SUSTAINABLE ENERGY AUTHORITY OF IRELAND

Feidhmeannacht na Seirbhíse Sláinte
Health Service Executive

Hospitals

A GUIDE TO ENERGY EFFICIENT AND COST EFFECTIVE LIGHTING

This guide provides advice on the most appropriate lighting for hospitals and information on running costs, energy efficiency and visual effectiveness of new technologies and techniques. By following the information provided, hospitals should be able to reduce the energy consumption of lighting systems by up to 50%, cut maintenance costs and improve the overall lighting quality.

UP TO **50%** SAVINGS

ENERGY EFFICIENT AND COST EFFECTIVE LIGHTING

Lighting is the largest single user of electricity, typically using almost 40%, in most healthcare buildings. Lighting should be energy efficient, effective and require minimum maintenance.

When these choices are integrated with good daylighting strategies, electricity costs can be dramatically reduced and the lighting effect vastly improved.

LIGHTING REQUIREMENTS AND TECHNIQUES

Lighting in hospitals must be suitable for medical staff to do their work and meet the needs of patients and their visitors. Good lighting can help provide a comfortable recovery environment. The main criteria for energy efficient and effective lighting in hospitals are:

- A colour appearance
- B colour rendering
- C light distribution
- D lamp and luminaire efficiency
- E controls
- F use of daylight
- G maintenance
- H lamp life

Accent and general lighting combined produces a good effect and impact.

COLOUR APPEARANCE AND COLOUR RENDERING

Colour appearance (Figure 1) defines the appearance of a colour 'white' and is measured on the Kelvin temperature scale (K). A colour temperature of less than 3,500 K is 'warm'; a colour temperature of 3,500 K is mid-white; and a colour temperature of 4,000 K and above is 'cooler'. The colour of 'white' which is often used in general areas is 4,000 K and for areas where people may dwell for long periods a warmer colour of 3,000 K may be more suitable.

Colour rendering (Figure 2) is the ability of a light source to give good colour representation of the colour it is illuminating. It is measured on a CRI (Colour Rendering Index) scale of Ra 0-100 with Ra 100 representing the best, which is equivalent to that provided by daylight. For diagnosis, accurate colour rendering of skin is essential.

- Clinical areas: Luminaires should use lamps of Ra 80 and above.
- Examination or treatment areas: Luminaires should use lamps with a colour rendering capability of Ra 80 to Ra 90+.
- Corridors or streets: These areas can use the less expensive and lower Ra 58 colour rendering lamps, with a colour appearance of choice.

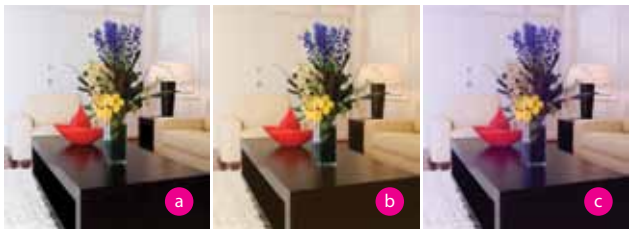


Fig.2 *Colour rendering characteristics of 3 different light sources*
(a) *Daylight = Ra 100,* ***(b)*** *Tungsten = Ra 100,* ***(c)*** *Single phosphor 'cool' white = Ra 58*

