LG9: Lighting Guide 9
Lighting for Communal Residential Buildings
Rob Lancaster – Industrial & Exterior Product Manager
- General aspects of lighting communal buildings
- LED’s, Automatic lighting controls and energy efficiency, maintenance
- Emergency lighting
- Luminaire types
Lighting for communal residential buildings

Lighting Guide 9: Lighting for communal residential buildings
“This document is based upon the best knowledge available at the time of publication. However, no responsibility of any kind for any injury, death, loss, damage or delay however caused resulting from the use of these recommendations can be accepted by the Chartered Institute of Building Services Engineers, the Society of Light and Lighting, the author or others involved in its publication”
• Over 3.6 million social housing properties in the UK

• Governed by a strictly defined system of rent control to ensure that rents are kept affordable

• Range from individual houses and apartments to high rise flats

• Quality lighting required to ensure reliability, performance and robustness

• Maximum amount of light from the minimum amount of energy, and utilising controls
Overview – LG9

- Covers new and refurbished buildings
- Lighting accounts for up to 30% electricity consumption
- Best practice for good illumination and pleasant ambience
- Considerations on maintenance and life costs
- Utilise daylight where possible
- Various overlap areas with other lighting guides
- Overall building layout and design considerations

Figure 2.4 Corridor in a care home designed with a high level of daylight
Daylight contributions

Sunlight availability by orientation at latitude 53°N
• First impression of buildings – light and welcoming
• Recommended 200 lux through direct and indirect luminaires
• Transition from outdoors to building
• Use less institutional products with good ceiling and wall illumination
• Warm white long life light sources
• Smooth light coloured décor
Entrances, Stairwells, and Lift Lobbies
Corridors

- Many corridors have little natural light
- Recommended 100lux, 20lux night time
- Care to be taken to avoid glare
- Vertical illumination important for facial recognition
- Standard downlighters and recessed patchy lighting to be avoided
- Avoid institutional and industrial type products where possible
Corridors

- Diffused lighting preferred to minimise glare
- Automated controls require good detection to cover all doorways
- Dimmed level for periods of vacancy down to 20% recommended
Corridors

- If recessed use specific downlighters designed for corridor use
- Corridor optic and lenses provide narrow distribution
- Small percentage washed onto walls and ceilings
- Minimal fittings required and excellent spacings
- Accessories help to improve the feel and look of an area
- May be used in conjunction with other feature luminaires
Corridors

Downlighting – corridor

Lighting requirements:
- 100lx ave, 0.40 Uo

42W PL-T
Downlight

Eav = 106lx (0.62MF*)
Uo = 0.76

*Based on 1 year luminaire clean, 3 year room clean and 3 year lamp change
## Corridors

![Corridor Lighting Image]

<table>
<thead>
<tr>
<th>Luminaire</th>
<th>Qty</th>
<th>Circuit Wattage</th>
<th>Total Circuit Watts (kW)</th>
<th>Annual Power Consumption (kW)</th>
<th>Running Cost per annum</th>
<th>Total Luminaire Cost</th>
<th>Maintenance Costs</th>
<th>10 Year Life Cycle Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>42W PL-T</td>
<td>5</td>
<td>47</td>
<td>0.235</td>
<td>0.705</td>
<td>£70.50</td>
<td>£560.00</td>
<td>£535.00</td>
<td>£1,800.00</td>
</tr>
<tr>
<td>32W LED</td>
<td>4</td>
<td>37</td>
<td>0.148</td>
<td>0.444</td>
<td>£44.40</td>
<td>£640.00</td>
<td>£0</td>
<td>£1,084.00</td>
</tr>
</tbody>
</table>

**Saving** £716.00  
**Payback** 1.00 Yrs

*Based on 3000 burning hours per annum and 10 pence per kW/hr Electricity tariff*
Stairs, Stairwells and lift lobbies

- Lighting on stairs is critical for safety
- Recommended 100lux on the treads
- Glare from lighting and windows should be kept to a minimum max 300cd/m²
- Light to shine downwards, treads illuminated, risers in shadow
- Controls may be used but should not leave areas in complete darkness – push button type systems not recommended
- Opal and diffused luminaires preferable

Figure 3.3 View down stairs with a repeating pattern parallel to the edge of the treads—this is dangerous because it is very difficult to distinguish one tread from the next

Figure 3.4 Good staircase lighting: the luminaire is well situated on the ceiling of a half landing
Stairs, Stairwells and lift lobbies

- Stairwell calculations – a balancing act!

