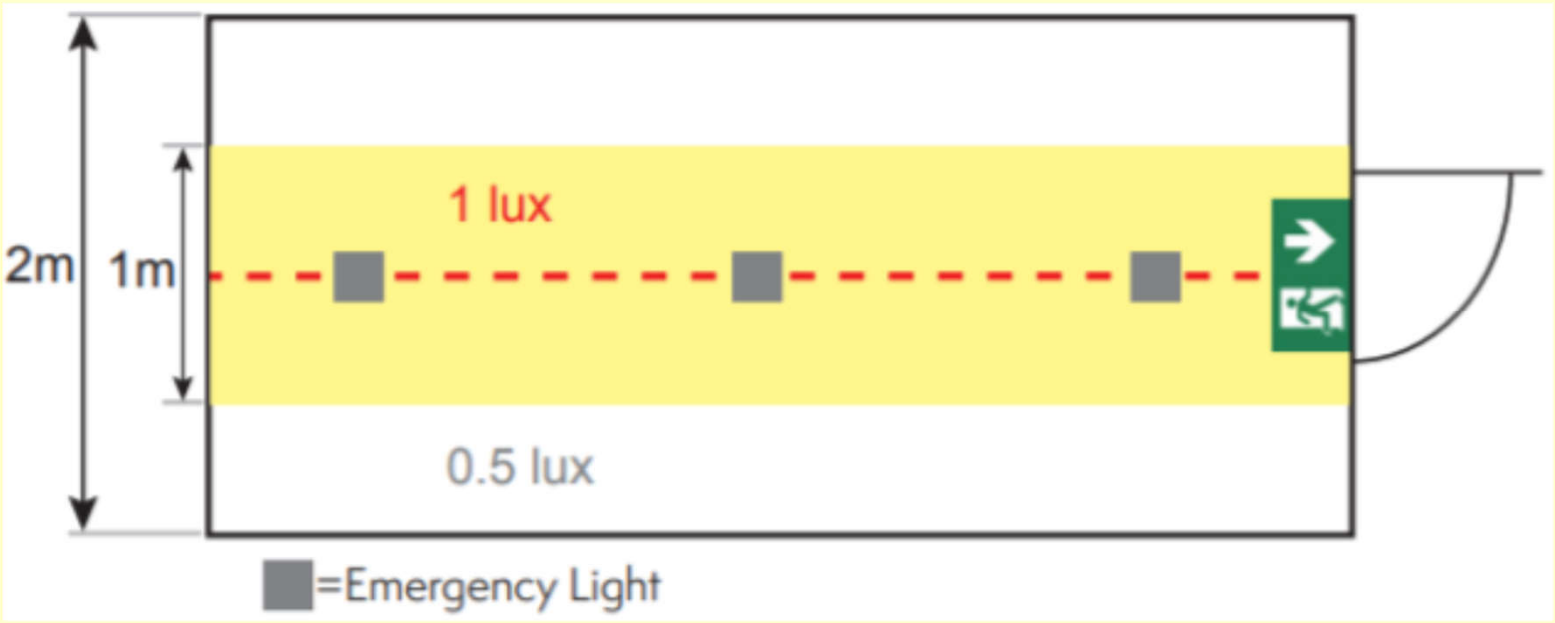
IBTM6010J Lighting Engineering

http://ibse.hk/IBTM6010J/



Lighting for Emergency, Safety & Security

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Contents

- Basic concepts
- Design requirements
- System components
- System design & operation
- Security lighting

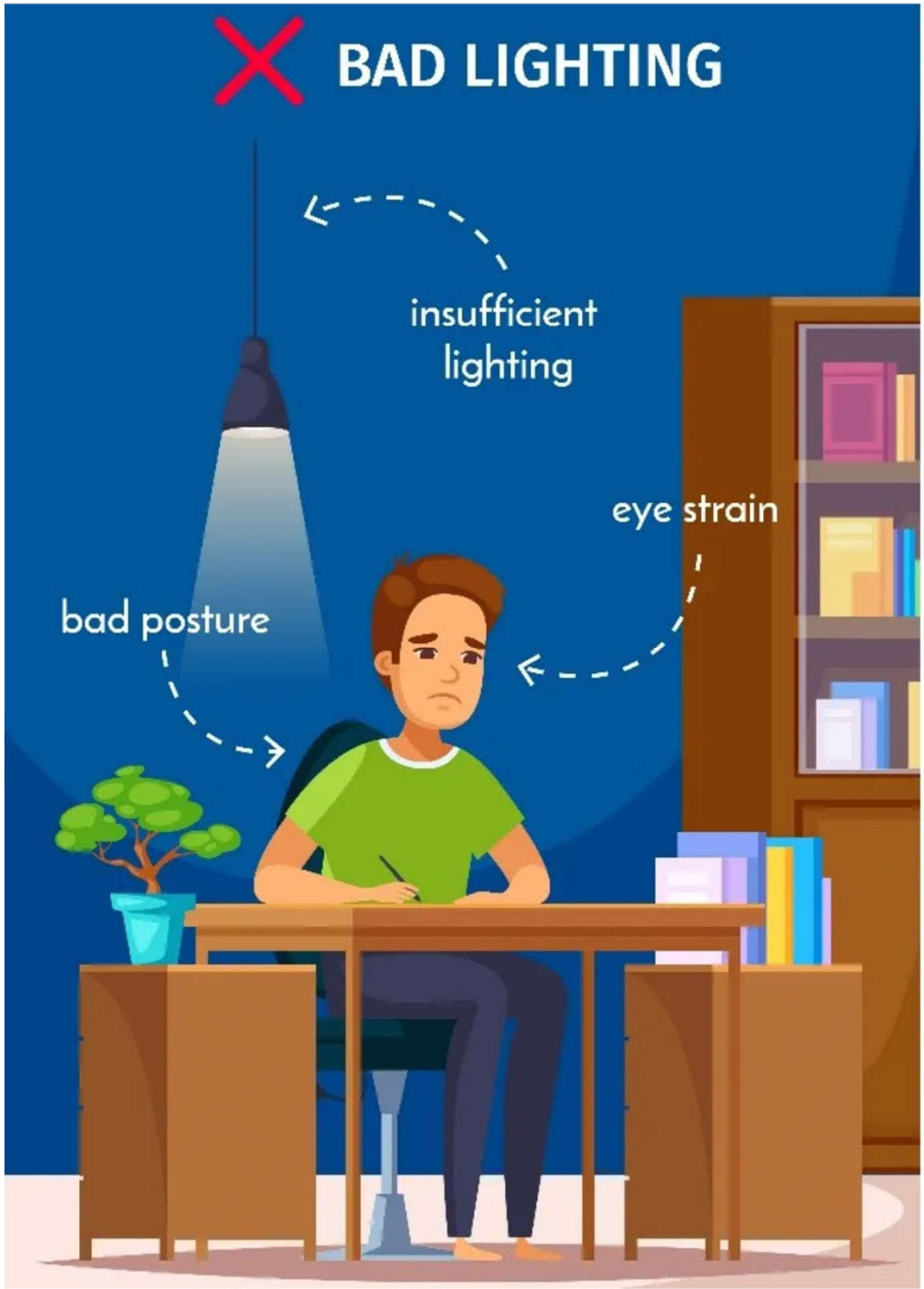
Basic concepts

- Lighting ergonomics 照明人體工程學
  - Appropriate lighting, without glare or shadows, can reduce eye fatigue & headaches
  - Prevent workplace incidents by increasing the visibility of moving machinery & other hazards
    - Good quality lighting also reduces the chance of incidents & injuries from “momentary blindness” (momentary low field vision due to eyes adjusting from brighter to darker, or vice-versa, surroundings)

  - Factors affecting the ability to “see” at work:
    - Time to focus on an object, the size of an object, brightness & contrast

(See also: Lighting Ergonomics - Survey and Solutions https://www.ccohs.ca/oshanswers/ergonomics/lighting_survey.html)

Ergonomics of lighting



(Source: https://thedesigngesture.com/ultimate-office-lighting-guide/)

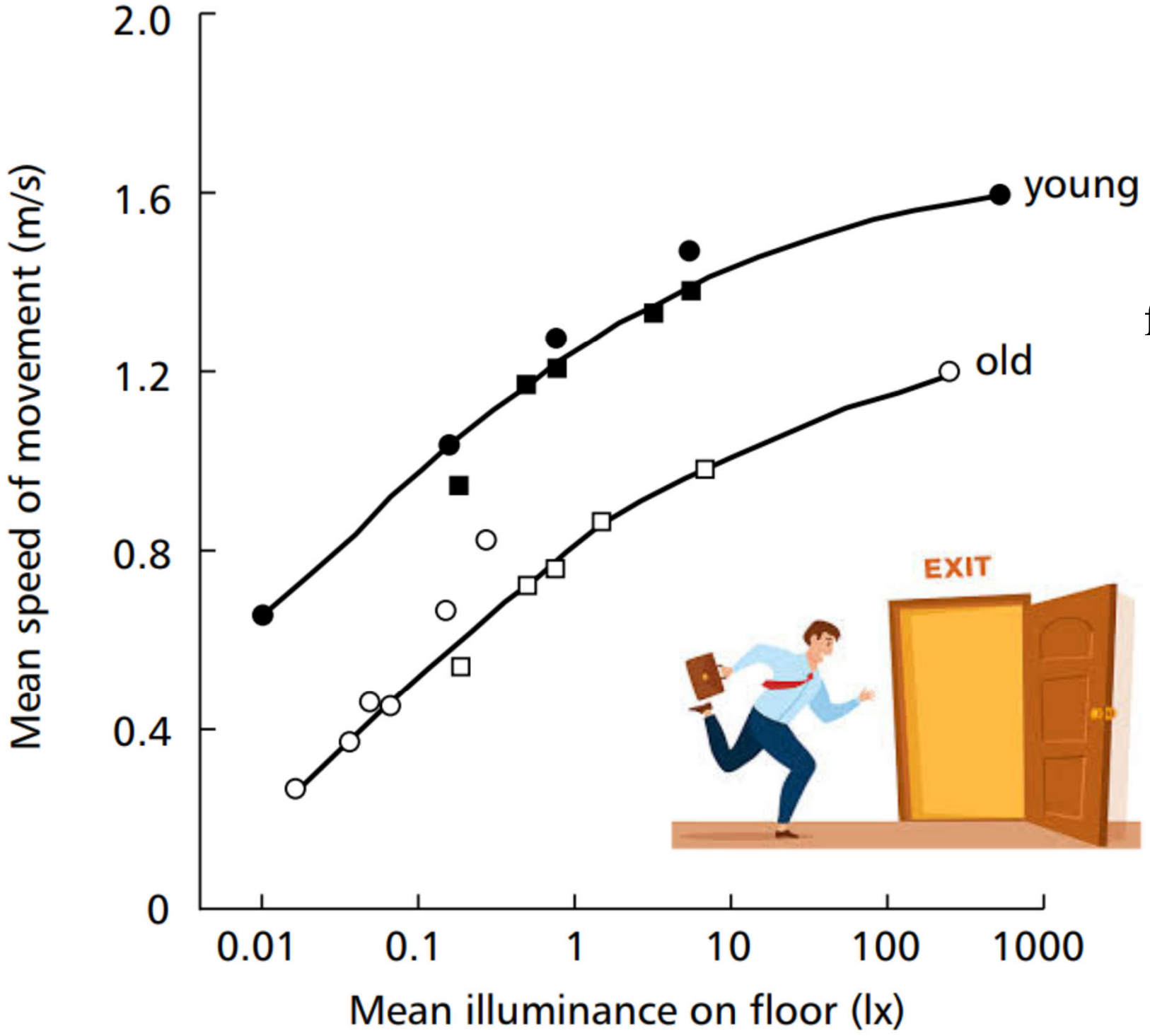
Basic concepts

- Lighting & safety
  - Lighting to enhance safety both indoors & outdoors

  - 1. Emergency escape lighting
    - Enable people to move along the path to the exit

  - 2. Road lighting
    - Enhance road safety & reduce property damage
    - Unlighted objects will have a low visibility after dark
  - 3. Lighting & crime

    - Lighting has a role to play in crime prevention
      - It facilitates surveillance by people after dark
      - It enhances community confidence & informal social control



Mean speed of movement in cluttered & furnished spaces in a clear atmosphere by young & old people, plotted against mean illuminance on the floor

(Source: SLL, 2017. *Introduction to Light and Lighting*, Lighting Guide 0, Society of Light and Lighting (SLL), London.)

Street lighting & road safety

(Source: https://europeanlightingpriorities.eu/the-betterlighting-campaign.html)

(Source: https://www.delmarfans.com/educate/outdoor-security-lighting/)

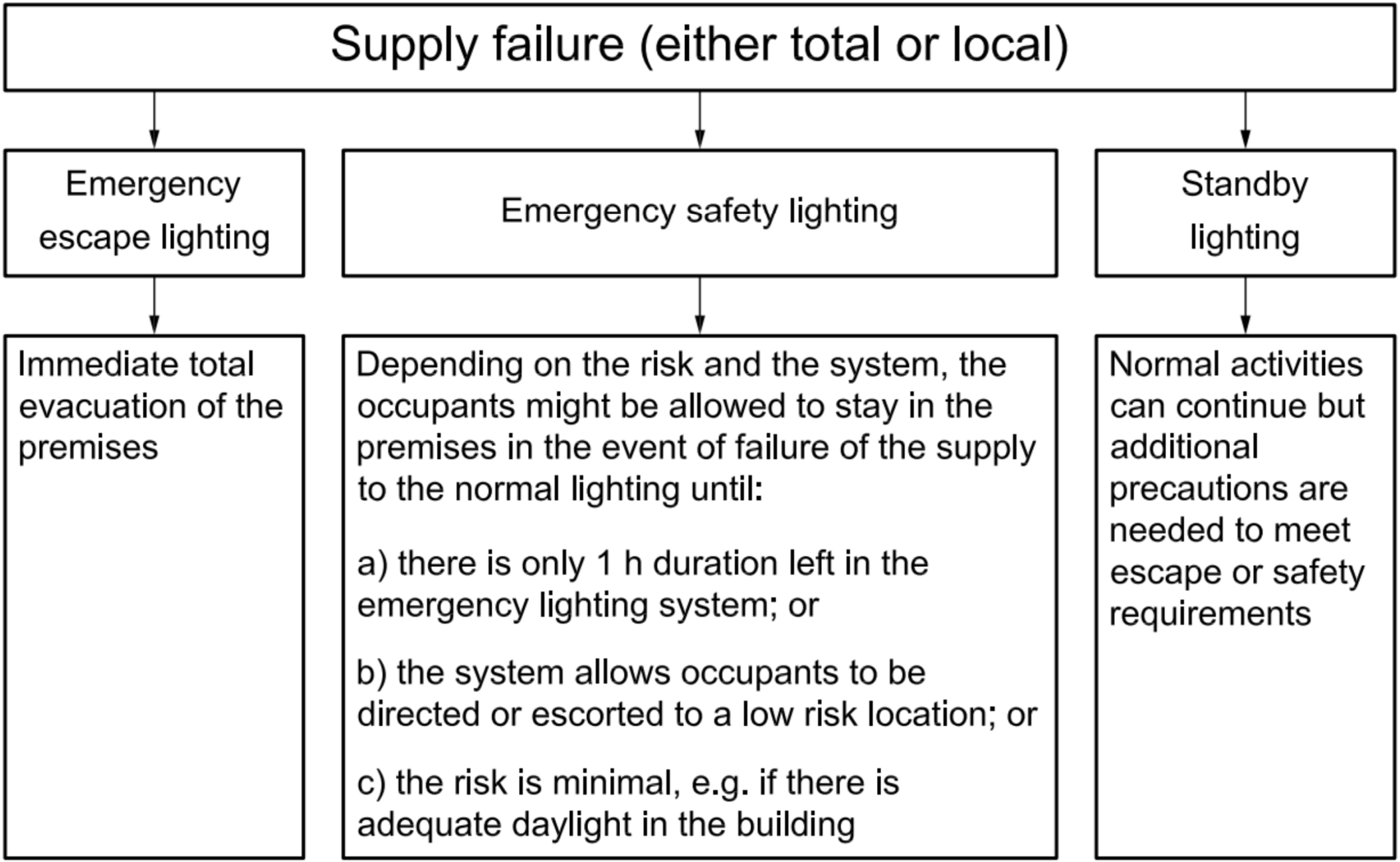
Basic concepts

- Emergency lighting 緊急照明

  - Provided for use when the supply to the normal lighting fails
  - Plays a critical role in building safety & particularly in an evacuation scenario

