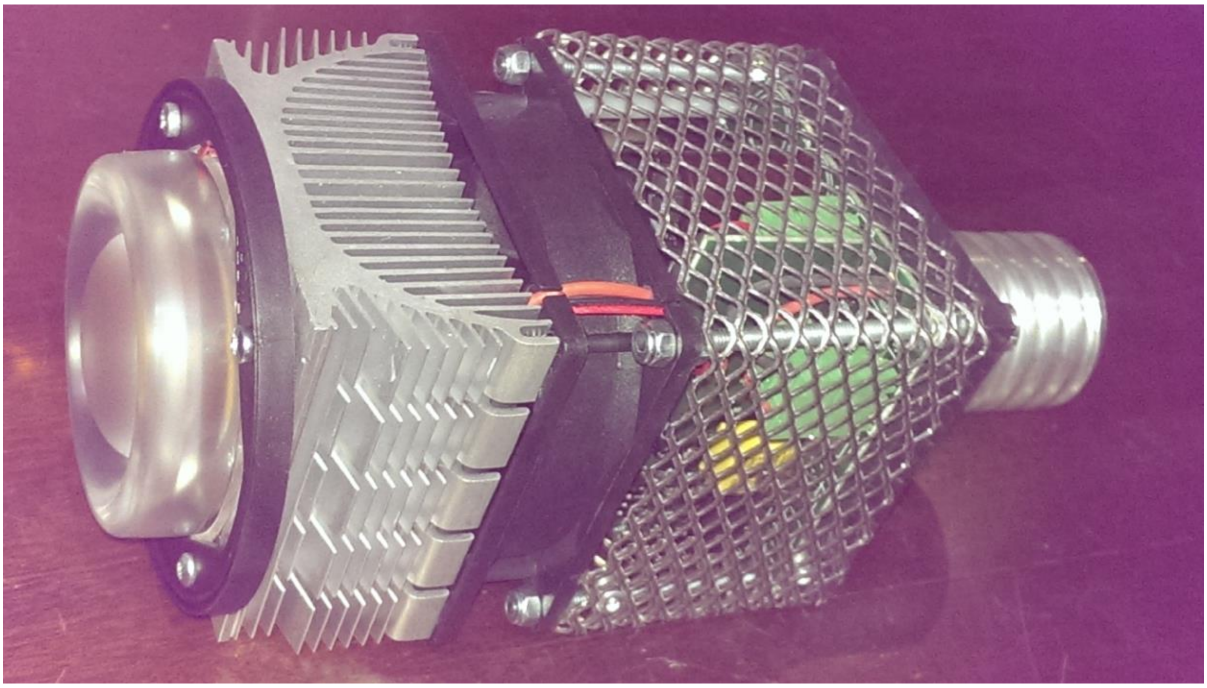
The Elexpert LED Hi-Bay lights are equipped with LED's that naturally provide beam angle of +-60 degrees. The base fitting provides no reflection of this light and it could thus a reasonable high glare factor.

The fitting can be modified to address the glare but it would cause an uneven spread of light and would also impact the ascetics of the light which is becoming a big factor in may applications. This options is thus not supported but can be done if required.

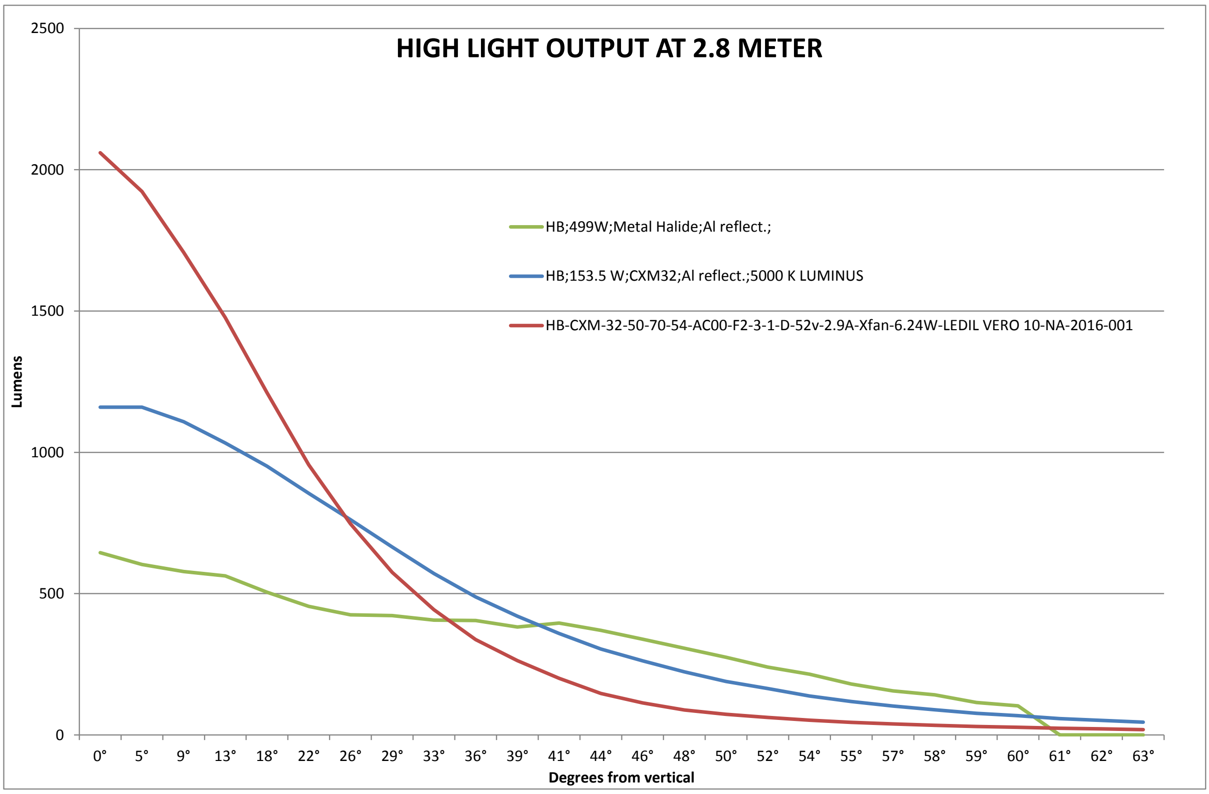
The standard solution to this is the provision of a lens that would change the effective beam angle to +-45 degrees. This would reduce the glare significant and would increase the light level on the ground significantly. At mounting heights of around 5 meters and spread between the lights of about 5 meters this would provide very good lighting with relatively even spread and acceptable glare.

The pictures below show the Elexpert un-lensed and lensed Hi-Bay lights.





The figure below shows the light levels at 2.8 meters for a 400 Watt HID light, the Elexpert 150 Watt Hi-Bay lights with and without lens inside an existing fitting with Aluminium reflector (has minimum impact on the LED lights).



It clearly shows much improved light levels and much reduced angle to the eye.

9. Contact details.

Please call if you have any further requests in this respect:

Hendrik Barnard	Tel:	27 11 787 7566
Managing Director	Fax	27 11 787 7566
Elexpert(Pty) LTD	Cell:	27 83 654 8402

E-mail hbbarnar@mweb.co.za
Address: P O Box 4069, Randburg, 2125, South Africa