- Luminaire access to be considered, LED reduces maintenance but emergencies still require battery changes

<table>
<thead>
<tr>
<th>Surface</th>
<th>$p$ [%]</th>
<th>$E_{20}$  [lx]</th>
<th>$E_{m}$  [lx]</th>
<th>$E_{max}$ [lx]</th>
<th>$u$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workplane</td>
<td>0.000 m</td>
<td>36</td>
<td>3.65</td>
<td>117</td>
<td>0.101</td>
</tr>
<tr>
<td>Floor</td>
<td>20</td>
<td>33</td>
<td>2.56</td>
<td>117</td>
<td>0.078</td>
</tr>
<tr>
<td>Ceiling</td>
<td>70</td>
<td>12</td>
<td>3.51</td>
<td>29</td>
<td>0.292</td>
</tr>
<tr>
<td>Walls (4)</td>
<td>50</td>
<td>97</td>
<td>2.55</td>
<td>734</td>
<td>/</td>
</tr>
</tbody>
</table>

**Workplane**
- Height: 0.000 m
- Grid: 128 x 128 Points
- Boundary Zone: 0.000 m

**Illuminance Quotient (according to L.7):** Walls / Working Plane: 2.734, Ceiling / Working Plane: 0.333.

**Luminaire Parts List**

<table>
<thead>
<tr>
<th>No.</th>
<th>Pieces</th>
<th>Designation (Correction Factor)</th>
<th>$\Phi$ (Luminaire) [lm]</th>
<th>$\Phi$ (Lamps) [lm]</th>
<th>$P$ [W]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
<td>THORLUX CT14542 Cobat LED - Satin Plain - 23W (1.000)</td>
<td>1447</td>
<td>1450</td>
<td>31.0</td>
</tr>
</tbody>
</table>

Total: 10130
Total: 10950

Specific connected load: 25.12 W/m² = 59.65 W/m²/100 lx (Ground area: 8.84 m²)
Stairs and Stairwells

Beware of dark spots and shadows

Use calculation surfaces where necessary
Stairs and Stairwells

- Alternative lighting positions can reduce luminaire points
- Half balconies easier to maintain than directly over stairs
- Consider emergency lighting levels
• Correct selection of luminaires within bathroom and toilet areas – IP ratings

• Recommended 100lux toilets, 150lux bathrooms

• Controls provide significant savings – reduce to 25% in communal toilets when vacant

• LED luminaires with instant light advantageous
Bathrooms and Toilets

- Minimum two luminaires in bathroom areas
- Higher IP ratings directly above shower advisable
- Night lighting advisable – in particular for elderly residents
- Higher lighting levels for specialised applications
- Consider alternative uses for areas
- Emergency lighting for disabled toilets or rooms over 8m²
Bedrooms

- Residential type direct and indirect luminaires required
- Recommended 100lux
- Good colour rendering
- Task lighting recommended for desks
- Homely appearance with minimal controls
- Anti ligature luminaires required in specialist applications
Kitchens

- Residential ceiling mounted enclosed luminaires
- Recommended 200lux and warm colour temperatures 3000-4000K
- Good colour rendering, and easily cleaned luminaires
- Avoid shadowing through multiple luminaires and under-cupboard lighting
- Automatic lighting recommended
External Lighting

- Basic safety and security for residents, staff and visitors
- Recommended 10lux pathways, 10lux car parks,
- Care homes 20-30lux with transition zones between interior and exterior areas
- Marking access routes and entrances and create a pleasant environment
- Steps and obstacles to be highlighted
- Smaller lower powered luminaires preferable to high output floodlights and care to avoid glare into residents' accommodation
Exterior Lighting – Car Park