- Aims (during an emergency):
  - Assist occupants to leave a building
  - Help protect occupants if they stay in a building during an emergency
  - Help occupants to continue normal operations in the event of failure of the supply to the normal lighting

Types of emergency lighting (*may be combined into a single system)



(Source: BS 5266-1:2016, Emergency lighting - Part 1: Code of practice for the emergency lighting of premises)

Basic concepts

- Emergency escape lighting
  - Provide illumination for the safety of people leaving a location or attempting to terminate a potentially dangerous process before doing so
- Emergency safety lighting
  - Provide illumination for the safety of people staying in a premises when the supply to the normal lighting fails (* new idea in risk management)
- Standby lighting
  - Enable normal activities to continue substantially unchanged

Basic concepts

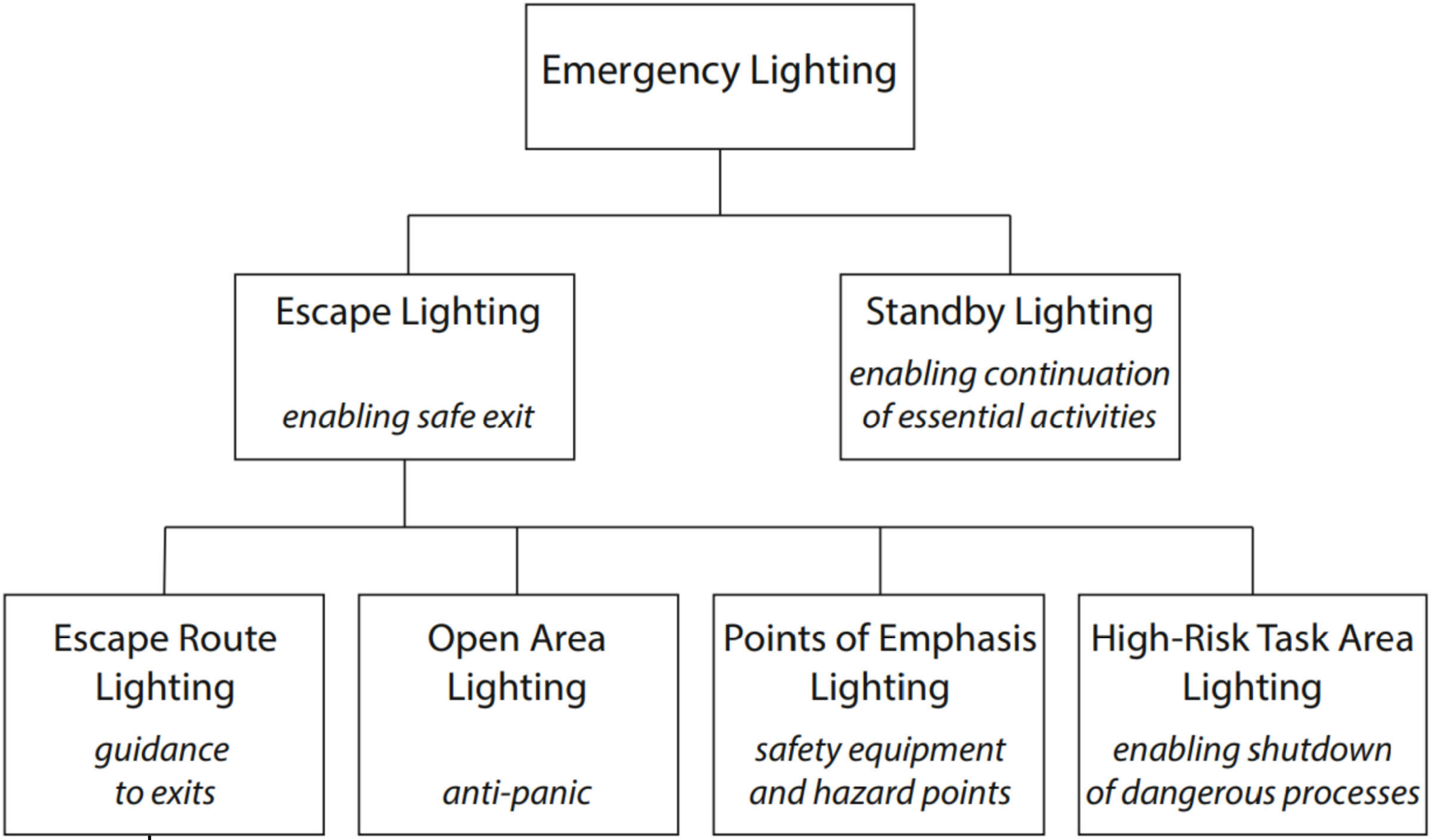
- Emergency lighting should be an integrated part of the building lighting
  - Ensure that people can orientate themselves & find their way confidently & safely through a building to a place of safety
  - People, even in familiar buildings, may become frightened & disorientated during an emergency
  - The occupants' reaction times, speed of adaptation, chance of panicking & ability to walk in a straight line may be different (e.g. users have disabilities or have taken alcohol or drugs)

(See also: Emergency Light – Wikipedia http://en.wikipedia.org/wiki/Emergency_light)

Basic concepts

- Main purpose (when normal lighting fails)
  - Guide people quickly & safely from the building
  - Enable specific tasks to be completed
  - Avoid panic & restore confidence
- Typical examples of installations
  - Emergency exit lighting, escape route lighting, standby lighting, open area (or anti-panic) lighting, the illumination of exit signs, specific lighting for high-risk task areas
  - Exit signs & safety signs

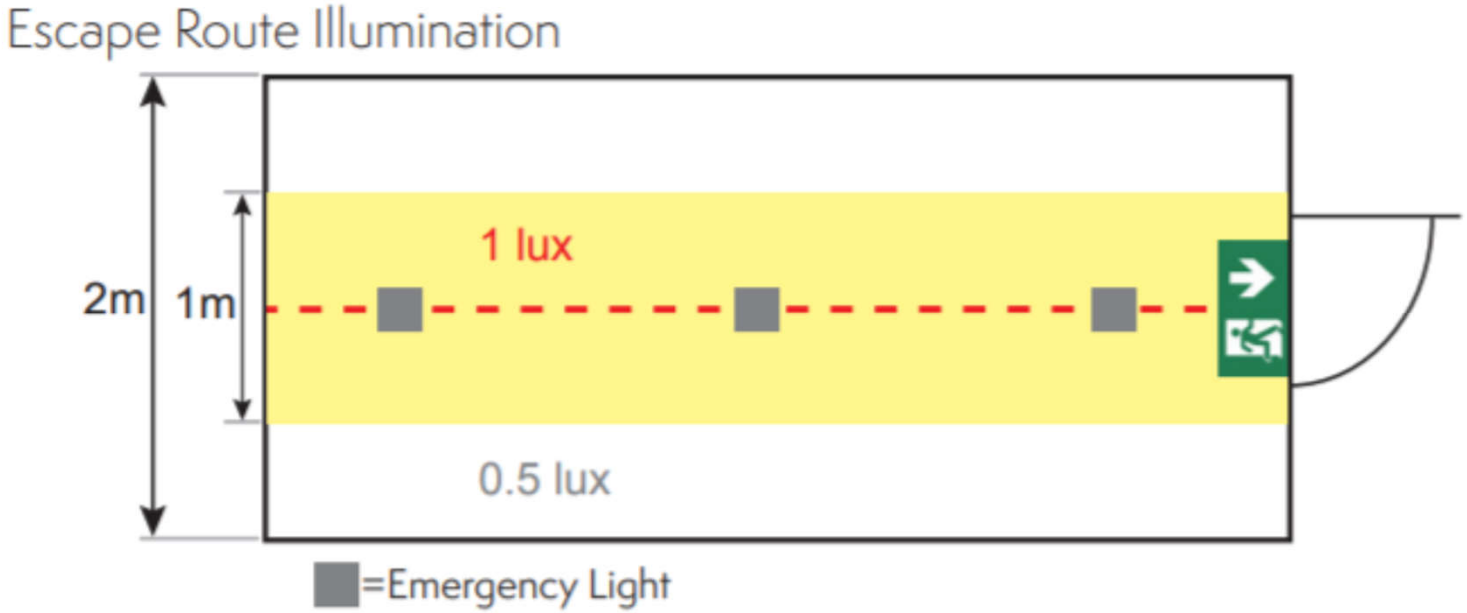
Different categories of emergency lighting & their objectives

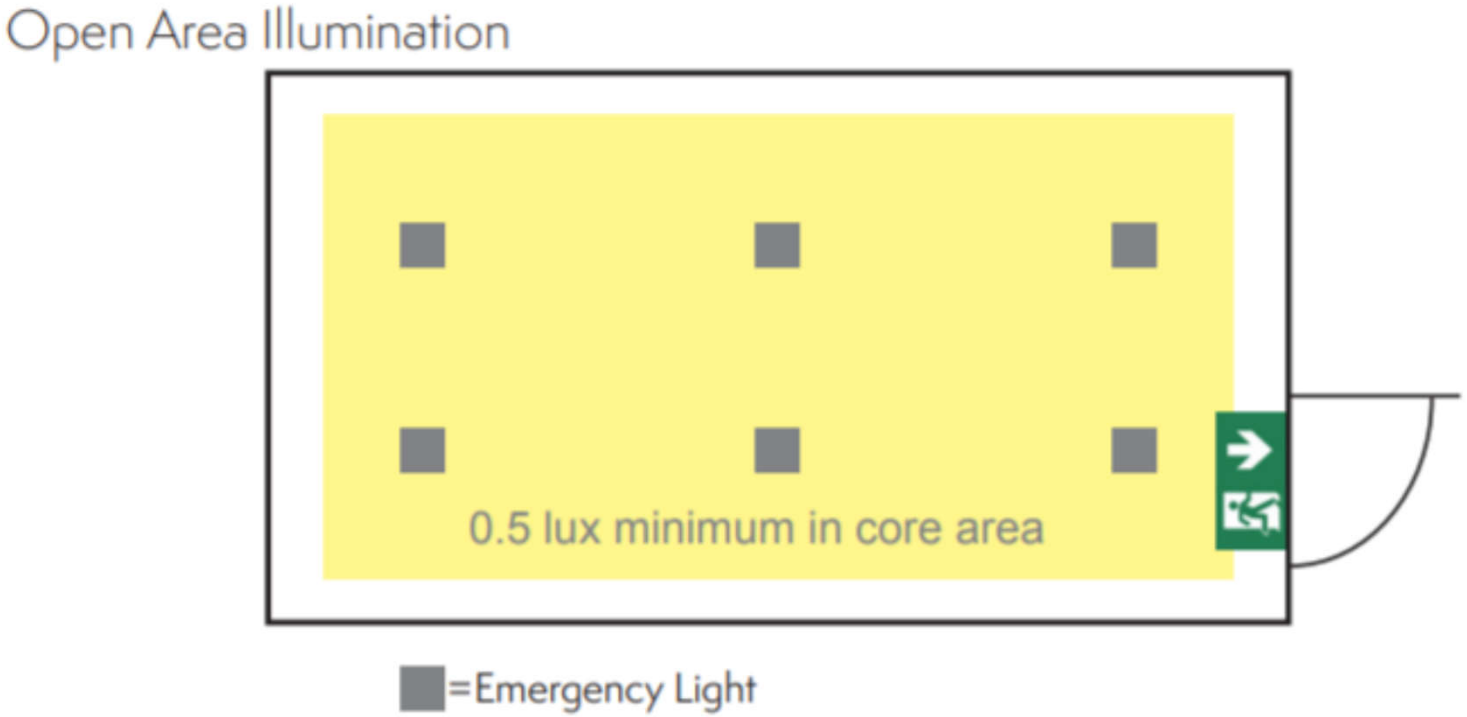


** Provide appropriate visual conditions & direction finding to assist escape routes to be readily located & used*

(Source: van Bommel W., 2019. *Interior Lighting: Fundamentals, Technology and Application*, Springer International Publishing, Cham.)

Escape route & open area illumination for emergency lighting





(Source: https://www.teknoware.com/sites/default/files/Emergency-Downloads/teknoware_emergency_lighting_design_guide.pdf)

