

Lighting Technology – Introduction Session



This Activity received funding from the Department of Industry as part of the Energy Efficiency Information Grants Program.

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Australian Government
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Lighting Technology – Intro Session

Session Content

Intro

- Briefing overview
- Daylight: The cheapest light

Lighting Theory

- Luminaires and light output ratio (LOR)
- Lighting standards
- Lighting benchmarks for commercial offices

Considerations When Reviewing Lighting Options

- Lumen output/efficacy
- Colour temperature
- Colour rendering index
- Lamp life

Lighting Technology – Daylight, the cheapest light



Key Benefits:

- Staff productivity and wellbeing
- Reduced need for artificial light, therefore reduced energy costs

Issues to consider:

- Glare
- Solar gain (heat transfer) through windows in summer

Lighting Technology – Luminaires

What purpose do they serve?

- Reduce glare
- Dissipate heat produced by lamp
- House circuitry



Example of a batten luminaire for a linear fluorescent (tube) lamp. Note the translucent plastic cover used to diffuse the lamp light and reduce glare.



Example of a troffer luminaire for linear fluorescent (tube) lamps. Note the use of louvers to obscure direct views of the lamps at low angles and reduce glare.

Lighting Technology – Luminaires (cont.)



An example of a high bay luminaire which could house a variety of high intensity discharge (HID) lamps such as metal halide, mercury vapour or LED.



An example of a floodlight luminaire incorporating an anodised aluminium reflector to improve light output.

Lighting Technology – Light Output Ratio (LOR)

LOR is a comparison of the ratio of the amount of light (luminous flux) emitted by the lamp and the luminous flux emitted by the luminaire.

LOR is represented as a percentage, the higher the percentage the more efficient the luminaire is in utilising the light generated by the lamp

Example:

- The troffer luminaire shown to the right has a LOR of 75%.
- The luminaire contains two 36 Watt T8 fluorescent tubes, these lamps have a rated output of 3,350lm each.
- Therefore the luminous flux of the luminaire will be 5,025lm

i.e. $(3,350\text{lm} \times 2) \times 0.75 = 5,025\text{lm}$



Lighting Technology – Lighting Standards

AS/NZS 1680 standards: Office and screen based tasks

Activity	Recommended illuminance (lux)
Typing, reading - task	320
and writing - background	160
Computer work - keyboard	160
- reference material	240–600 (depending on print quality)
- background	160
Drawing - drawing board	600
- reference material	320–600 (depending on print quality)
- background	240
Meeting rooms, training rooms and boardrooms	240–320
Photocopy rooms - general	160
- collating	240

Source: The down-to-earth officecare guide a practical guide to environmental action in the office revised edition 2005

Lighting Technology – Building Code of Australia (BCA)

The BCA specifies minimum levels of energy efficiency performance for new builds and renovations.

Table J6.2a MAXIMUM LAMP POWER DENSITY	
Location	Lamp power density (W/m ²)
Within a Class 3 and 9c aged care building sole-occupancy unit	10
Within a dormitory of a Class 3 building used only for sleeping	5
Within other areas of a Class 2, 3 or 39c aged care building that are frequently occupied such as a lounge room, a dining room, restaurant or gymnasium	8
Within public corridors and the like	3
Within stairways	5
Services areas such as a plant room or store room	6
Employees' work areas such as a reception	10

J6.2(b) - Interior lighting

Table J6.2b MAXIMUM ILLUMINATION POWER DENSITY	
Space	Maximum illumination power density (W/m ²)
Entry lobby	15
Factory, industrial tasks and processes	17
Laboratory	15
Office – artificially lit to an ambient level ≥ 200 lux	10 (7 if < 200 lux)
Restaurant, café, bar, hotel lounge (food/beverages)	20
Retail space including sales area of museum/gallery	25
School – general purpose learning area	10
Storage – shelving height $\geq 75\%$ aisle lighting height	10 (8 if $< 75\%$)
Service area, locker, staff, rest and cleaner's rooms	3

The requirements of J6.2(a) and (b) do not apply to:

- Emergency and exit lighting
- Signage and display lighting within cabinets and display cases
- Lighting of specialist processes (theatre, sport, art, fume cupboard, operating theatre)



Source: EcoSmart Electricians, Electrical Energy Efficiency Starter Kit

Lighting Technology – Benchmarking

Office Buildings - Benchmarking

Illumination Power Density (IPD)	Band ratings
<7W/m ²	Excellent
7 to 10W/m ²	Good
10.1 to 15W/m ²	Median (Average)
>15W/m ²	Poor