Lighting requirements:
Medium traffic - 10lx ave, 0.25 Uo

70W MBI Lantern

Eav = 11lx (0.46MF*)  Uo = 0.39

*Based on 2 year cleaning and bulk lamp change
### LEDs – case study

#### Exterior Lighting – Car Park

<table>
<thead>
<tr>
<th>Luminaire</th>
<th>Qty</th>
<th>Circuit Wattage</th>
<th>Total Circuit Watts (kW)</th>
<th>Annual Power Consumption (kW)</th>
<th>Running Cost per annum</th>
<th>Total Luminaire Cost</th>
<th>Maintenance Costs</th>
<th>10 Year Life Cycle Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>70W MBI</td>
<td>12</td>
<td>86</td>
<td>1.03</td>
<td>3.921</td>
<td>£392.16</td>
<td>£1,200.00</td>
<td>£5,460.00</td>
<td>£10,581.60</td>
</tr>
<tr>
<td>31W LED</td>
<td>12</td>
<td>34</td>
<td>0.40</td>
<td>1.550</td>
<td>£155.04</td>
<td>£3,000.00</td>
<td>£0</td>
<td>£4,550.40</td>
</tr>
</tbody>
</table>

- **Saving**: £6,031.20
- **Payback**: 2.3 Yrs

*Based on 3800 burning hours per annum and 10 pence per kW/hr Electricity tariff*
Special Applications

• Sheltered accommodation, residential accommodation and care homes
• Recreation areas – 200-500lux depending upon use
• Laundry rooms and utility areas – 200lux
• Dormitories – 100lux
• Nursing homes
• Hospices
• Schools
• Mental health trusts

Local task lighting for reading
Colour and Decor

- Co-ordination of lighting and colours essential
- Contrasting colours help identify areas in large blocks and on multiple floors
- Use of colour can help visually impaired people
- Finished need to durable and generally light in colour
- LG11 gives guidance on surface reflectance and colours

Figure 6.4 White nosing highlighting stair treads, with yellow to indicate the first and last in each flight
• Use Daylight where possible and practical

• Select efficient luminaires and use them effectively

• Avoid overlighting

• Ensure luminaires are not left on unnecessarily

• Insure effective maintenance – including lumen depreciation

• Monitor lighting to ensure correct operation and switching
Equipment

Energy saving strategy

Correct product selection

Occupancy detection

Harness daylight/maintain levels
### Lamps

Some Lamps are better than others:

<table>
<thead>
<tr>
<th>Lamp Type</th>
<th>Typical Life</th>
<th>Typical Life</th>
<th>Typical Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>T12</td>
<td>20,000hrs</td>
<td>90lm/W</td>
<td></td>
</tr>
<tr>
<td>T8</td>
<td>20,000hrs</td>
<td>90lm/W</td>
<td></td>
</tr>
<tr>
<td>T5 High Output</td>
<td>25,000hrs</td>
<td>106lm/W</td>
<td></td>
</tr>
<tr>
<td>T5 High Efficiency</td>
<td>25,000hrs</td>
<td>106lm/W</td>
<td></td>
</tr>
<tr>
<td>T5 ECO</td>
<td>25,000hrs</td>
<td>106lm/W</td>
<td></td>
</tr>
<tr>
<td>Compact Fluorescent</td>
<td>20,000hrs</td>
<td>74lm/W</td>
<td></td>
</tr>
<tr>
<td>2D Lamps</td>
<td>12,000hrs</td>
<td>80lm/W</td>
<td></td>
</tr>
<tr>
<td>Mercury</td>
<td>20,000hrs</td>
<td>50lm/W</td>
<td></td>
</tr>
<tr>
<td>SON-T</td>
<td>28,000hrs</td>
<td>123lm/W</td>
<td></td>
</tr>
<tr>
<td>MBI-T</td>
<td>18,000hrs</td>
<td>110lm/W</td>
<td></td>
</tr>
<tr>
<td>GLS</td>
<td>400-2,000hrs</td>
<td>10lm/W</td>
<td></td>
</tr>
</tbody>
</table>