Example of an escape route lighting design

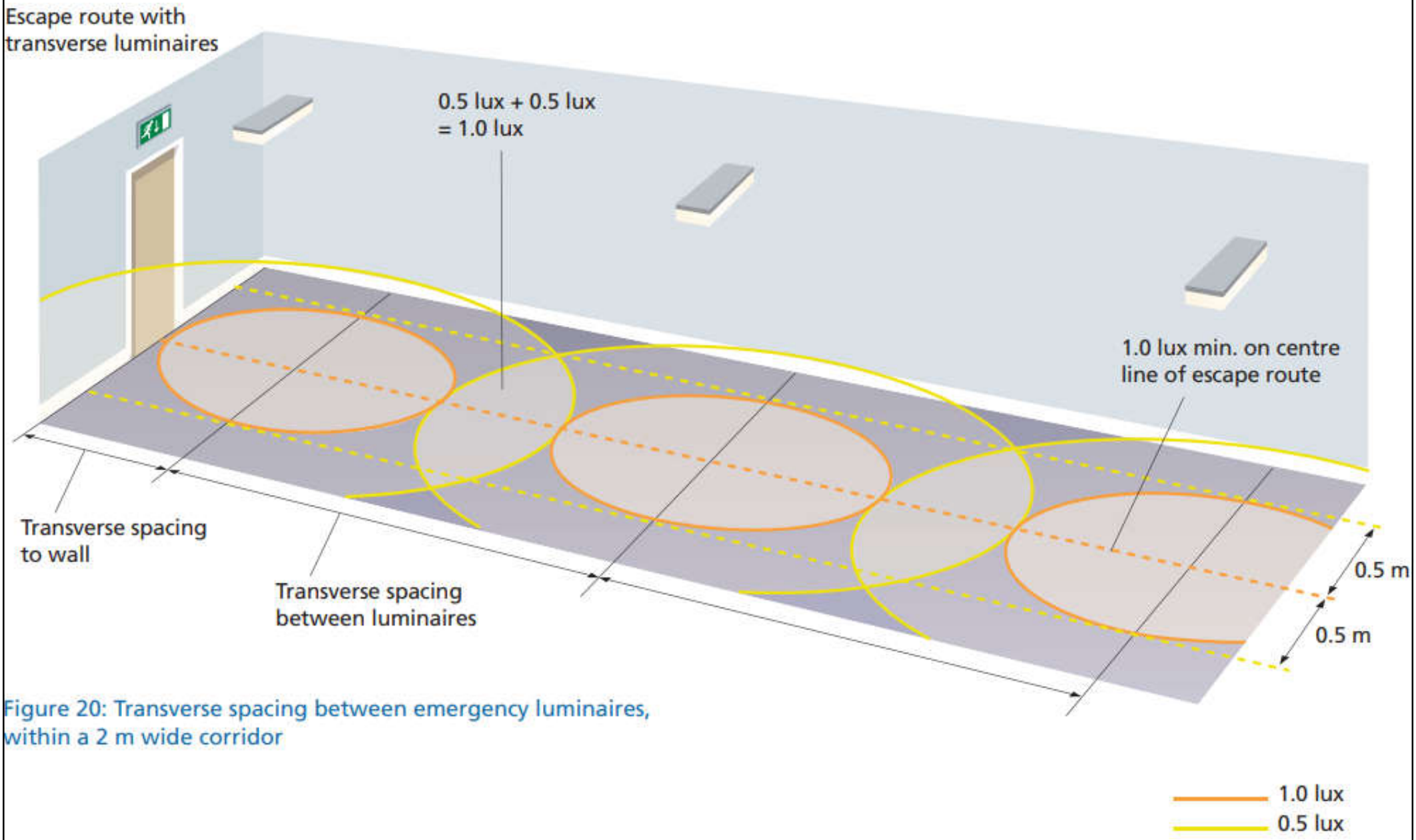
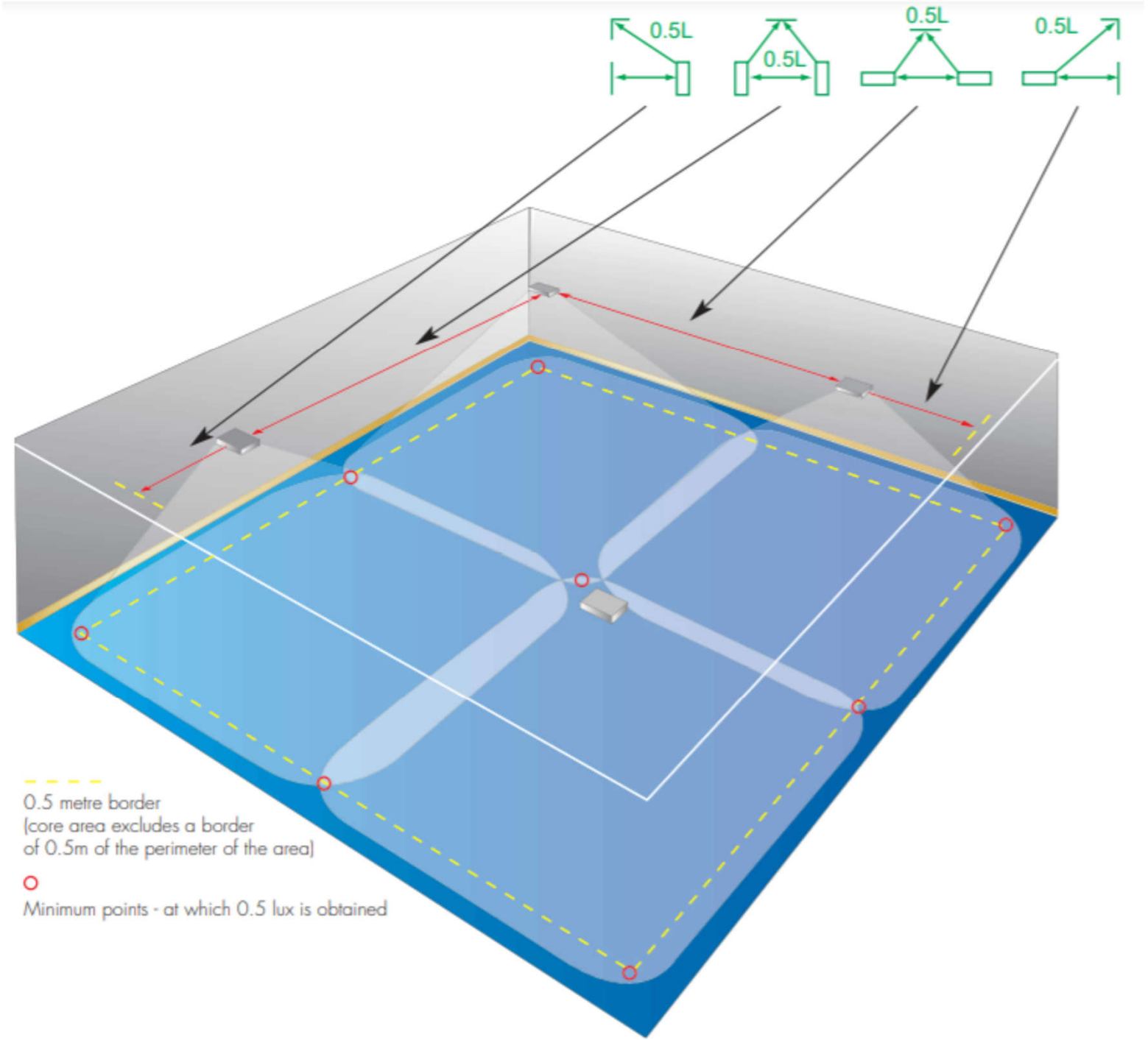


Figure 20: Transverse spacing between emergency luminaires, within a 2 m wide corridor

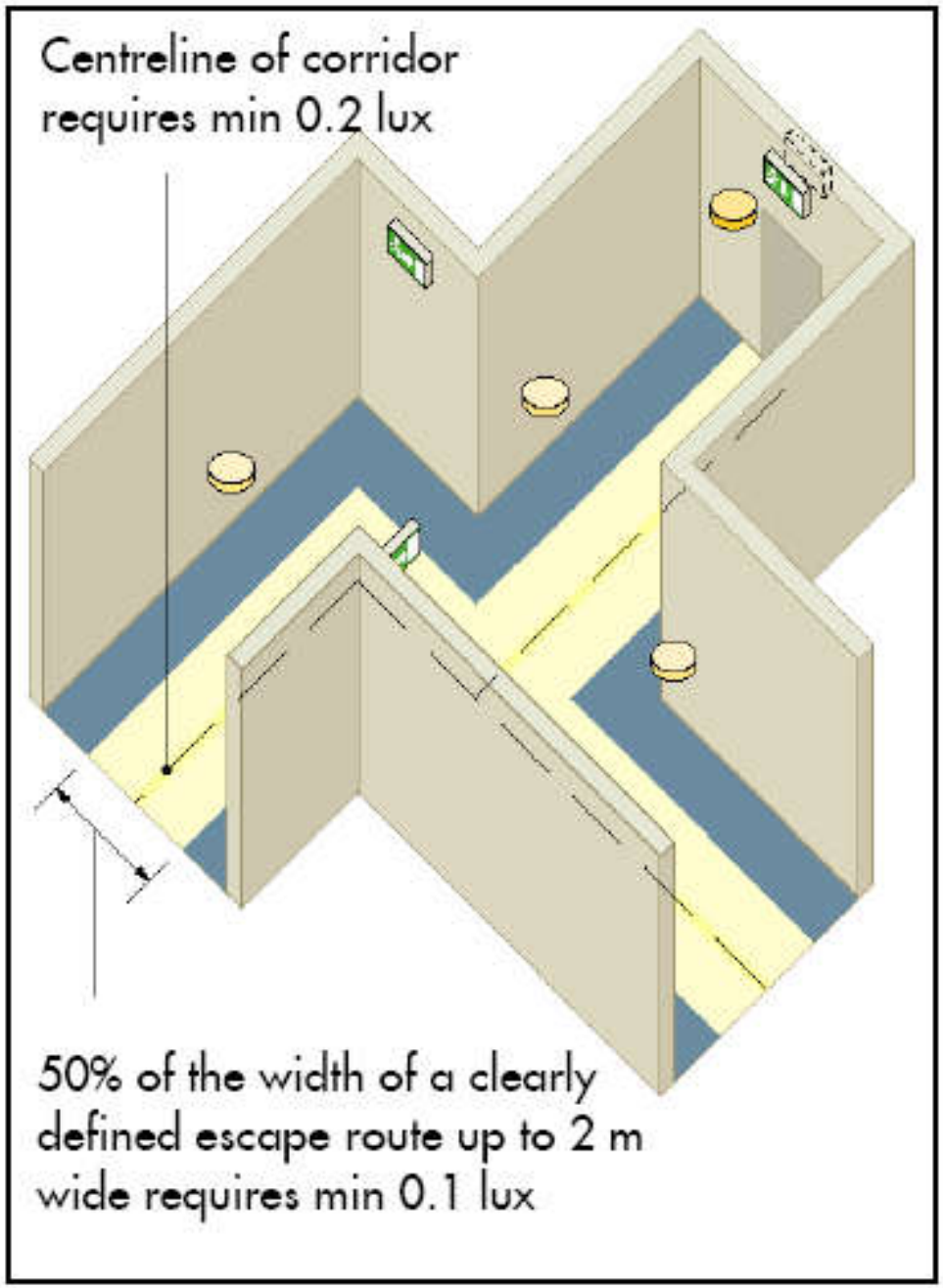
(Source: http://www.emergi-lite.co.uk/)

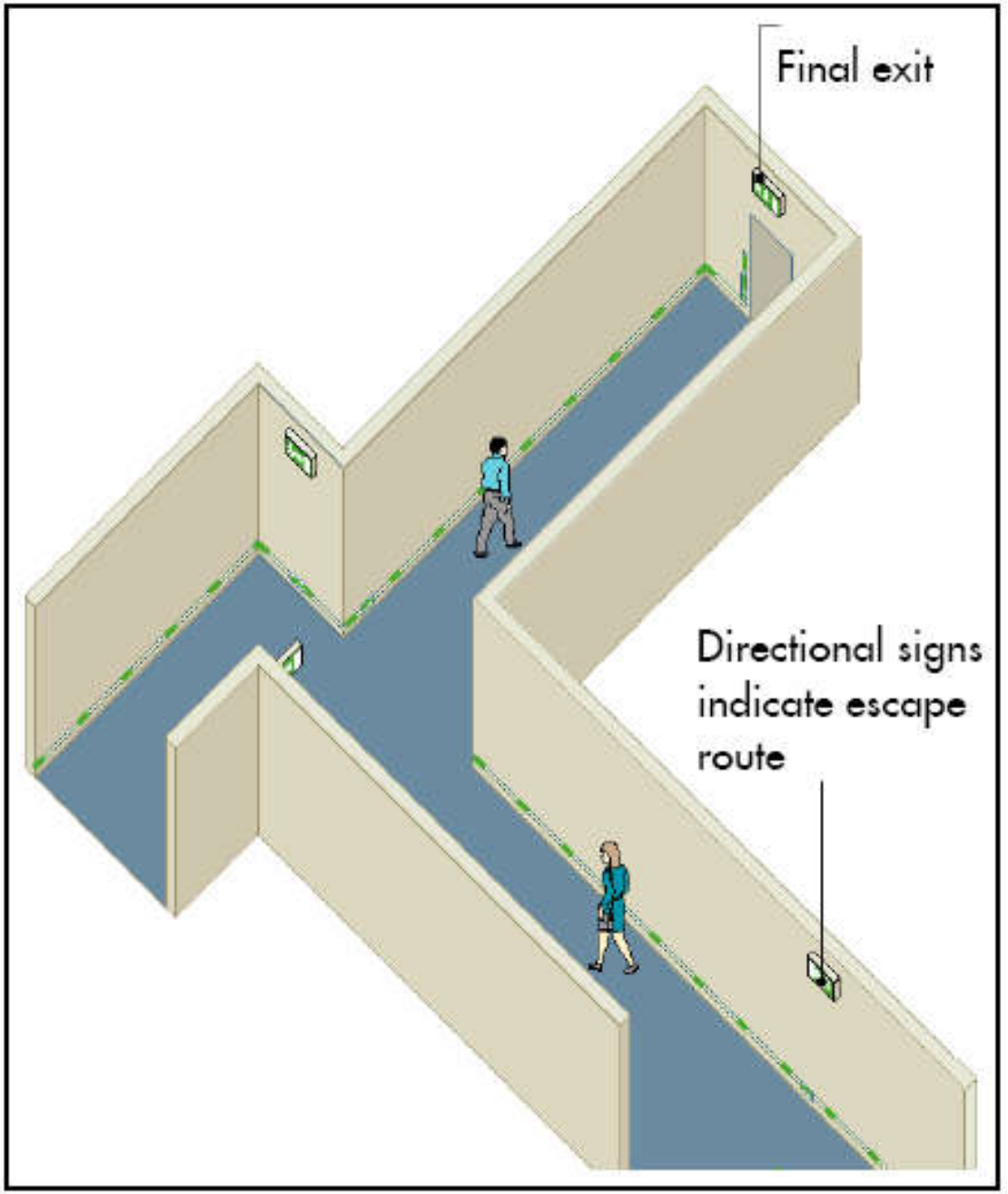
Luminaire spacing in open (anti-panic) core areas



(Source: https://hosting.iar.unicamp.br/lab/luz/ld/Seguran%E7a/emergency_lighting_design_guide.pdf)

Emergency lighting & signage on escape route



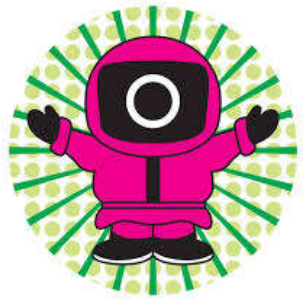


(Source: Thorn Lighting, UK)

Design requirements

- Legislation & standards
  - Building regulations
  - Fire safety legislation
  - Technical standards
    - e.g. BS 5266-1
- Typical requirements:
  - Illumination level = 1 lux; uniformity 40 : 1
  - Must be in operation ≤ 5 sec, last for 1 or 2 hours
  - Correct positioning & power supply
  - Battery backed up & automatic switch on