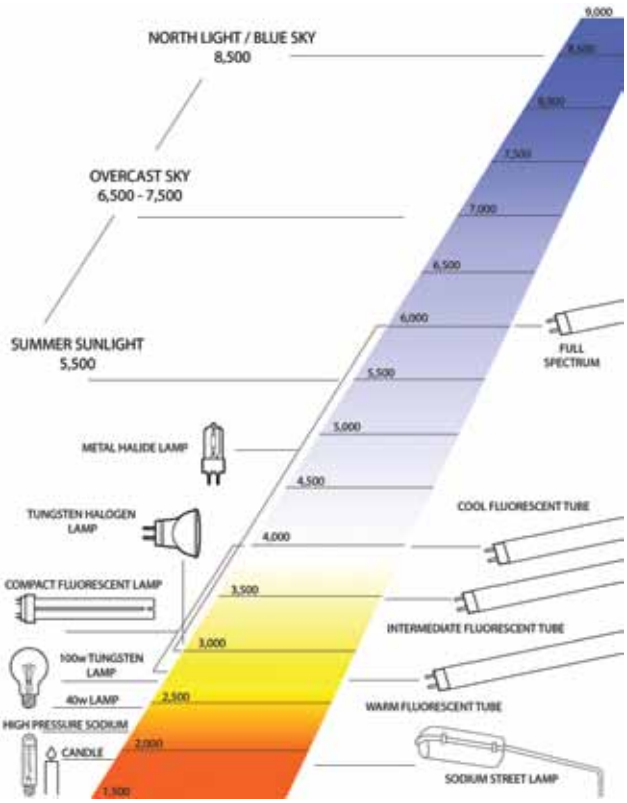


Fig.1 *Colour temperature (K) of various light sources.*

LIGHT DISTRIBUTION

- Even and uniform lighting in patient areas.
- Avoid glare by using direct and indirect lighting techniques as appropriate.
- Accent lighting to nurses' stations should provide area focal point.
- Reduce lighting levels overnight with appropriate controls.
- Illumination levels are measured in lux and readings can be taken with a hand-held meter. Guidelines for appropriate lux levels for hospital areas are shown overleaf.

APPLICATIONS IN HOSPITALS

The most appropriate lamp choices for different hospital areas are shown below. More detailed guidelines on light levels for the wide range of hospital areas are available from the National Standards Authority of Ireland guide *I.S. EN 12464-1:2002 Light and lighting – lighting of work places – Part 1: Indoor work places*. This guidance should be consulted for more comprehensive data. Full details of the properties of each of the recommended lamps are given in the Lamp Comparison Chart on page 5.

RECEPTION & NURSING STATIONS

Appropriate lighting levels – 300 lux
Colour Appearance 4000 K – Colour Rendering Ra 80+
For 'General Lighting' use lamp – 8, 9 or 10
For 'Under Cabinet Lighting' use lamp – 8, 9 or 10
For 'Task Lighting' use lamp – 11
For 'Accent Lighting' use lamp 6 or 7

CORRIDORS & CIRCULATION AREAS

Appropriate lighting levels – 150/200 lux
Colour Appearance 4000 K – Colour Rendering Ra 58+
For 'General Lighting' use lamp – 8, 9 or 10
Always light the walls as this gives the appearance of brightness

PATIENT WARDS

Appropriate lighting levels – 300/500 lux (1000 lux inspection)
Colour Appearance 3500 K to 4000 K – Colour Rendering Ra 80+
For 'General Lighting' use lamp – 8, 9 or 10
For 'Task Lighting' use lamp – 3, 4 or 11

OFFICE AREAS

Appropriate lighting levels – 300/500 lux
Colour Appearance 4000 K – Colour Rendering Ra 80+
For 'General Lighting' use lamp – 8, 9 or 10
For 'Task Lighting' use lamp – 11

EXAMINATION AREAS

Appropriate lighting levels – 300/500 lux (1000 lux inspection)
Colour Appearance 4000 K – Colour Rendering Ra 80+
For 'General Lighting' use lamp – 8 or 9
For 'Task Lighting' use lamp – 3, 4, 10 or 11

LAMP EFFICIENCY

Lamps in hospitals should generally be either compact or tubular fluorescent using electronic high frequency control gear, taking into consideration colour rendering, colour appearance, lamp life and energy effectiveness.

NB – Surgical theatre lamps are sourced from specialist suppliers and outside the scope of this document. They must conform to *EN 60601-2-41:2000 Particular requirements for the safety of surgical luminaires and luminaires for diagnosis.*

LUMINAIRE EFFICIENCY

Light Output Ratio (LOR) is a measure of the proportion of the lamp output that emerges from the luminaire. All luminaires chosen should emit the maximum amount of light. Luminaires vary considerably in LOR with some types of luminaires ranging from 24% to 80%, this information can be obtained from the luminaire manufacturer.

- Choose the highest LOR to minimise the number of fittings and lamps that are required. A minimum of 65% is recommended.
- Always consider the appropriate louvre/diffuser to minimise glare where required.

CONTROLS

Effective automatic lighting controls can detect presence and daylight to reduce lighting requirements and minimise running costs.

- Zoned lighting: for corridors and larger administration areas where lighting levels can be adjusted according to daylight availability by either switching to 'off' or continuous up/down dimming (Figure 3).
- Presence detectors: for small areas such as toilets, equipment stores, medical record stores, wherever variable occupancy occurs. Available as infra-red (Figure 4) for cellular areas or ultrasonic detectors (Figure 5), with ranges between 5m and 60m depending on the application.
- Daylight sensors: to turn lights on and off and also dim lights when sufficient daylight is available in circulation areas and administration areas. They can be integrated with a presence detector. They should be used for external floodlighting.
- Lighting to bed spaces should be on individual switches and should be switched off if the bed is unoccupied.
- Central lighting control systems should be of the digital type. DALI (Digital Addressable Lighting Interface) is one of the appropriate options.
- Controls should be set to ensure that fluorescent lamps are not switched on and off at too short an interval. Fluorescent tubes which have 'soft start' i.e. electronic starters or electronic high frequency ballast types, provide a less detrimental impact on the life cycle of lamps.

