Advanced Applications of Light

In the modern healthcare environment

EAGLE LIGHTING

Introduction

On the following pages we take a brief look at several different lighting solutions for the modern healthcare sector, including specialist colour LED Solutions, CRI 95+, and Tuneable white.

At Eagle Lighting, we are committed to designing and manufacturing luminaires using the best available technology which has a positive impact on human wellbeing. We value our commitment to follow, learn, apply, and share the latest advances in lighting technology in the relevant fields of research such as vision, neuroscience, circadian biology, and colour science.

The ever-increasing understanding of the effects light has on people within the healthcare environment, coupled with the technological advances within surgical suites, has resulted in an increased demand for a range of coloured LED options, along with luminaires focused on optimising circadian rhythm.

Eagle Lighting Australia supplied Werribee Mercy Hospital with customised Cleanroom CR65L luminaires for use in numerous operating theatres. Controlled by a wall panel, each fitting contained green, blue and CRI90+ white LEDs.

Image featuring DesignPlan **Monitor** in amber

Coloured LED Solutions

The continuous growth of technological advances within surgical suites has resulted in an increased demand for coloured LED solutions.

For example, doctors now rely on advanced surgical technology, including robots and information displayed on video monitors to undertake procedures. To ensure that equipment can be viewed optimally, a green background light can be used to enhance contrast for higher visibility on screen-based information.

The use of green background light also means that turning off the lights within the operating theatre is no longer necessary. This means that OR (operating room) nurses and anaesthetists do not need to struggle to function in the dark.

With that in mind we now offer specialist colour LED solutions, which include:

Colour	Nominal Peak Wavelength (nm)	Ela-Measured Peak Wavelength (nm)
Royal Blue	452	451.4
Blue	485	476.2
Green	530	526.3
Amber	590	595.9
PC Amber	590	596.6
Red	625	633.8
Deep Red	660	658.8
Far Red	730	737.7

To achieve these colour changes we provide a controls interface to facilitate the transition between lighting scenes.

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Coloured LED Summary Table

Amber

- Provides ambient light (i.e., for fall prevention) without disturbing the circadian phase
- Research has shown that:
  - It helps melanopsin regeneration in the ipRGCs
  - It plays a role improving executive skills after a dark period that follows exposure to amber light (photic memory).

PC-amber has a wider spectrum but is still sufficiently away from the melanopic region.

Green

- Preferred in ORs where surgical videoscopy (arthroscopy, laparoscopy, thoracoscopy, etc.) is used
- Less visual strain on the surgeon while allowing for adequate ambient light.
- Turning off the lights no longer necessary so OR nurses and anaesthesia providers do not need to struggle to function in the dark.

Blue/Royal Blue

- Treatment of newborn jaundice (breaks down bilirubin), range of 430-490nm.
- Also used as night lights (which will likely change due to melatonin suppressing effects).
- Specialty uses such as FIGS (fluorescence image-guided surgery).

Red/Deep Red

- Elicit alertness without suppressing melatonin secretion.
- Similar effect as with amber light.
- Specialty uses such as FIGS
- Veterinary medicine / specialty uses.
- Red light therapy

Amber/Red

Using amber light as a functional lighting solution for indoor applications is a relatively new concept in the lighting world. Since the discovery of light's biological effects on people, we have established that high levels of cold (blueish) light activate us, and low levels of warm light calm us.

Almost all living organisms on Earth exhibit circadian rhythms, biological cycles that repeat themselves daily, the most important one being the natural 24-hour light-dark cycle.

Research in the last two decades has clearly shown that disruption of this natural 24-hour pattern of light and dark can lead to a wide variety of serious illnesses. Light levels at night should be low to not disturb our sleep, but if we do wake up, there should still be enough light to see our surroundings and safely navigate the room. Even warm white light typically contains a relatively strong blue component which, depending on the illuminance level, can suppress the emission of melatonin, the sleep hormone, disrupting sleep patterns and causing shifts in our circadian clock.

On the other hand, Amber light without any blue component is much more suitable for use as night light. This is particularly important within both hospital and aged care facilities in areas such as patient rooms/wards and amenities.

The key here is for the spectrum of the light source to lie away from the melanopic region. Any wavelengths in the amber-red region (amber, orange or red) would be similarly effective to avoid disruption to sleep patterns.

One should be mindful of low-cost amber solutions that achieve the amber colour by mixing low-cost green and red LED strips: Even though the resulting light may "look" amber, it does contain high amounts of short wavelengths due to the green component, making it inappropriate for maintaining good sleep.

Luminaires with red and deep/far red LEDs are also used in red and near-infrared phototherapy (such as non-thermal photo-biomodulation).