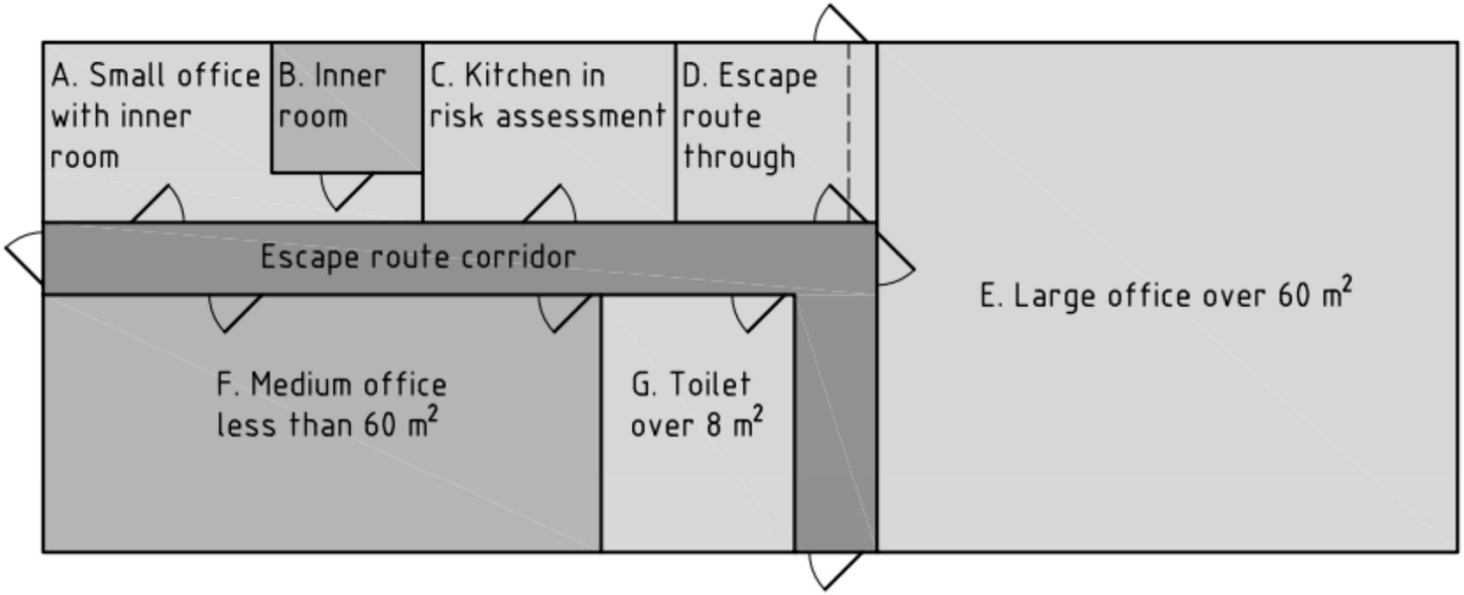
Design requirements



- HK FSD requirements for emergency lighting:
  - Comply with BS 5266-1 & BS EN 1838
    - ≥ 2 lux for staircase/exit route
    - ≥ 1 lux for night club, restaurant, dance hall, etc.
    - ≥ 0.5 lux for cinemas & theatres (auditorium)
  - Activation time within 5 sec. & emergency generator set be up in 15 sec.
  - A minimum of 2 luminaires per compartment (to ensure uniformity & reliability)
  - Batteries shall be heavy duty, rechargeable type
  - Routine inspections & tests

(Source: https://www.hkfsd.gov.hk/eng/source/circular/2021_05_eng_20210601_104701.pdf)

Example of rooms requiring emergency lighting



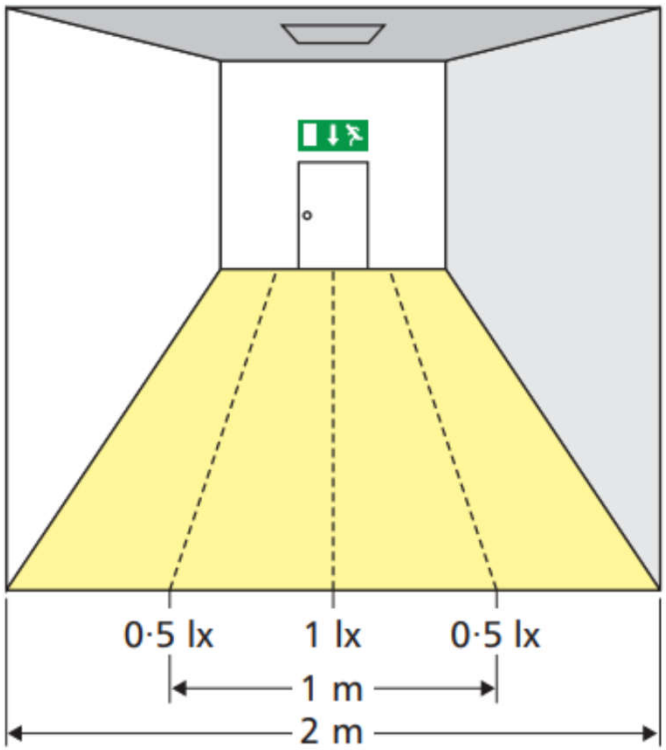
Key

Area	Dimensions	Function and relevant considerations	Emergency lighting needed
Escape route	(2 × 17) m	Corridor leading to exits; luminaires required at change of direction, exits and outside building to place of safety	Yes
Room A with inner room	(3 × 9) m = 27 m²	Small office in which the office becomes the escape route of the inner room and needs emergency lighting	Yes
Room B	(2 × 4) m = 8 m²	Inner room with no risks	No
Room C	(3 × 4) m = 12 m²	Kitchen needing emergency lighting in the risk assessment for the premises	Yes
Room D	(3 × 4) m = 12 m²	Small office, escape route passes through this open area	Yes
Room E	(10 × 8) m = 80 m²	Main office larger than 60 m² floor area	Yes
Room F	(5 × 11) m = 55 m²	Medium office smaller than 60 m² floor area	No
Room G	(5 × 6) m = 30 m²	Toilet larger than 8 m² floor area	Yes

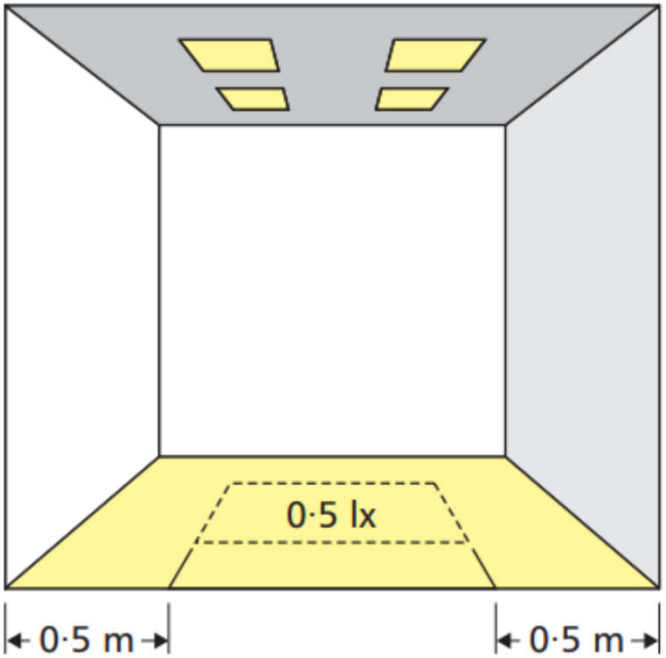
(Source: BS 5266-1:2016, Emergency lighting - Part 1: Code of practice for the emergency lighting of premises)

Requirements for escape route/area lighting

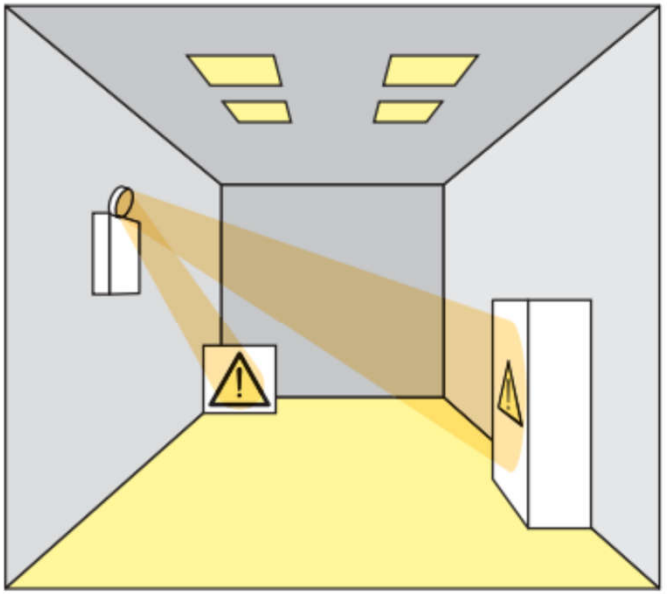
Escape route lighting



Escape area lighting



Emergency task spotlighting



Practical skills (Videos):

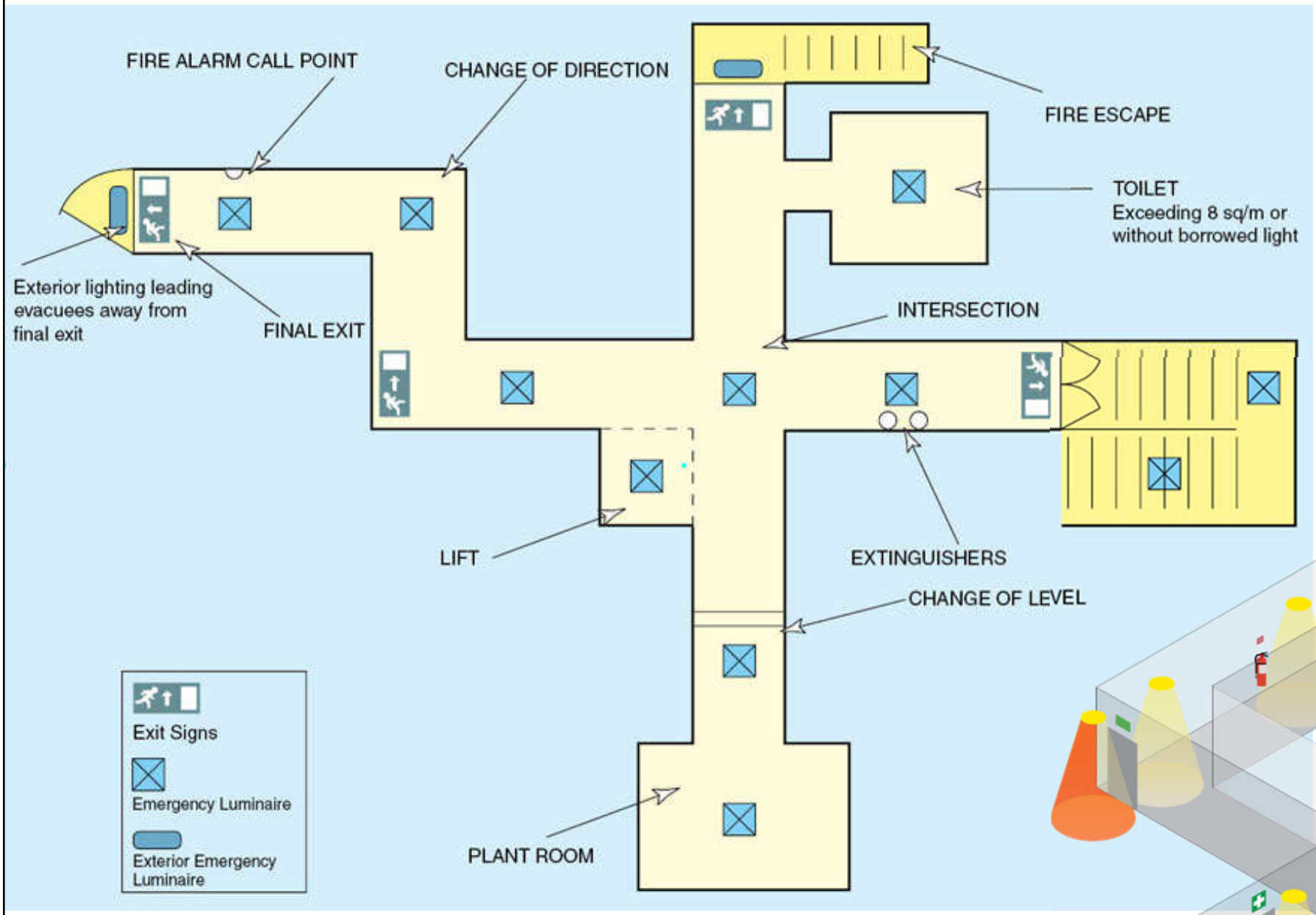
Emergency Lighting Design Guide (10:16) https://youtu.be/crUjqnvhn5Y

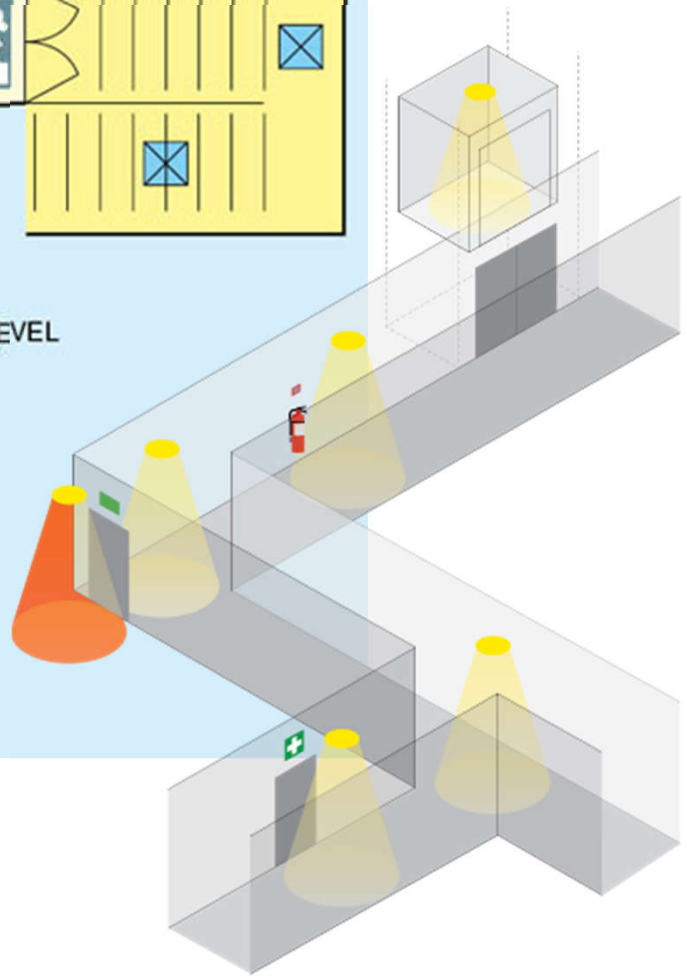
Tutorial: Emergency lighting with DIALux evo 10 (5:11)
https://youtu.be/6T0HehEV828

DiaLux evo - How to create emergency lighting (15:43)
https://youtu.be/fh3LsHHKWk0

(Source: SLL, 2011. *Lighting for Education*, Lighting Guide 5, Society of Light and Lighting (SLL), London.)