*All lamp life figures based on High Frequency control gear and to 50% failures*
- Roadmap – 4000K 70CRI
  - 2015 - LUXEON Rebel ES – Typical 140lm/W @ 700mA
  - Typical Led output +10% efficacy year on year,
<table>
<thead>
<tr>
<th>Equipment</th>
<th>4x14W</th>
<th>4x13W Eco</th>
<th>30W LED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wattage</td>
<td>4x14W</td>
<td>4x13W Eco</td>
<td>30W LED</td>
</tr>
<tr>
<td>Luminaire Lumens</td>
<td>3520lm</td>
<td>3486lm</td>
<td>3030lm</td>
</tr>
<tr>
<td>Circuit Wattage</td>
<td>66W</td>
<td>57W</td>
<td>35W</td>
</tr>
<tr>
<td>Efficacy (lm/W)</td>
<td>53.3</td>
<td>61.1</td>
<td>86.6</td>
</tr>
</tbody>
</table>

62% Increase in efficiency
White light

- Lead wires
- Cathode
- Mercury atoms
- Mercury atom in transition from excited state emitting UV
- UV Photons
- Phosphor coating
- Light emitted by phosphor coating after excitation by UV Photons
- Shield
- Cap
- Pins
White light

Phosphor coating

Blue light

White light
Phosphor coating
<table>
<thead>
<tr>
<th>Grade</th>
<th>CRI</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>100</td>
<td>Print Production</td>
</tr>
<tr>
<td>Good</td>
<td>80</td>
<td>General Environments</td>
</tr>
<tr>
<td>Moderate</td>
<td>60</td>
<td>Exterior Lighting</td>
</tr>
<tr>
<td>Poor</td>
<td>40</td>
<td></td>
</tr>
</tbody>
</table>
Colour performance

CRI

100

80

60

40

BSEN12464 - 1
Colour performance

- Colour Temp
- Colour Rendering
- Lumen Output

BIN A

BIN B

BIN C
Colour performance

Black Body Locus
The life of an LED luminaire is defined by the luminaire manufacturer.

Manufacturers will select their own ‘L’ and ‘B’ values and consequently the life they wish to claim.

Luminaire life time to L70/B10 is currently the ‘norm’ but there is nothing the defines these values must be used.

When comparing with lamp life – remember lamps rated life are to 50% failures!

Make sure you are comparing apples with apples!!
Lamps and LEDs….. but what about the rest of the luminaire?

- LEDs
- Circuit boards
- Wiring
- Plugs/sockets
- Optics
- Control gear
- Luminaire body
Typical LED series circuit
SYSTEM RELIABILITY!

Thermal management
Circuit protection
Quality construction
Electronics
Quality materials
How do we photometrically test luminaires?
Photometry

Relative Photometry + Absolute Photometry
Photometry

**32W TC-T**
- Lamp Lumens – 2400lm
- Light Output Ratio – 66%
- Circuit Wattage – 35W

**24W LED**
- Lamp Lumens – No lamp!
- Light Output Ratio – 100%
- Circuit Wattage – 29W

**Lumen Output**
- **32W TC-T**: Lumen Output – 1584lm, Lumen Output – 45.3LL/CW
- **24W LED**: Lumen Output – 2100lm, Lumen Output – 72.4LL/CW
<table>
<thead>
<tr>
<th>LED CHARACTERISTICS</th>
<th>Ra</th>
<th>°K</th>
<th>L70/B10</th>
<th>P/U</th>
<th>%</th>
<th>R/Rx</th>
<th>PF</th>
<th>LL/CW</th>
</tr>
</thead>
<tbody>
<tr>
<td>70+</td>
<td>4000</td>
<td>100K</td>
<td>P</td>
<td>&gt;90</td>
<td>R</td>
<td>&gt;0.90</td>
<td>101.2</td>
<td></td>
</tr>
<tr>
<td>80+</td>
<td>4000</td>
<td>100K</td>
<td>P</td>
<td>&gt;90</td>
<td>R</td>
<td>&gt;0.90</td>
<td>87.9</td>
<td></td>
</tr>
</tbody>
</table>
• The most efficient luminaire is still wasting 100% of its energy if it is on when it is not required

• Most basic form are Photocells, these are usually non-adjustable but switch off when daylight enters the sensor

• PIR’s switch when activity is detected through Infra-Red detection. These have built in light detectors and time delays that maybe adjusted manually.