Operating Theatre Light

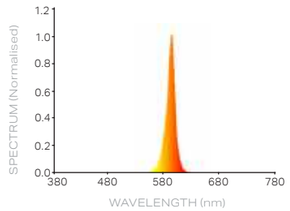
Aureled

Cleanroom Range

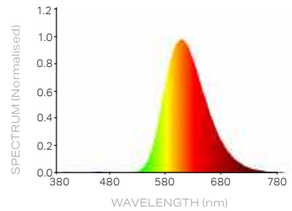
Monitor

Concava

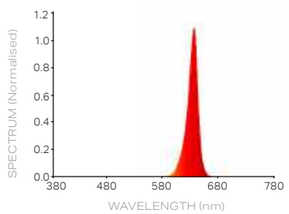
Secureroom



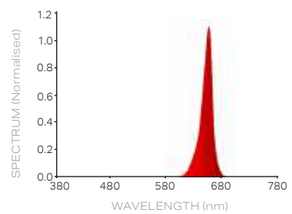
Amber



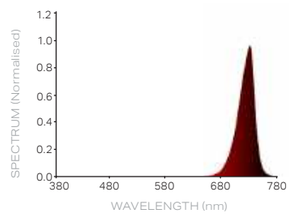
PC Amber



Red



Deep Red



Far Red

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Green

Doctors now rely on advanced surgical technology, including robots and information displayed on video monitors to undertake procedures; to ensure that equipment can be viewed optimally, a green background light can be used to enhance contrast for higher visibility on screen based information.

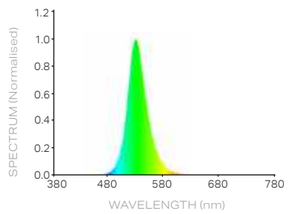
The use of green background light also means that turning off the lights within the operating theatre is no longer necessary, meaning that OR nurses and anaesthetists do not need to struggle to function in the dark.

Operating Theatre Light

Protekt

Cleanroom Range

Secureroom



Green

Blue

Blue light has long been used in the treatment of newborn (physiologic) jaundice in hospitals. In intensive phototherapy, the blue light in the range of 430-490nm break down the excessive amounts of bilirubin, the cause of the dangerous condition.

Now with the availability of highly efficient blue LEDs with sufficiently narrow spectra in various peak wavelengths to choose from, the process can be more effective than ever before.

Luminaires with colour LEDs also have other vital uses such as in FIGS (fluorescence image-guided surgery) procedures where a fluorescent dye is injected to the patient and, following a short waiting period, the area of interest is illuminated with the coloured light of specific wavelengths and the light (secondary emission) from the tissue is observed directly or captured by a camera and displayed on a monitor.

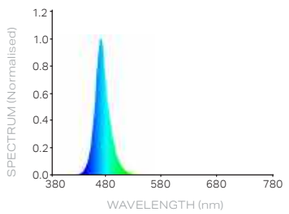
The colour LED options that we have enable us to fine tune our products to suit the requirements of various FIGS procedures.

Operating Theatre Light

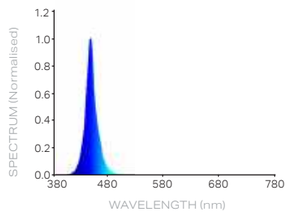
Protekt

Cleanroom Range

Secureroom



Blue



Royal Blue

Tuneable White for Healthcare

Lighting for hospital applications is one of the more complex tasks as there are opposing requirements when considering best outcomes for patient recovery – which usually conflict with the requirements of lighting for staff caring for the patients.

Considering the requirements for patients, and these vary depending on complexity of condition and stage of recovery cycle, providing flexibility in control of lighting in support of photoentrainment, circadian cycle is proven to be beneficial to recovery.

The provision of tuneable lighting and control of colour temperature plus levels of illumination throughout the day and night is necessary. Access to daylight is also a key consideration for improvement of patient care. For lighting overnight, the contribution of amber spectrum is best practice.

Cleanroom Range

OmniPOD Linear

Florence+

Aureled

Pleiad G4 Robust

Pleiad G4 125/165/205

Operating Theatre Light

Concava

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How does tuneable white work technically?

The LED modules contains a mixture of diodes providing warm or cold light. By mixing the light from these we can get colour temperatures between 2700-6500 Kelvin out of a single luminaire. Everything is controlled via DALI Device Type 8 and can be managed with different types of control units depending on what you want. The simpler panels have buttons or levers where the colour temperature is controlled with a slider and the intensity with another.

For an automatic dynamic control of colour and intensity a router system that dictates the levels over time is used. The colour temperature and intensity is controlled by the clock and doesn't reflect the actual lighting conditions outdoors as it would be very dark in the room during the winter months.