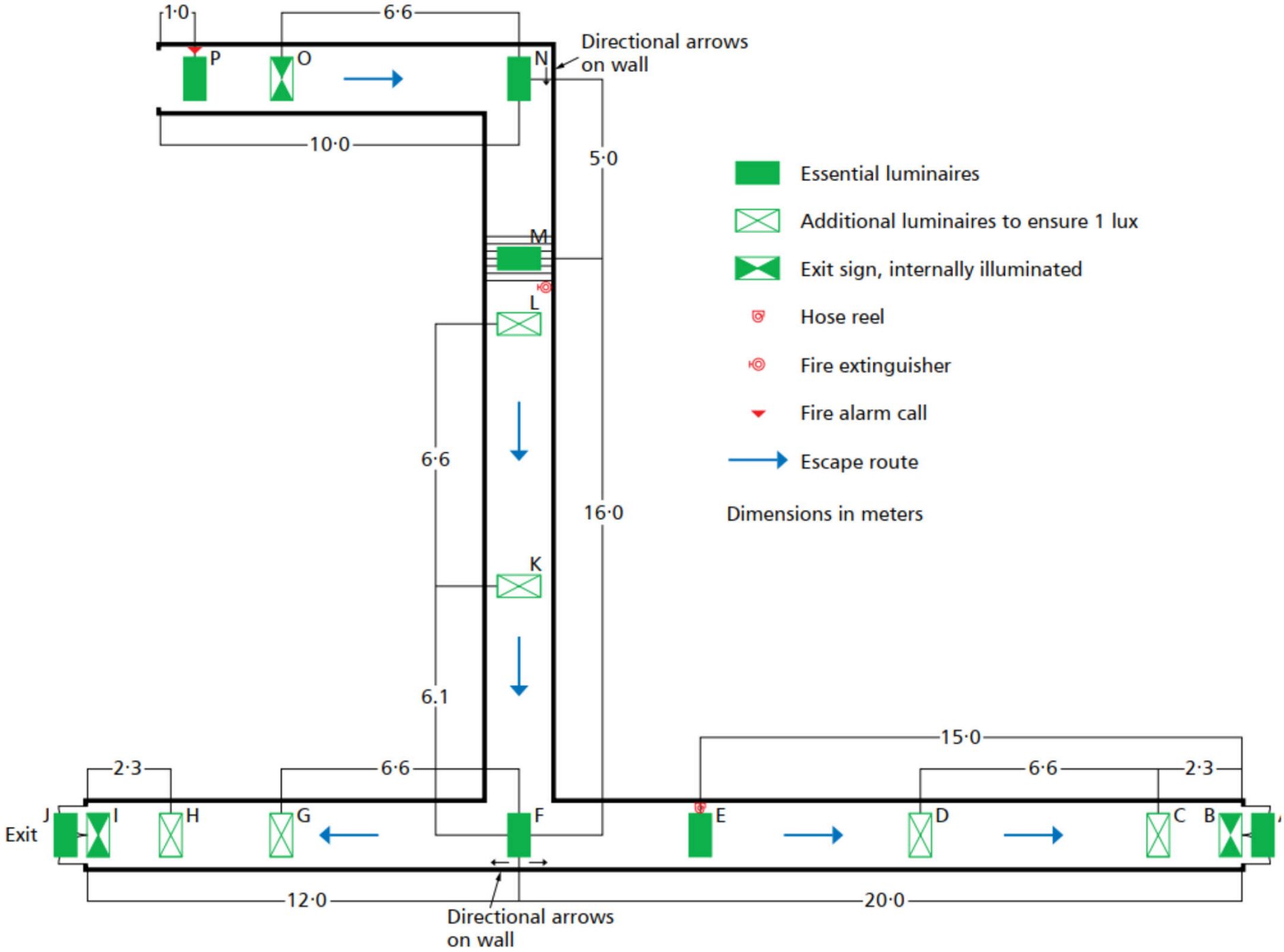
Specific forms of emergency lighting & design drawings





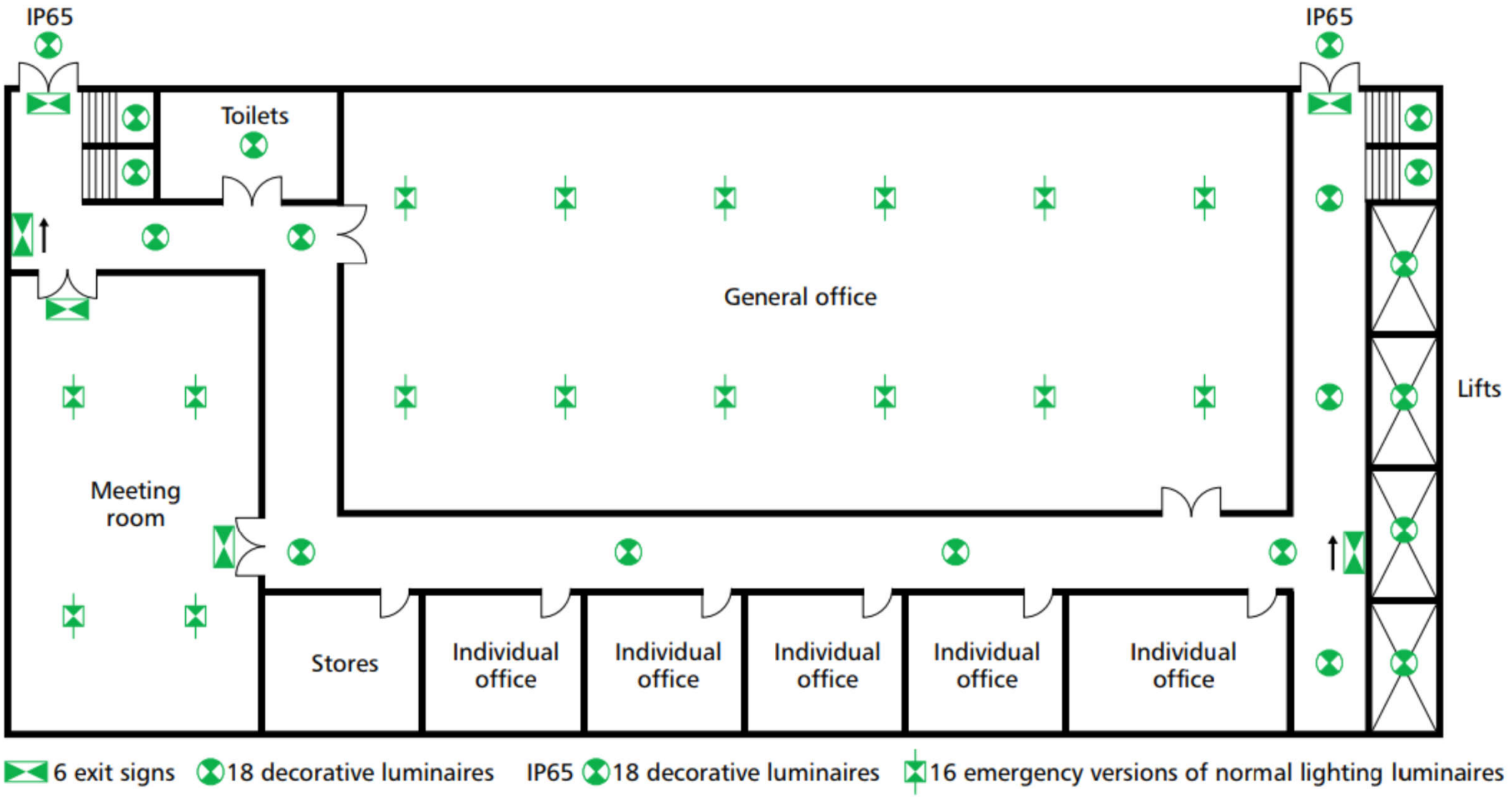
(Source: ICEL 1006: Emergency Lighting Design Guide http://www.icel.co.uk)

Worked example: escape route emergency lighting positioning



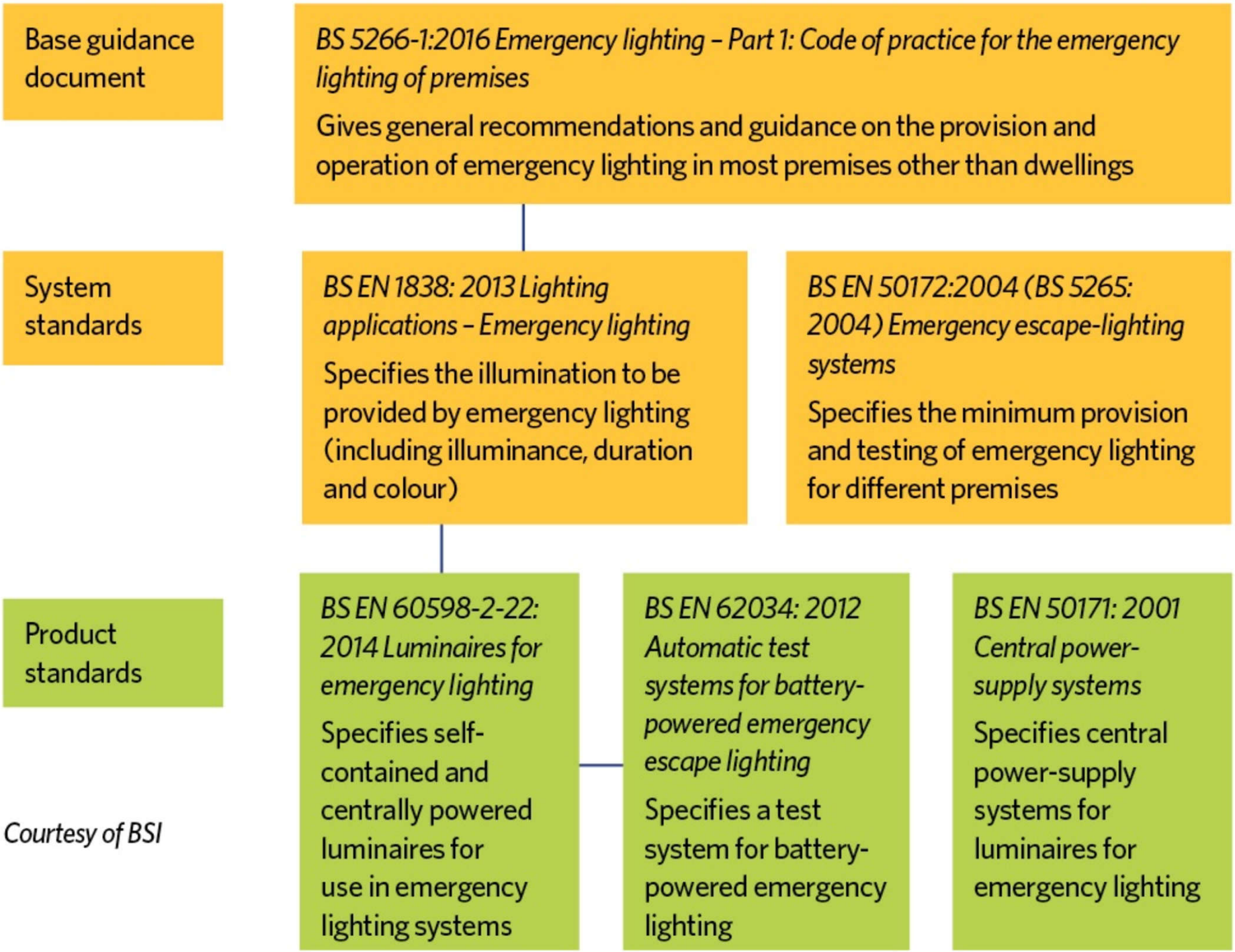
(Source: SLL, 2015. *Lighting for the Built Environment, LG12: Emergency Lighting*, Society of Light and Lighting (SLL), London.)

Typical floor plan for an office block showing the emergency lighting scheme



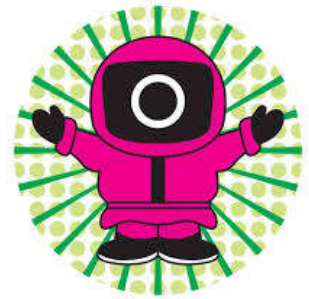
(Source: SLL, 2015. *Lighting for the Built Environment, LG12: Emergency Lighting*, Society of Light and Lighting (SLL), London.)

Summary of standards covering emergency lighting

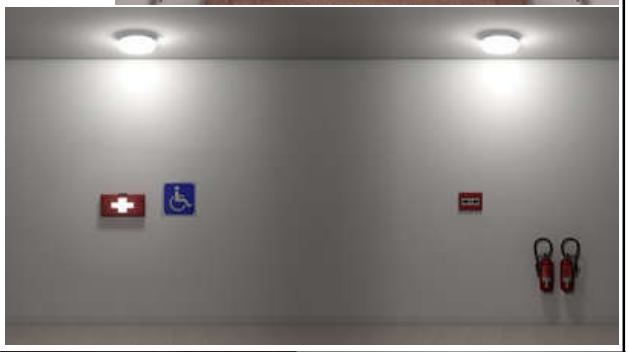


(Source: https://www.cibsejournal.com/general/emergency-lighting-standards/)

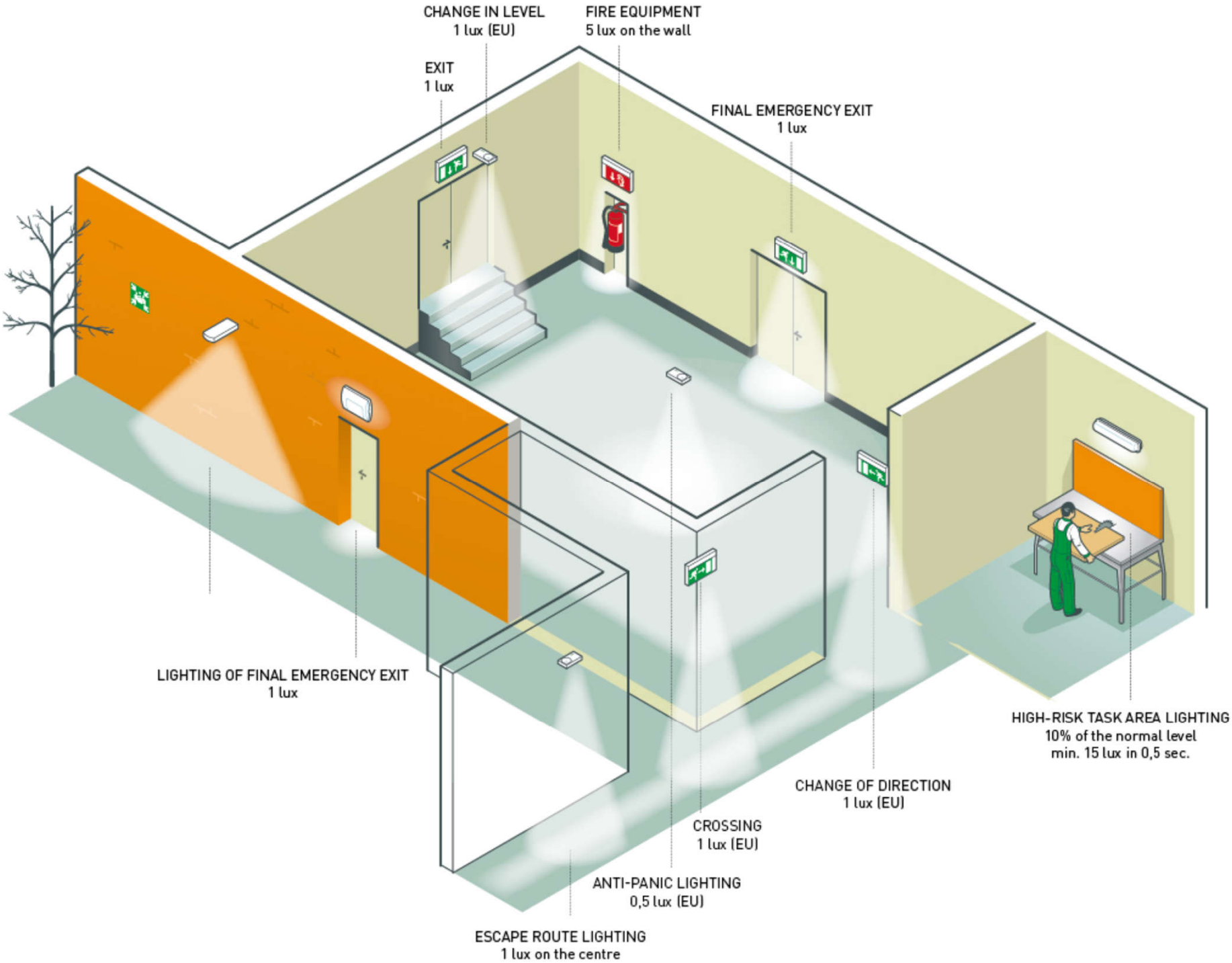
Design requirements



- Locating emergency lights
  - Changes in direction
  - Stairways, steps & ramps
  - Fire & first aid points
  - Exit doors (external & internal)
  - Escalators
  - Lifts & elevators
  - Toilets
  - Large open areas
  - Generator room & high risk areas