• Microwave detectors simple cheap detection system, false triggering and nuisance switching through vibration and noise

• Smart controls are the most complete lighting control system, they combine PIR detection with light a light sensor, and are fully programmable
Lighting controls

- Energy savings through switching
- User comfort and convenience
- Systems should be simple and intuitive
- Ensure detection patterns cover all eventualities and entry points
- Absence / Presence detection options
- Never leave critical areas in darkness
- Huge energy savings to be made
GOOD COVERAGE

INDIVIDUAL LUMINAIRE DETECTION

Plan view
Lighting controls

- Energy saving strategy
- Occupancy detection
- Correct product selection
- Harness daylight/maintain levels
Lighting controls

EXPLOITING DAYLIGHT

• Buildings should be designed to maximise daylight contributions

• Typical daylight sensor savings 40-60%

• Individual dimming control preferable over group dimmed systems

• Luminaires away from windows can still make significant savings through maintained illuminance and internal reflections

• Dimming and switching helps with part L compliance when used with efficient luminaires
Data logging

• In many cases users do not realise energy usage and wastage

• Before and after data logging provides excellent evidence of power use

• Results through daylight dimming and PIR detection are often better than expected

• Payback on installations can usually be justified in short time periods

• Combined with carbon taxes, energy costs and maintenance controls are invaluable
72% Saving - 7am-8pm application
University Case Study

- Corridor & Stairwells in Halls of Residence
- Mainly 28W 2D Switch Start & 26W TC-T HF
- Never switched off
University Case Study

• **Trial Installation**
  – 19W LED + Intelligent controls
  – 33% reduction in load of a typical luminaire
  – Fewer luminaires

• **Power Monitoring Exercise**
  – 1 week in January
  – Luminaires on for 6 hours/day, not 24
  – Whilst on, average output = 30%

  >95% energy saving

Electricity cost reduced from £26.9K to £3K
Social Housing – 24/7 operation
Intelligent controls integral to LED luminaires (Internal and external versions)
Used on stairwells, balconies, and lift lobbies
External version used by doorways, open balconies
## Social Housing

<table>
<thead>
<tr>
<th></th>
<th>Luminaire 1</th>
<th>Luminaire 2</th>
<th>Luminaire 3</th>
<th>Luminaire 4</th>
<th>Luminaire 5</th>
<th>Luminaire 6</th>
<th>Luminaire 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Burns Hours</td>
<td>8760</td>
<td>8760</td>
<td>8760</td>
<td>8760</td>
<td>8760</td>
<td>8760</td>
<td>8760</td>
</tr>
<tr>
<td>(Switched)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-Hours Powered</td>
<td>321</td>
<td>321</td>
<td>321</td>
<td>322</td>
<td>321</td>
<td>322</td>
<td>321</td>
</tr>
<tr>
<td>R-Hours Lamp On</td>
<td>94</td>
<td>116</td>
<td>26</td>
<td>30</td>
<td>91</td>
<td>20</td>
<td>36</td>
</tr>
<tr>
<td>Lamp Hours Corrected</td>
<td>2565</td>
<td>3166</td>
<td>710</td>
<td>816</td>
<td>2483</td>
<td>544</td>
<td>982</td>
</tr>
<tr>
<td>PIR Saving</td>
<td>71%</td>
<td>64%</td>
<td>92%</td>
<td>91%</td>
<td>72%</td>
<td>94%</td>
<td>89%</td>
</tr>
<tr>
<td>DSI Average</td>
<td>34</td>
<td>53</td>
<td>39</td>
<td>33</td>
<td>32</td>
<td>36</td>
<td>24</td>
</tr>
<tr>
<td>Average Power</td>
<td>42%</td>
<td>58%</td>
<td>46%</td>
<td>41%</td>
<td>40%</td>
<td>44%</td>
<td>33%</td>
</tr>
<tr>
<td>Dimming Saving</td>
<td>57.5%</td>
<td>42.0%</td>
<td>54.0%</td>
<td>59.0%</td>
<td>60.0%</td>
<td>56.0%</td>
<td>67.5%</td>
</tr>
<tr>
<td>Total saving</td>
<td>88%</td>
<td>79%</td>
<td>96%</td>
<td>96%</td>
<td>89%</td>
<td>97%</td>
<td>96%</td>
</tr>
<tr>
<td>Total Saving</td>
<td>92%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Actual data downloaded from intelligent luminaires
7 luminaires installed within housing corridor
PIR saving up to 94%
Daylight saving up to 67.5%
Actual figures recorded from Site
2.8 year payback
£1.5k pa Energy saved
£1.1k pa maintenance saved