Light in a Patients Room

A patient's room is very complex from a lighting perspective because both the patient's and staff's needs must be considered. Regardless of the time of day the patient needs a calm and stress-free environment that feels safe and promotes healing and well being. Staffs needs sufficient work light to examine and treat patients, administer medication and make notes.

Concava

Aureled

Pleiad G4 125

Patient– day

During the day, sunlight is supplemented with cool ambient light with a proportion of blue light. Using the Concava over-bed light, 4000k direct / indirect light can mimic natural daylight to help suppress the production of melatonin and stimulate the production of cortisol to ensure alertness throughout the day.

Patient– evening

During the afternoon and evening, the light levels are reduced and the light becomes warmer. The lighting follows recommendations for light that supports the circadian rhythm and prepares the body for the night by permitting melatonin production. Direct/Indirect warm light is generated from the Concava over-bed light.

Patient– night

Lighting is also needed in patient rooms at night and then preferably light without blue elements so that important night-time sleep is not disturbed. Amber is a light where we quite simply remove the blue part of the light. By using lighting with low levels of amber, we ensure enough light for the staff to be able to check on the patient and for the patient to be able to orient themselves in the room. Downward amber light only is one of the 3 lighting modes the Concava over-bed light can provide.

Patient– examination

During an examination, light of at least 1,000 lux is required on the bed and we achieve this by combining the light from the Aureled, Concava, and Pleiad G4 125 downlights. Including all three locally made products in a patient room offers flexibility by meeting various lighting levels needed for nurses to perform various tasks.

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CRI 95+

How important is adequate lighting in healthcare applications?

Most people equate "better lighting" with "how much light".

However, visual performance in medical applications requires the consideration of multiple factors beyond the simple metric of the required quantity of light.

Modern healthcare applications have breathtaking capabilities, but for medical staff to deliver the expected outcomes at the highest quality, a lighting criterion must be specified to enable optimum visual performance. A clear visual perspective is essential to apply processes and execute procedures quickly and accurately.

Whether the procedure is surgery, patient examination, monitoring recovery or diagnosing problems, medical staff need excellent illumination and colour rendering to differentiate conditions and identify symptoms.

When considering the perception of colour, accuracy of colour discrimination, differentiation of shades of skin tone (Cyanosis Observation Index) the colour quality of the LED light source is paramount.

Eagle Lighting have introduced CRI 95+ as an option for the Operating Theatre Light, Cleanroom IP65, and Secureroom (see below). CRI 95+ provides enhanced visual performance for medical staff and delivers beneficial outcomes for patient care.

Main benefits of CRI 95+

CRI 95+ delivers the best-in-class COI (Cyanosis Observation Index) of <0.9. The lower the number, the greater the capability of Cyanosis detection. The maximum permitted Index score is 3.3. Refer AS/NZS 1680.2.5:2018).

An exceptionally high R9 value of 80+ is achieved enhancing the visual representation of objects within the space. Recent studies recommend using red light as it promotes alertness in settings where (or at times when) you don't want to suppress melatonin but maintain/increase alertness and attention levels. This is particularly beneficial for surgeons, night shift workers, nurses, and patients in recovery. See in **Figure 1.1** comparison in red light between CRI90+ and CRI 95+.

2 SDCM (Standard Deviation of Colour Matching) is also achieved which maintains a high quality and prestigious impression across the complete operating duration of the lighting installation. The lower the SDCM value, the tighter the colour tolerance, meaning that the colour difference between any two luminaires of the installation is small. **Figure 1.2** highlights where 2 SDCM sits in the Chromaticity diagram.

CRI 95+ gives our customers access to the best colour rendition LED technology on the market, and it is locally available! New CRI 95+ product codes are now published on our website for the Operating Theatre Light, Cleanroom IP65, and Secureroom ranges. However, this technology can also be specified for most of our locally made products upon request. Please speak to your Eagle Lighting representative for further information.

Operating Theatre Light
CRI 95+

Cleanroom IP65
CRI 95+

Secureroom CRI 95+

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Figure 1.1
CRI 95+ 4000K R9: 80+ vs CRI90+ 4000K R9: 61