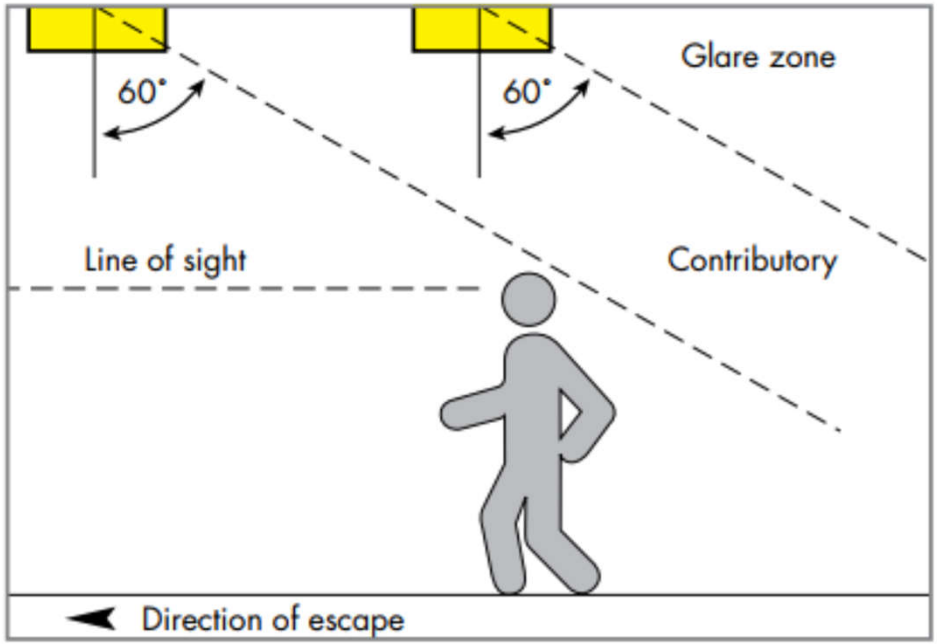
Locating emergency lights & typical requirements

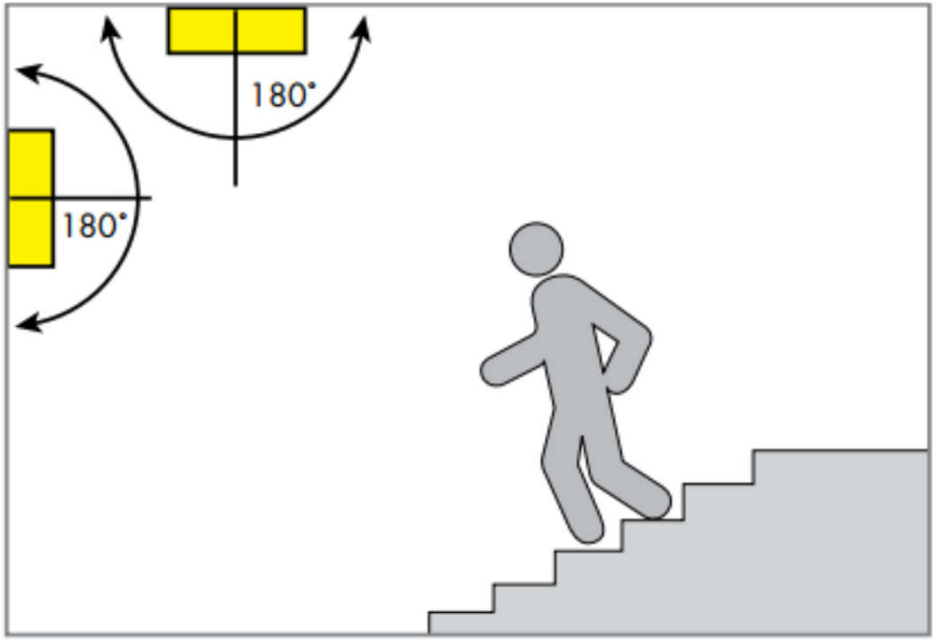


(Source: https://www.etaplighting.com/en/emergency-lighting)

Disability glare limits

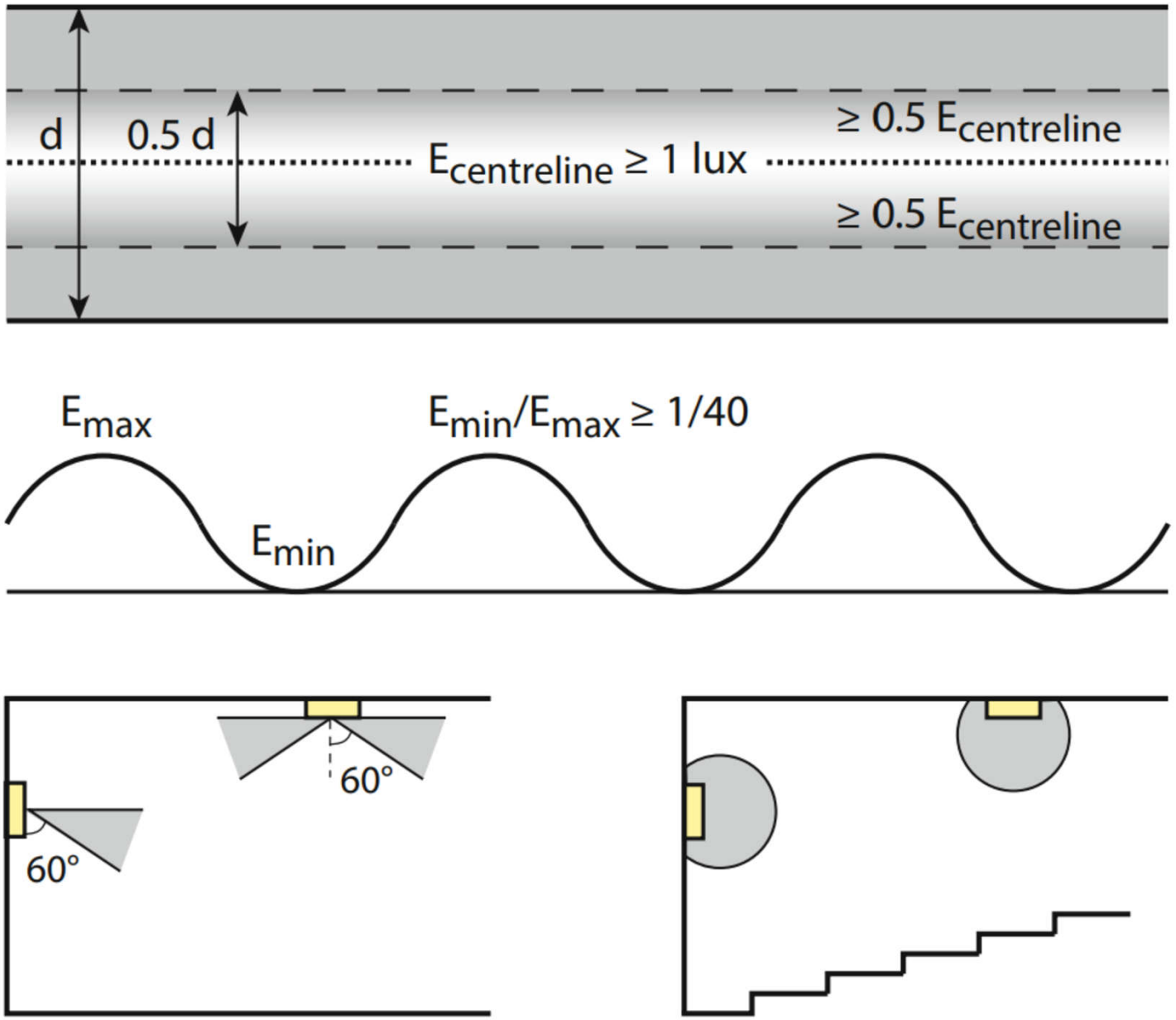
Mounting height h (m)	Escape route & open area max. luminous intensity I_{max} (cd)	High risk max. luminous intensity I_{max} (cd)
$h < 2.5$	500	1,000
$2.5 < h < 3.0$	900	1,800
$3.0 < h < 3.5$	1,600	3,200
$3.5 < h < 4.0$	2,500	5,000
$4.0 < h < 4.5$	3,500	7,000
$h \geq 4.5$	5,000	10,000





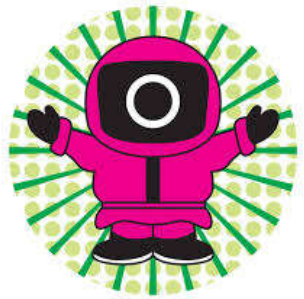
(Source: BSI, 2013. *BS EN 1838:2013, Lighting applications -- Emergency lighting*, British Standards Institution (BSI), London.)

Escape-route lighting requirements for routes up to 2 m in width (Illuminance levels, illuminance diversity & zones in which luminous intensities have to be limited to restrict disability glare)



(Source: van Bommel W., 2019. *Interior Lighting: Fundamentals, Technology and Application*, Springer International Publishing, Cham.)

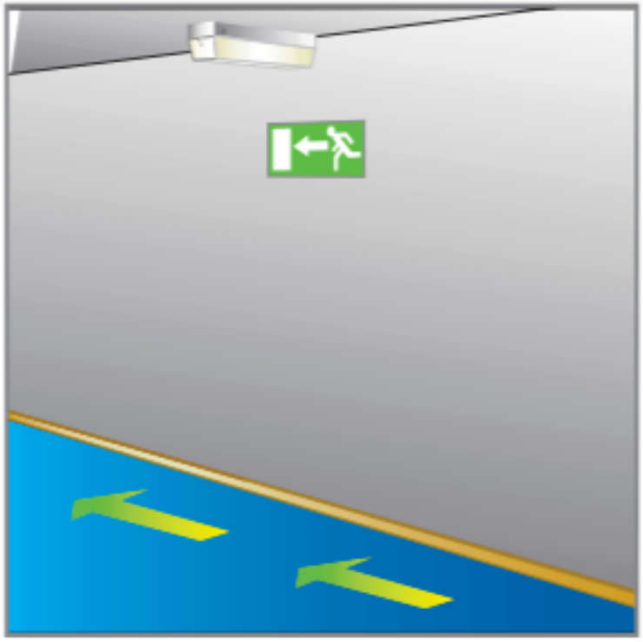
Design requirements



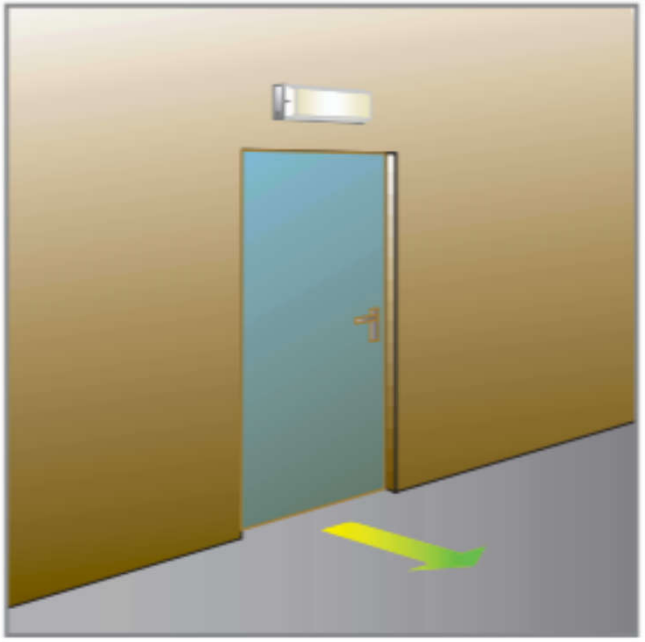
- Points-of-emphasis lighting
  - Can be part of the escape route or anti-panic open-area lighting
  - Critical points of emphasis are:
    - Exit doors intended for use in an emergency
    - Each flight of stairs or any other change in level
    - Each change of direction & intersection of corridors
    - First-aid posts, call points & disabled escape equipment
    - Disabled refugee points
    - Safety signs that are part of the emergency plan
    - Outside the final exit at a place of safety

Examples of points-of-emphasis lighting

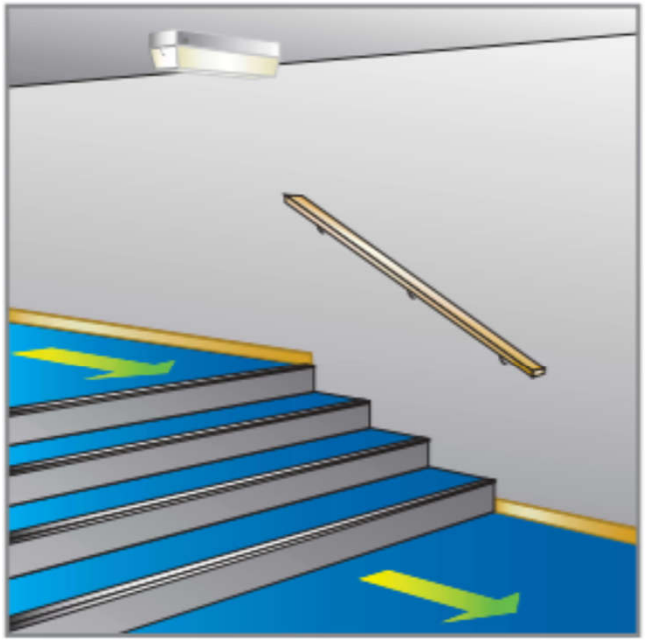
At each exit door



All safety exit signs



Outside and near each final exit



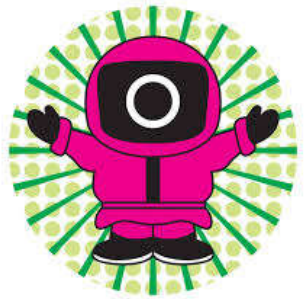
Near stairs so that each tread receives direct light

At each change of direction

Near each first aid post

(Source: https://hosting.iar.unicamp.br/lab/luz/ld/Seguran%E7a/emergency_lighting_design_guide.pdf)