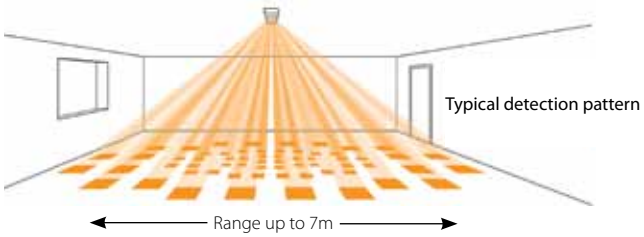


Fig.3 *Infra-red presence detection for 'zoned' areas can also provide daylight sensing and manual override control.*

Fig.4 *Infra-red wall sensor – Detects presence (in a range of 5 to 9 metres) and daylight – This 'No neutral' type can directly replace a standard manual switch.*

Fig.5 *Ultra-Sonic / Microwave detectors are more sensitive presence detectors.*

Further details on lighting controls are available in a separate document in this series.

DAYLIGHT

Effective use of natural lighting can greatly reduce lighting costs and improve the ambience of all areas.

- Ensure that daylight does not produce glare or discomfort, particularly in ward areas or where display equipment is being used.
- Use independent photocells in long corridors which have areas partially lit by daylight.
- Investigate the use of light pipes, rooflights or other ways of getting more daylight into the building as part of refurbishment works.
- Consider 'daylight blinds'.
- Always link daylight to electric lighting.

DAYLIGHT BLINDS

Some areas that receive good quantities of natural light could benefit from using 'daylight blinds'. These blinds reduce glare and allow daylight to enter the space in a controlled way as shown in Figure 6, instead of the more common standard horizontal or vertical blinds which cut out the light into the space when they are drawn to alleviate glare or excessive sunlight. There may be little need to use artificial lighting during daylight hours, if daylight blinds are installed and linked to the electric lighting.

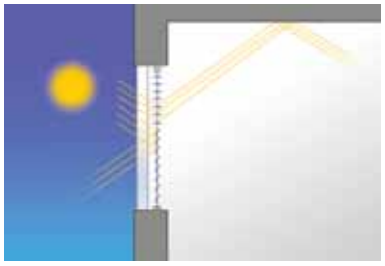


Fig.6 *Daylight Blinds*

MAINTENANCE AND LAMP REPLACEMENT

There are great cost advantages to upgrading existing lamps and fittings and recommendations for the most common lamp replacements are given below, with typical expected savings.

Additional lamp comparisons are shown on Page 5. When replacing lamps, the new lamp should have comparable colour appearance and light levels to the lamp it replaces. It should be trialled in an area before widescale lamp replacement.

Existing Lamp Type	Replacement Lamp Type	Benefits
Incandescent GLS 40W 60W 75W 100W 150W	CFLi (integral ballast) 9W-11W 11W-14W 15W-19W 20W-25W 26W-29W	75% energy saving Up to 12 times the lamp life of an incandescent lamp Use 'warm white' (2,700 K) CFLi lamps
Mains Voltage Halogen Dichroic Reflector 35W 50W	CFLi (GU10 fitting) 7W 11W	80% energy saving Seven times the lamp life As the light distribution differs between these two lamp types lower light levels may be expected
T12 (38mm) or T8 (26mm) switch start luminaires.	T5 (16mm) high efficiency fluorescent tube.	Between 30% and 50% energy saving A conversion kit is required which includes the new electronic control gear (kits can also be used for T12 to T8 conversions) Further energy savings can be made by using fewer fluorescent tubes when 'clip-on' tube reflectors are used within luminaires with no internal reflectors
T8 (26mm) Halophosphor fluorescent tube	T8 (26mm) Triphosphor fluorescent tube	10% energy saving Twice the lamp life achieved when used with electronic ballasts Fluorescent triphospor tubes are available with up to 60,000 hours lamp life

Note: *Always use reputable suppliers and products that comply with all national and EU lighting regulations and standards. Trial newer products for their suitability before widescale upgrades. Refer to* ***www.seai.ie/aca*** *for energy efficient products.*

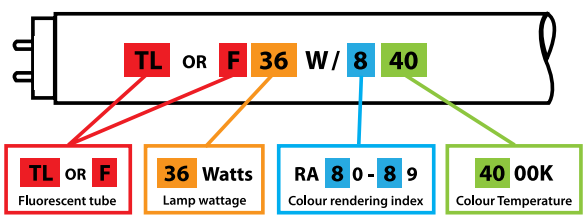
- When positioning luminaires always consider ease of access for maintenance and cleaning, this is particularly important in hospitals.
- When using wall mounted luminaires they should be mounted at least 1.8m above floor level.
- Fluorescent tubes in corridors should be mounted parallel to corridor walls.
- Choosing the longer life lamps will reduce maintenance requirements by minimising the number of lamp changes required. Always select the appropriate colour temperature (K) and CRI values as this will reduce lamp types used and storage requirements

LIGHTING TECHNICAL DETAILS

LAMP CODES

Treatment rooms lit with luminaires containing 36W T8 or T5 fluorescent tubes with a colour temperature of 4000 K and a colour rendering Ra 85 would give a 'cool white' light and good colour rendering.