Source: Commercial Building Disclosure program, Australian Government

Lighting Technology – Lumen Output and Efficacy

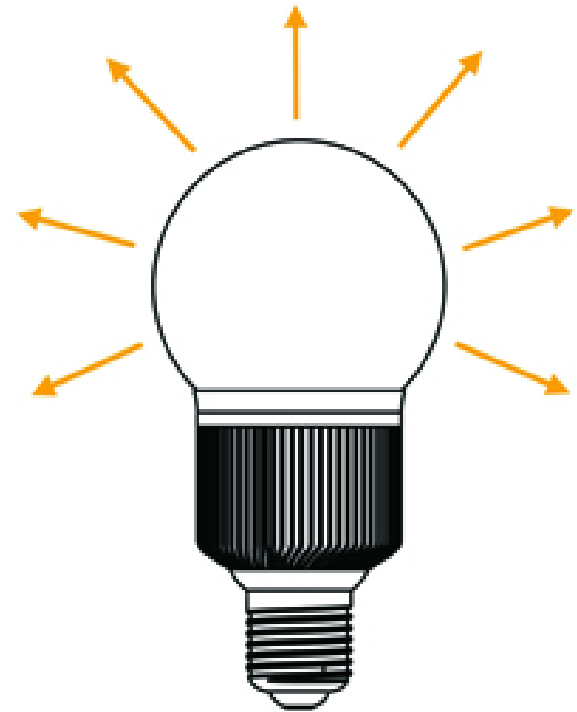
Lumen = A measure of light output

Efficacy = How much light a lamp produces per watt of electricity consumed, usually measured in lumens per watt (l/W)

Example:

The system efficacy of a 1 x 28 watt T5 fluorescent lamp (tri-phosphor with 2,600 lumen output at 25°C) luminaire operating on a standard electronic ballast of 3 watts loss would be:

28 watt + 3 watt = 31 watts divided by 2,600 lumens = 83.87 l/watt.



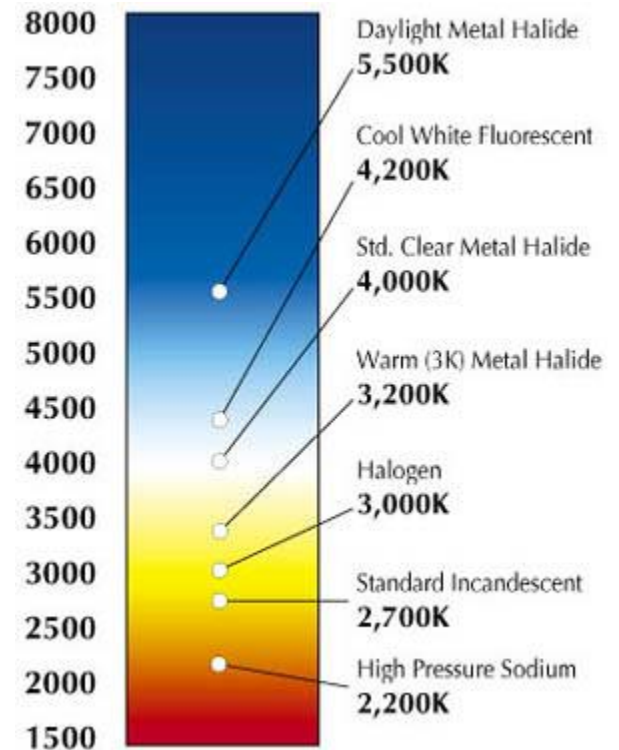
Lighting Technology – Colour Temperature

Colour temperature – Kelvin (K)

Daylight has a colour temperature of between 5,000 -6,000k.

Lower Kelvin numbers mean the light appears more yellow.