Design requirements

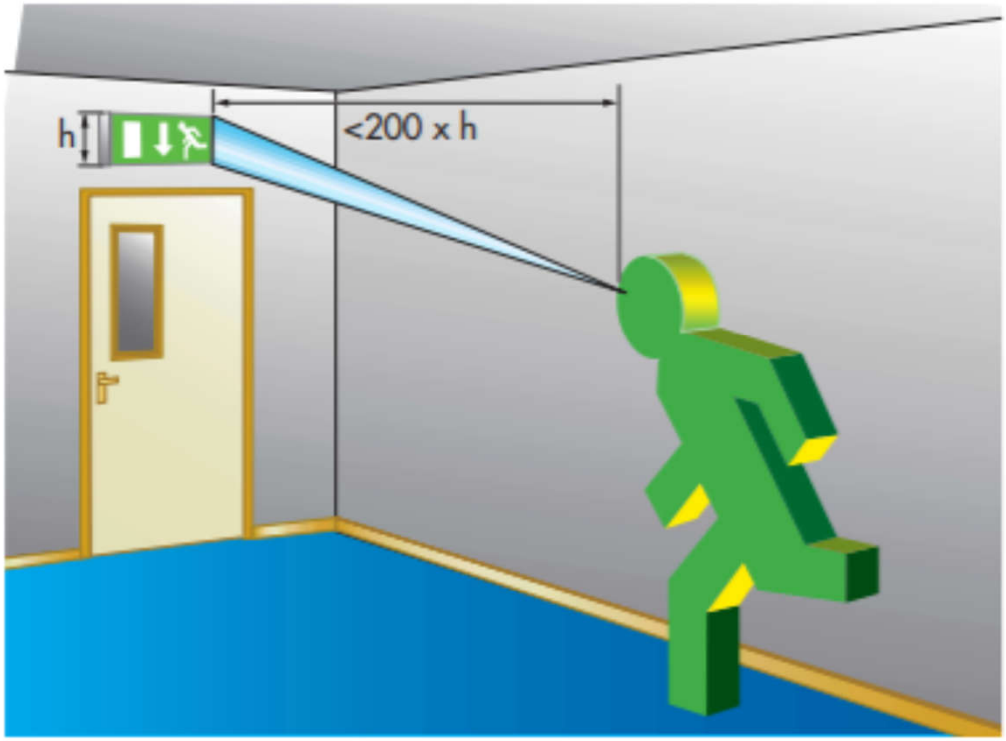


- Escape route indication
  - Escape routes may lead either towards normal exits or to emergency exits, which are indicated by means of appropriate signs

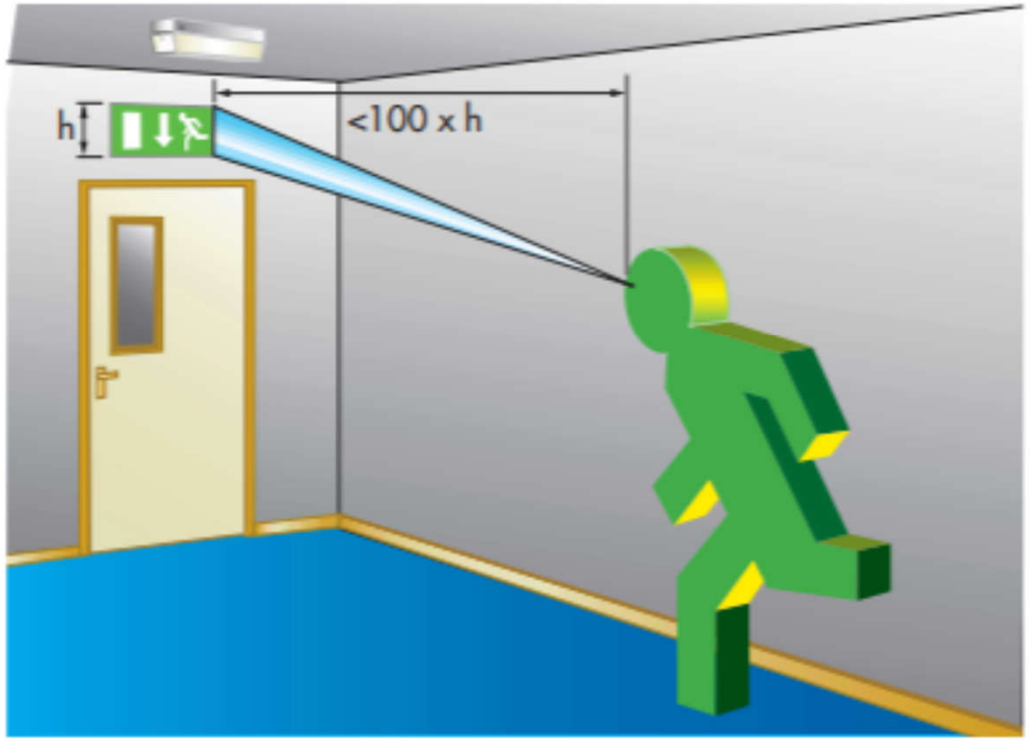
    - Normal exit signs: illuminated at all times & should remain so when the normal supply fails
    - Emergency exit signs: illuminated in times of emergency & may be illuminated at all times in general practice
- Methods for illumination of signs:
  - 1. Lamps external to the sign
  - 2. Lamps contained within the sign

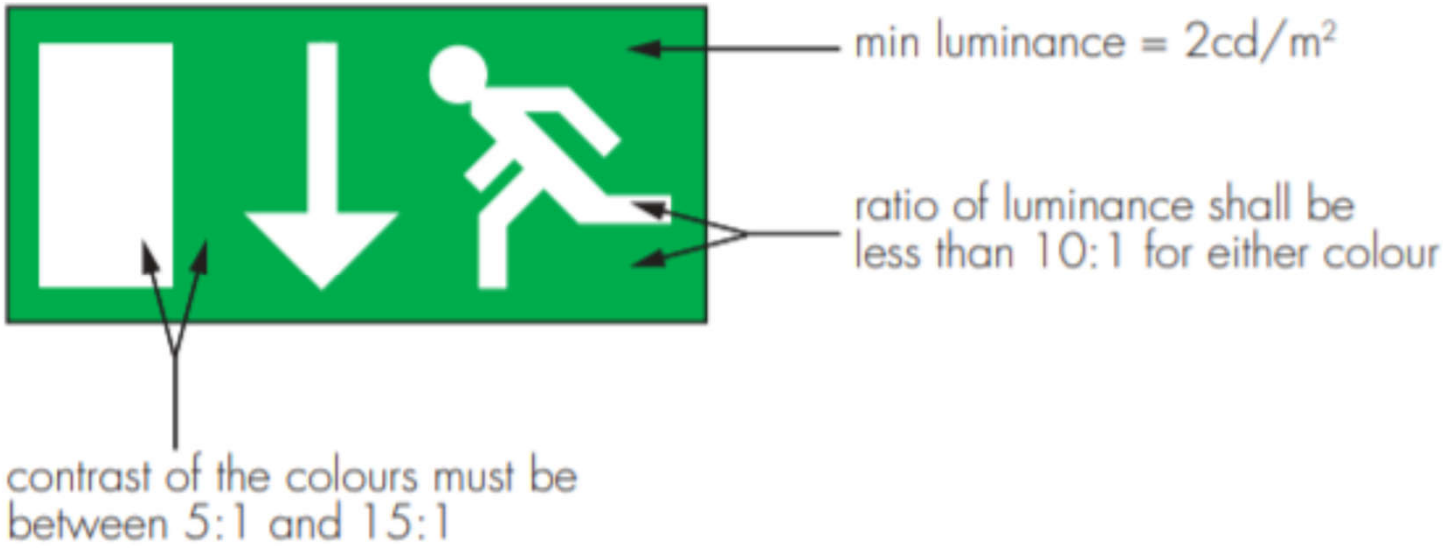
Maximum viewing distances & luminance/contrast of safety signs

Internally illuminated signs - 200 x the panel height



Externally illuminated signs - 100 x the panel height





(Source: https://hosting.iar.unicamp.br/lab/luz/ld/Seguran%E7a/emergency_lighting_design_guide.pdf)

Summary of requirements for safety signs

Item	Requirement
Luminance	Safety colour 2 cd/m^2 minimum
Diversity	Luminance of a colour < 10 (max./min.)
Contrast	Luminance of white to colour > 5 but < 15 (L_{white}/L_{colour})
Viewing distance	100 × height of externally illuminated sign 200 × height of internally illuminated sign
Mounting height	Minimum 2 m above floor
Response time	50% of design value in 5 s, 100% of design value in 60 s
Minimum duration	As risk assessed for the premises

(Source: SLL, 2015. *Lighting for the Built Environment, LG12: Emergency Lighting*, Society of Light and Lighting (SLL), London.)

Common exit & safety signs in Hong Kong

Characters exit signs

Combined graphical symbol & characters exit signs

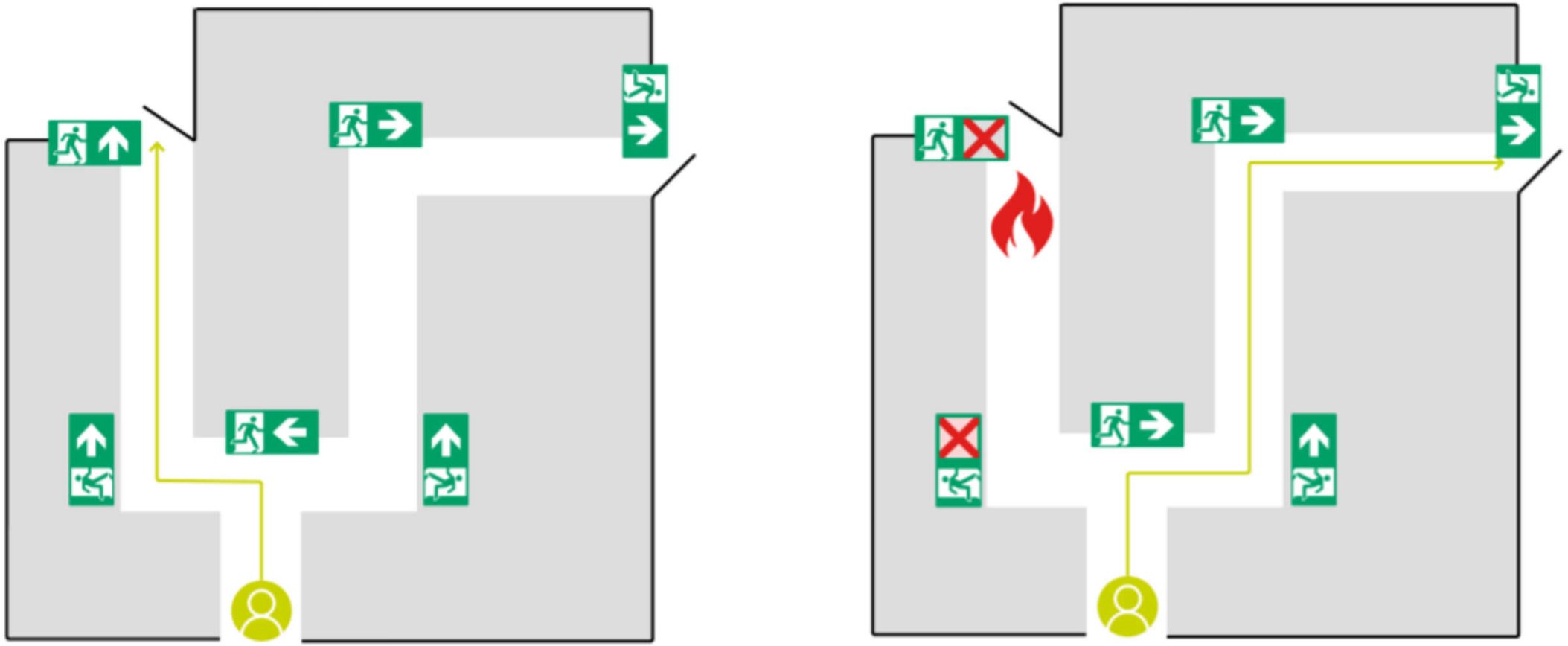
Graphical symbol exit signs

Directional signs

Other signs

(Source: http://www.crystalitehk.com/)

Adaptive signage changes to indicate shortest escape route avoiding fire hazard

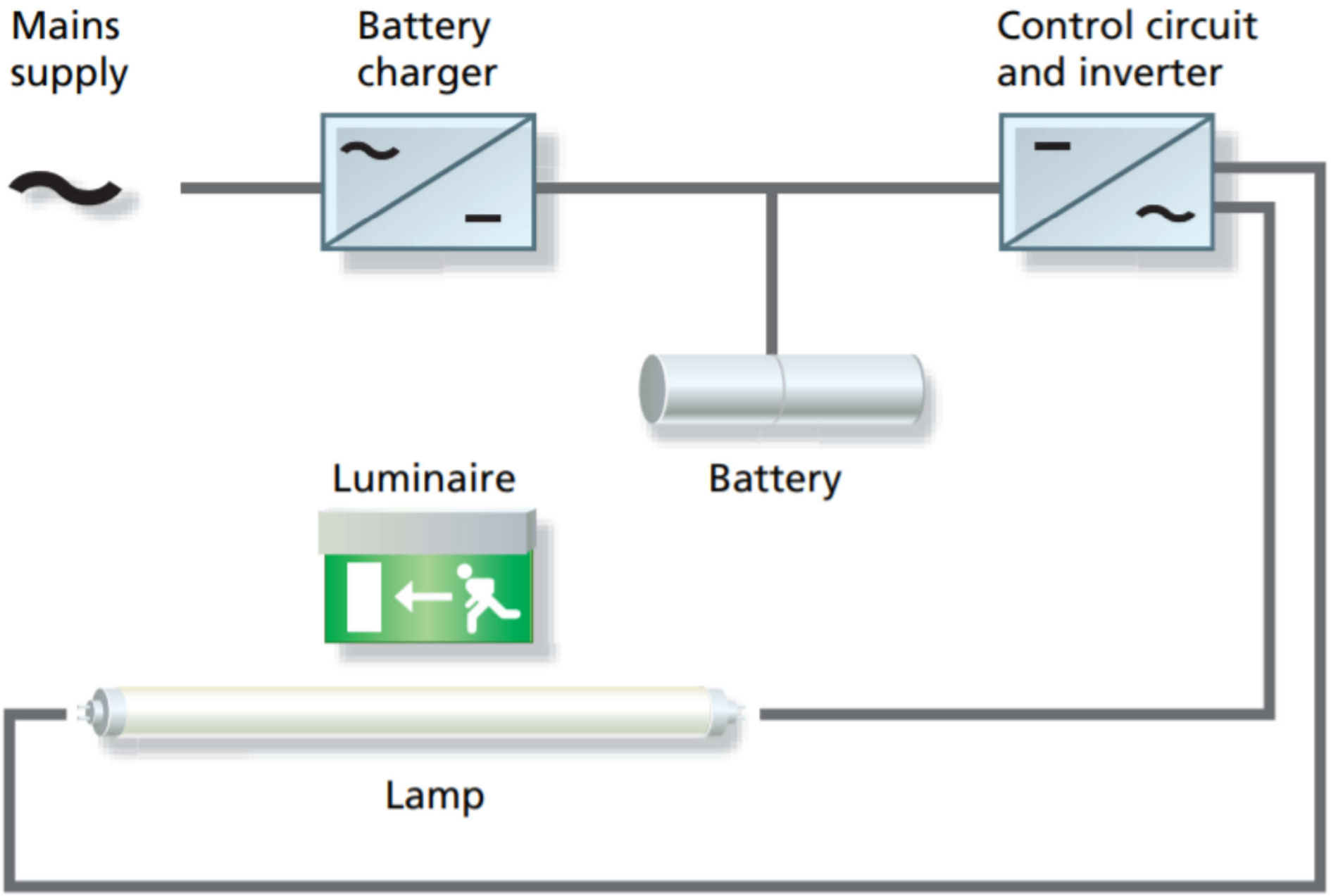


(Source: https://www.eaton.com/content/dam/eaton/markets/buildings/fundamentals-of-emergency-lighting-guide.pdf)