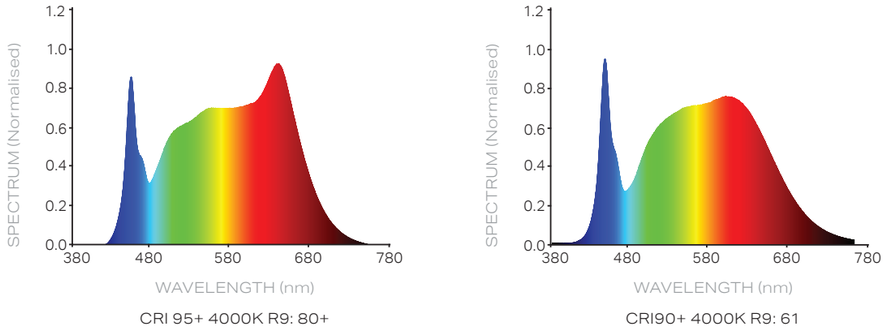
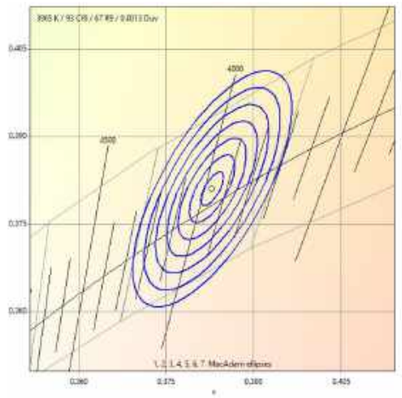


Figure 1.2
SDCM chart, visibility descriptions, and chromaticity diagram.

Size MacAdams Ellipse	Visibility
1 SDCM	Hardly any colour difference visible
2 SDCM	Differences are visible only with instruments
3 SDCM	Slight difference in colour visible
4 SDCM	Colour difference visible
5 SDCM	Marked difference visible



Antimicrobial Coating

Our complete cleanroom ranges (listed below) come with Antimicrobial powder coatings that protect against microbial growth, as standard.

By incorporating silver ion antimicrobial technology, our cleanroom luminaires will now be even easier to keep hygienically clean.

How Does it Work?

While cleaning will help prevent microbial growth on products, the new powder coatings applied to our cleanroom luminaires provide an additional defence against microbial growth.

With the antimicrobial coating, a concentration of silver ions is available on the surface of the luminaire to act against target microorganisms.

In the presence of environmental moisture, silver ions in the coating penetrate microbes contaminating the surface of a treated product, disrupting their growth and reproduction. This leads to a reduction in the number of microorganisms on the surface of the coating, thus providing 24-hour protection, seven days a week.

The Benefits

- Providing antimicrobial performance for the lifetime of the product
- Demonstrable ability to reduce bacteria by more than 99.9%
- The ability to inhibit the growth of moulds and yeasts.
- Meeting the highest antimicrobial standards.

Products offering this powder coating as standard

Cleanroom Range

Operating Theatre Light

Secureroom

Concava

Antimicrobial powder coating available for other products upon request

Case Study

Sunshine Coast University Hospital

Birtinya, QLD

Eagle Lighting are proud to be positioned as the key lighting solutions partner for projects of this size and complexity within Australia.

Eagle Lighting worked closely with Lend Lease to achieve all of their requirements. 75% of the luminaires in this project are Australian Made by Eagle Lighting. The remaining 25% of luminaires include our brands Fagerhult, Simes, Whitecroft and Designplan.

Luminaires supplied:

LED Operating Theatre Light | Pleiad Compact | Pleiad Comfort IP44 Cleanroom | Vertex | Enviro Evoline | Densus | Pleiad Evo | Herculed | A range of luminaires by Designplan, Fagerhult, Simes & Whitecroft

Case Study

Calvary Bruce Hospital

Bruce, ACT, Australia

Opening in September 2017, Calvary Bruce Private Hospital is a $77 million dollar state of the art private hospital on Calvary's Bruce Campus. We supplied luminaires from theatres to patient areas, back of house and car parking.

Luminaires supplied:

LED Operating Theatre Light | Pleiad Compact | Pleiad Comfort IP44 Cleanroom | Vertex | Enviro Evoline | Densus | Pleiad Evo | Herculed | A range of luminaires by Designplan, Fagerhult, Simes & Whitecroft

EAGLE LIGHTING

A Fagerhult Group Company

Contact us today

https://eagle.lighting

eagle@eaglelighting.com.au

Australia

Vic (Head Office)
17-19 Jets Court
Melbourne Airport 3045
(03) 9344 7444

NSW
Level 1, 71-73 Alexander St
Crows Nest 2065
(02) 9420 5799

QLD
53 Caswell Street
East Brisbane 4169
(07) 3891 0744

ACT
0411 889 406

WA (Distributor)
H.I.Lighting
(08) 9377 1322

SA (Distributor)
Buckford Illumination Group
0448 064 412

TAS (Distributor)
Southern Lighting
(03) 6231 5599

New Zealand

Auckland (Head Office)
Ground Floor,
82 Wyndham Street
Auckland Central 1010
0800 324 374

Wellington
021 597 900

Christchurch
Unit 4
107 Wrights Road
Christchurch 8024
021 655 609

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GCC ISO 14001 Certified

GCC ISO 45001 Certified

JAS-ANZ

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NATA