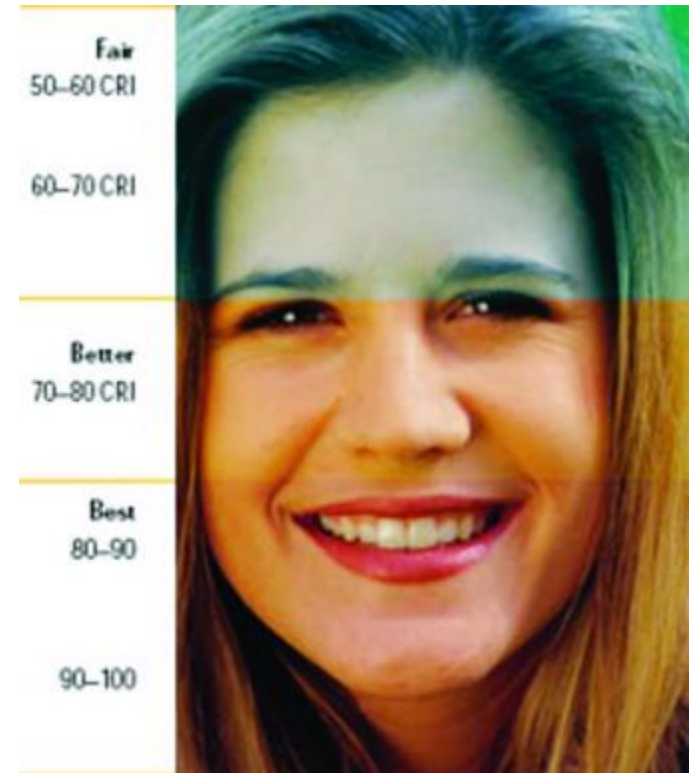
Higher Kelvin numbers mean the light is whiter or bluer.



Lighting Technology – Colour Rendering Index

Colour rendering, expressed as a rating from 0 to 100 on the Colour Rendering Index (CRI), describes how a light source makes the colour of an object appear to human eyes and how well subtle variations in colour shades are revealed.

The higher the CRI rating is, the better its colour rendering ability.



Lighting Technology – Colour rendering index

Typical CRI figures for various lamp types are provided below:

Lamp Type	Typical CRI Figure	Lamp Type	Typical CRI Figure
Incandescent	100	Standard Quartz Metal Halide	65
Tungsten Halogen	100	Ceramic Metal Halide	80+
Fluorescent (halophosphor)	60+	Standard Mercury Vapour	45
Fluorescent (triphosphor)	80+	High Pressure Sodium	25
Compact Fluorescent (CFL)	80+	White High Pressure Sodium	60
Specialised Fluorescent (enhanced CRI)	90+	Low Pressure Sodium	15
Light Emitting Diode (LED)	75+		

Lighting Technology – Lamp Life and Lumen Maintenance

Lamp Life: How long will they last?

Lamp type	Typical rated life
Incandescent	1,000 hrs
Fluorescent (incl. CFL)	10,000 - 36,000 hrs
High Intensity Discharge	10,000 - 24,000 hrs
Halogen	2,000 - 4,000 hrs
LED	35,000 - 70,000 hrs

Lamp Lumen Maintenance Factor: Is there any change in the amount of light output over this useful life?

Example:

Factor 0.96 after 2,000 hours: the light output of the lamp after 2,000 hours is 96% of the initial light output.

What Next?

- Next webinar: Specific Lighting Technologies
- Call VECCL's Carbon Compass Helpline on **8662 5490** for advice on lighting upgrade considerations, different technologies and subsidies available.
- www.carboncompass.com.au
- www.whatcanidorightnow.com.au



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Lighting Technology – References and Further Reading

Further Information Resources

- EcoSmart Electricians-Electrical Energy Efficiency Starter Kit
http://www.ecosmartelectricians.com.au/starter-kit/a00_01.html
- The Basics of Efficient Lighting-A reference manual for training in efficient lighting principles 2009, Dept. of Environment, Water, Heritage and the Arts
<http://www.energyrating.gov.au/wp-content/uploads/2011/02/2009-ref-manual-lighting.pdf>
- Light's Labour's Lost-Policies for energy-efficient lighting, International Energy Agency
<http://www.iea.org/publications/freepublications/publication/name,3644,en.html>

Lighting Standards

AS1680.1-2006, 'Interior and workplace lighting - general principles and recommendations'
AS/NZS 1680.2 series, 'Interior and workplace lighting - specific applications'

Daylighting Research Articles

- Okura S, Heschong L, Wright R, 2000, "Skylighting and Retail Sales"
- Leslie R P, 2002, "Capturing the daylight dividend in buildings: why and how?", Lighting Research Center, Rensselaer Polytechnic Institute, 12180 Troy, NY, USA
- Li Danny H W, Lam Tony N T, Wong S L, 2005, "Lighting and energy performance for an office using high frequency dimming controls", Energy Conversion and Management 47