Running Cost per annum
EXISTING SCHEME £1,589.41
PROPOSED SCHEME £52.43
Annual savings £1,536.98

Total savings including maintenance per annum £2,681.48

Estimated payback time [yrs] 2.8
Estimated payback time [months] 34
Types of environments where LG9 applies

Luminaires should be suitable for such environments
Lighting controls

Open areas 0.5lux minimum

Escape routes 1.0lux minimum / centre line
Emergency Lighting – LG12

- Technically known as “Escape Lighting”
- To facilitate safe exit from the building when the normal lighting fails
- To allow potentially dangerous equipment to be made safe before evacuation
- To enable Fire Wardens & Fire and Rescue Service to search the building & locate missing people

UK Law
- Building Regs 2006
- H & S Signs 1997
- RRO (Fire Safety) 2005

EN Standards
- EN60598-2-22
- EN1838
- EN 50172
- EN 12193
- EN 62034
- ISO 7010

BS Codes of Practice
- BS 5266:1, 7 & 8
- BS5499:1-5
- BS ISO 7010
Emergency Lighting

- Regulatory Reform (Fire Safety) Order 2005
- Comply with Means of Escape Requirements (BS5266:1, :7 & BS5499:4)
- Determine Policy/Procedures & provide Information
- Training & Drills
- Test & Maintain essential systems (BS5266:8)
- Keep records – Certificates/ Policy/ Risk Assessment/ Reviews / Monitoring/ Maintenance/ Upgrades (BS5266:8)
Emergency Lighting

- Emergency Lighting needs to be fed from the local lighting circuit
- Lighting designs must meet uniformity requirements 40:1
- Avoid disability glare
- Minimum of 2 luminaires per compartment
- Exit sign requirements on exit routes, near exits and to avoid any confusion in an emergency
ILLEGAL since 1999

BS5499-4:2000 (white man – internally lit / green man externally lit.)

European Signs Directive 1996
SI 341 HSE Signs Directive

HTM65 – NHS HOSPITALS

BS ISO 7010 – specified in BS5266-1:2011
Emergency Lighting

• Lens technology
  • Standard 6m spacing
  • Area 9m spacing
  • Corridor 20m spacing

• 3W LED @ 800mA = 220 lumen output

• 50,000 hour life

• 100,000 hr 4w LED strip vs.
  • 4,000 hr T5 8w fluorescent
Emergency Lighting

- Inspection & Testing
  BS EN 50172:2004
- Commissioning
  Full rated duration (after 24 hours uninterrupted charge time)
- Monthly
  Short test to ensure emergency lamp functionality
- Annual
  Full rated duration test
- Autotest systems reduce much of the testing time required
- Networked systems can maintain records of testing
- Reduced ongoing testing costs & remote monitoring

**STATUS LED**
The result of the last test is displayed on the status LED.

- Steady Green: Healthy
- Flashing Green: Under test/Battery charging
- Flashing Red: Fault
Other Considerations

Luminaire selection:
- Installation
- IP Rating
- Robustness
- Emergency options
- Light output
- Energy use
- Types of controls
- Expected life
- Maintenance

Low cost of ownership over lifecycle which meets the needs of end users
Thank You