Lamp Code example: *F36W / 840*
F *= Fluorescent,* ***36*** *= 36 lamp watts,* ***8*** *= Colour rendering in the 80s (between 80 and 89),* ***40*** *= Colour appearance = 4,000 K*



LAMP COMPARISON CHART

	Lamp Description	Lamp Image	Colour Rendering (Ra)	Colour Temperature (K)	Lighting Type				Lamp Life (Hours)
					General	Accent	Decorative Pendant	Table Top	
1	**Tungsten Lamps, GLS** Common low efficiency light source, is hot and has short life (1,000 hours)		100	2,600	✗	✗			1,000
2	**Tungsten Halogen GU10** Mains voltage Dichroic lamps provide approx. 35% of the illumination of (12V) IRC versions for the same wattage and have short life (1,500 hours)		100	3,000	✗	✗			1,500 - 8,000
3	**Mains Voltage Tungsten Halogen** These lamps save 30% energy when compared with GLS and have an expected life of 2,000 hours		100	3,000			✓	✓	2,000
4	**CHLi - Low Voltage (12v) GLS** These compact halogen lamps with integral control gear save 50% energy when compared with GLS and have an expected life of 3,000 hours		100	3,000	✓		✓	✓	3,000
5	**Mains Voltage GU10 CFLi** These lamps save 80% energy but they are only available in low wattages and therefore do not have high levels of illumination		80	2,700		✓			8,000+
6	**Low Voltage (12v) Tungsten Halogen Infra-Red Coated (IRC)** Infra-red Coated (IRC) versions are brighter and more efficient than standard (12v) Tungsten Halogen Lamps and 300% brighter than GU10 mains voltage models		100	3,000	✓	✓			3,000 - 5,000
7	**Mains Voltage GU10 LED Lamps** Many models of high-efficiency LEDs are available		70	4,000	✓	✓			35,000 - 50,000
8	**T8 (26mmØ) Triphosphor Fluorescent Tubes** Use T8 with Electronic High Frequency (EHF) control gear		80	2,700-6,000	✓				20,000 - 60,000
8a	**T8 (26mmØ) Halophosphor Fluorescent Tube** Use with Electronic High frequency (EHF) control gear		58	2,700-4,000	✓				6,000+
9	**T5 (16mmØ) Triphosphor Fluorescent Tubes** These tubes are available in High Efficiency (HE) and High Output (HO) versions		80	2,700-6,500	✓				16,000+
10	**Compact Fluorescent Lamps (CFLs)** Use models with electronic high frequency control gear for higher efficiency		85	2,700-4,000	✓				8,000+
11	**Compact Fluorescent Lamps with Integral Control Gear (CFLi)** These lamps are available from 3W to 29W equal in lumen output as GLS from 15W to 150W		85	2,700-4,000	✓		✓	✓	8,000+

Low Efficiency | Low/Medium Efficiency | Medium Efficiency | Medium/High Efficiency | High Efficiency

Efficacy is the ratio of light emitted by a lamp to the power consumed by it, i.e. lumens per Watt. Lamp efficacy values are available from SEAI's document, *"A guide to energy efficient and cost effective lighting."*

Lamp life is the expected operating life hours of the lamp. When lumens fall to 80%, this is the rated 'life' and when the lamp should be replaced.

Lux is a measure of illuminance, where one lux is defined as an illumination of one lumen per square metre. It can be determined from manufacturer's data or measured with a handheld digital lux meter.

General Lighting: Used to provide the main light source for the space or area.

Accent Lighting: Used to highlight an object or a particular feature of the space or area.

Table Lighting: Used to provide localised lighting on table-tops.

Decorative Lighting: Typically describes lamps in fittings used for visual effect rather than general illumination.

When selecting equipment, hardware and control systems for projects, you are encouraged to benchmark your specifications against the energy efficient equipment specified by SEAI for the Accelerated Capital Allowance (ACA) tax incentive scheme. This equipment meets minimum energy efficiency criteria. Lists of qualifying equipment are available at **www.seai.ie/aca**

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