System components

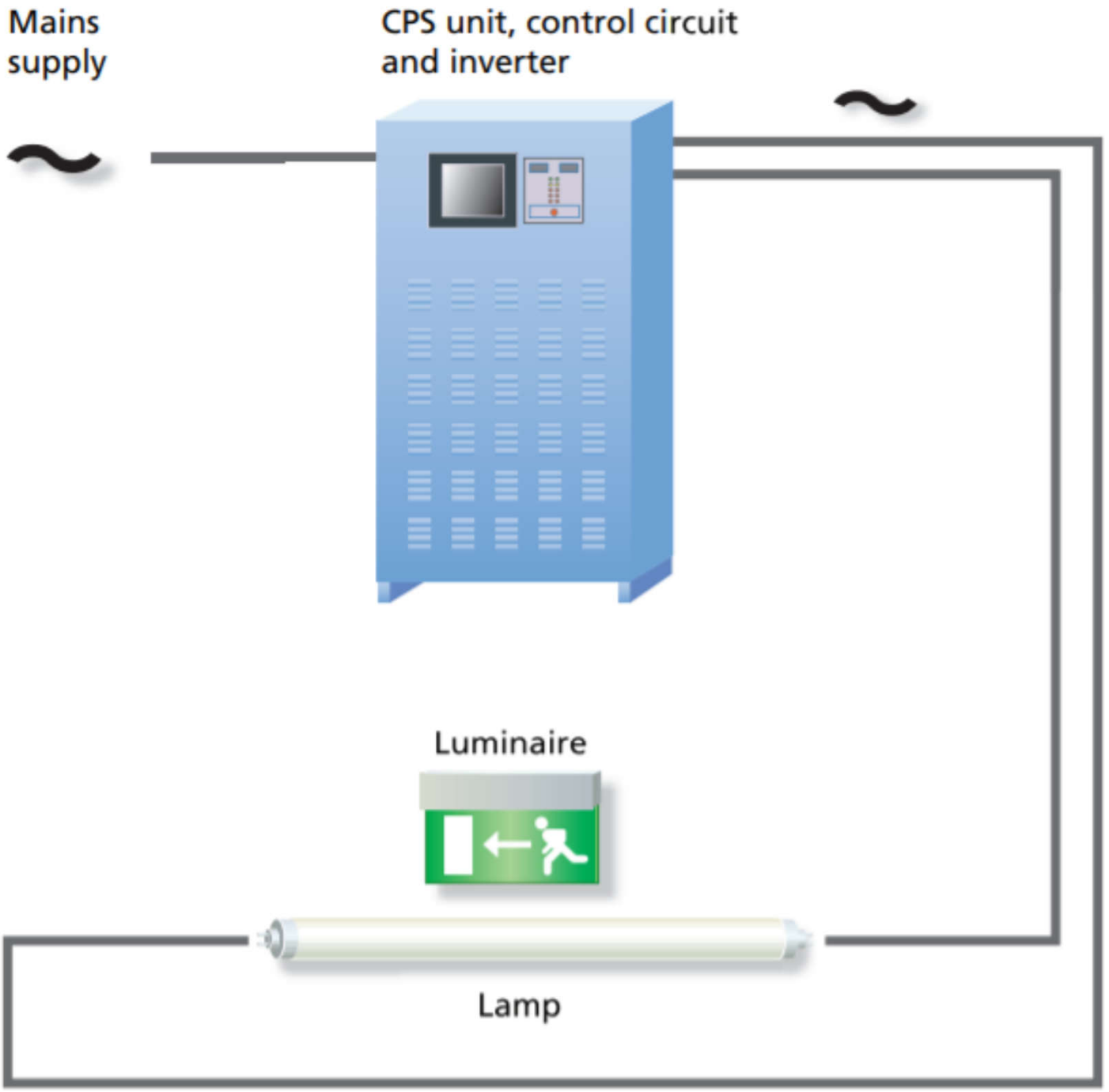
- System types
  - Self contained systems (with their own secondary battery power supply)
  - Centrally powered systems (centrally located power source connected by protected wiring)
    - AC/DC battery powered systems
    - AC/AC battery powered systems
    - Uninterruptible power supplies (UPS)
  - Compound systems with a central control unit & intelligent addressing (can receive input from fire detection systems to assist users to direct occupants)

Schematic of a self-contained emergency luminaire



(Source: http://www-public.tnb.com/eel/docs/emergilite/Emergi-Lite_Emergency_Lighting_Design_Guide.pdf)

Schematic of a centrally powered system with slave emergency lighting

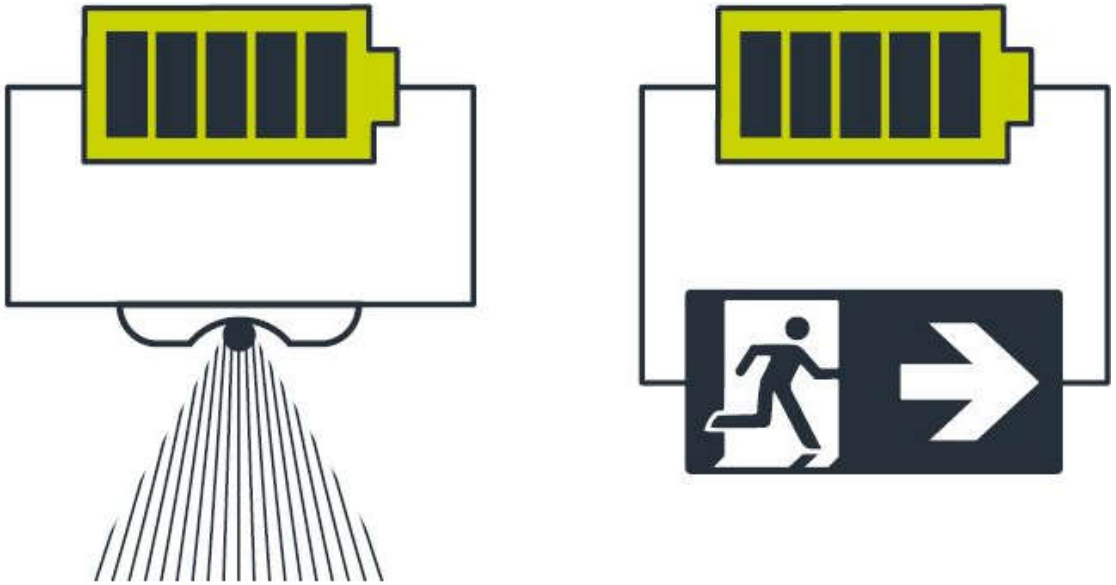


(Source: http://www-public.tnb.com/eel/docs/emergilite/Emergi-Lite_Emergency_Lighting_Design_Guide.pdf)

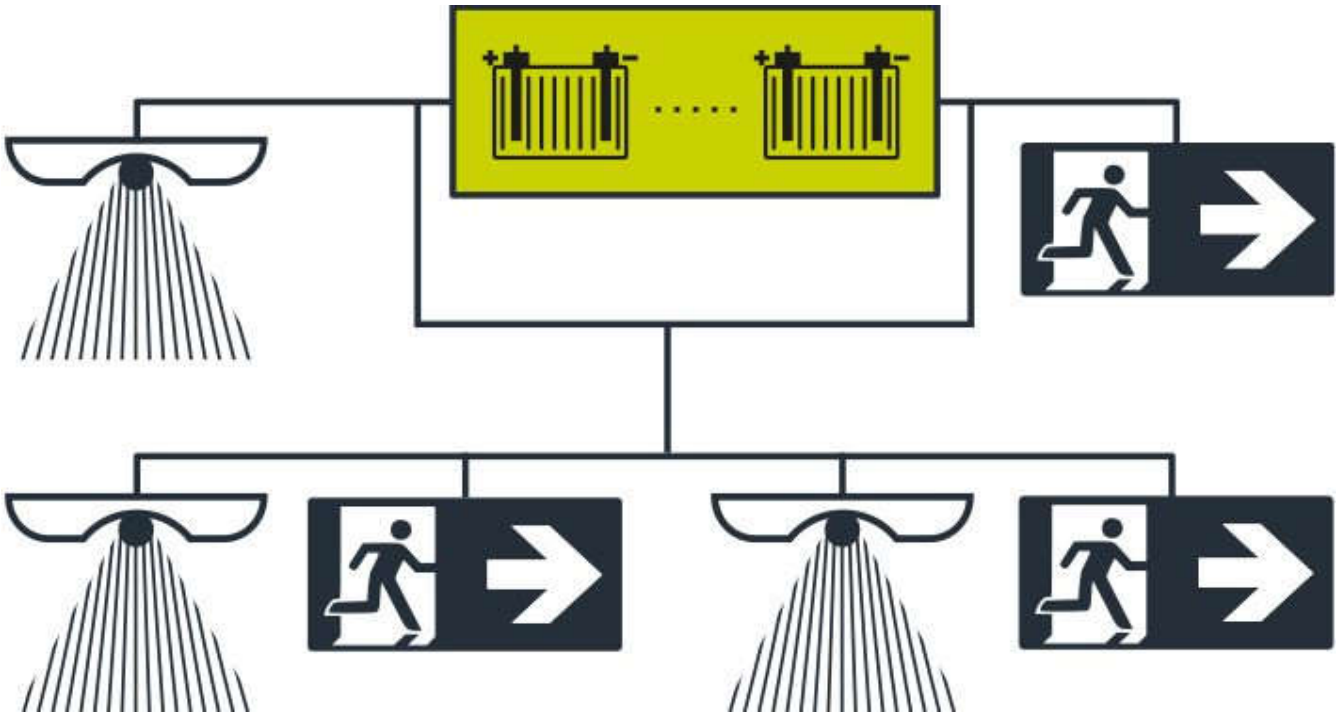
System components

- Power sources:
  - Batteries for self-contained systems
    - Sealed rechargeable cells: nickel-cadmium (Ni-Cd) or nickel-metal hydride (Ni-MH) or lead acid (Pb)
  - Batteries for central systems
    - Vented or sealed lead acid or nickel-cadmium alkaline rechargeable batteries (have high storage capacity, long operational life & wide operating voltage range)
  - Generators
    - A prime mover driving an alternator, fuel tanks, operating controls & starter batteries
    - Start automatically to provide power within 5 s

Emergency lighting battery technologies



(a) Self-contained emergency lighting



(b) Central battery systems

(Source: https://www.eaton.com/tw/en-us/markets/buildings/how-we-drive-building-efficiency-and-safety/safe-evacuation/evacuate/basics-emergency-lighting-systems.html)

System components

- Modes of operation:
  - Maintained luminaires 長明式

    - Permanently illuminated, and remain illuminated when power fails, e.g. for emergency exit lighting
    - In some cases they may be switched off deliberately, but are required to be active when the building is occupied
  - Non-maintained luminaires 後備式

    - May be switched on & off normally
    - If the power fails, they turn on automatically
  - Sustained or combined luminaires
    - Includes two lamps, one operating on a mains supply, and the other from a battery source

Summary of modes of operation

	Mains mode	Emergency mode
Non-maintained (NM)	 lamp is off	 lamp is on
Maintained (M)	 lamp is on	 lamp is on
Sustained/ Combined (C) or (S)	 mains lamp is on	 emergency lamp is on

(Source: Thorn Lighting)

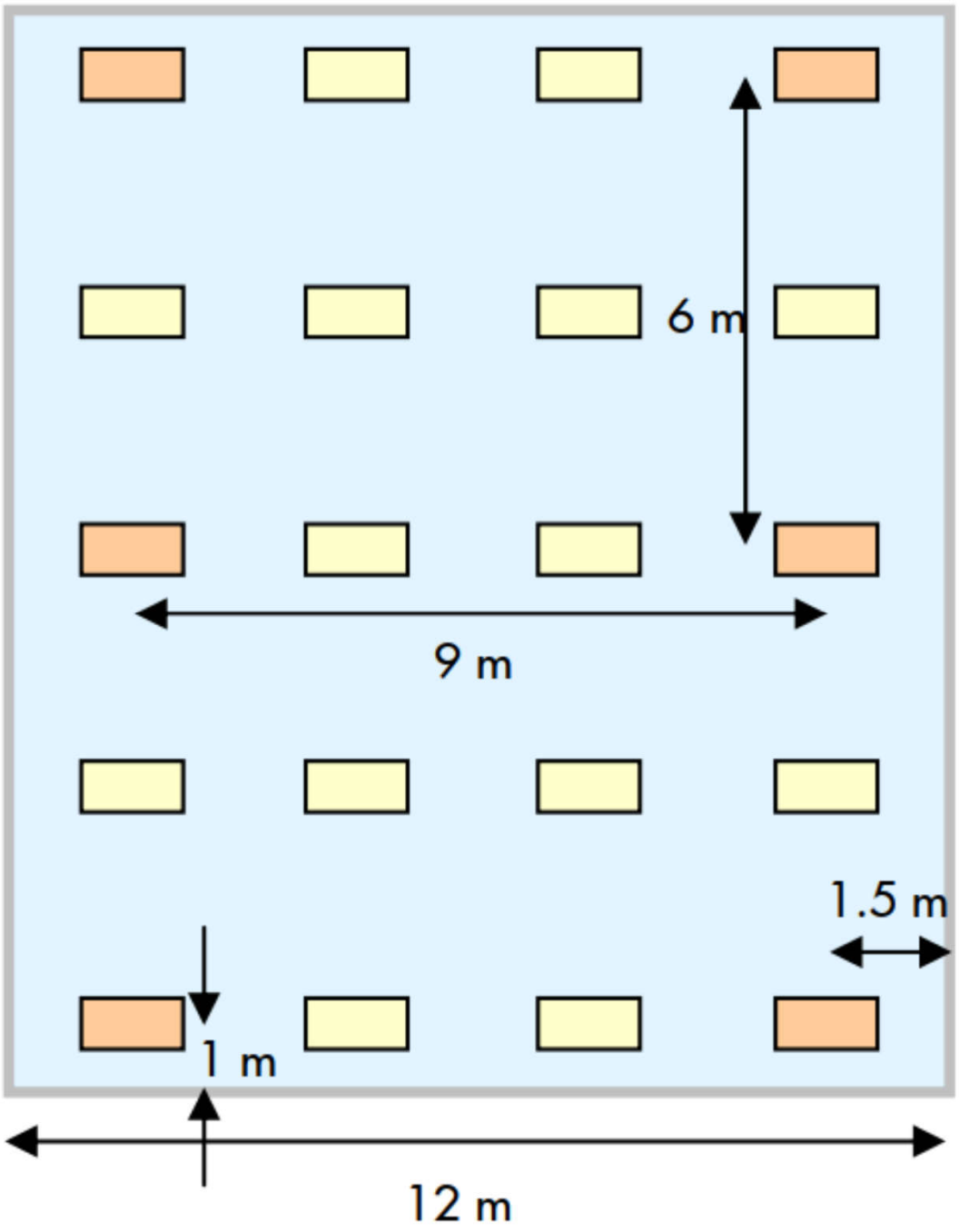
System components

- Wiring systems & circuits
  - Should adequately resist the effects of fire & mechanical damage and retain circuit integrity
    - Cables with high resistance to the effects of fire, mechanical damage, physical damage or rodent attack
    - Routed through areas of low fire risk wherever practicable
    - Methods of cable support & fixings should be non-combustible
    - Conduit, ducting, trunking & channel should have adequate strength & be non-flame propagating
  - Periodic inspection & testing

System components

- Integration with normal lighting luminaires
  - By using emergency version of the main luminaires (e.g. with a charge/healthy indicator)
- Extreme environments: special considerations
  - Hazardous areas: self contained luminaire systems need appropriately protected luminaires
  - Cold environments
  - Hot & humid environments (affect battery life)
  - Corrosive environments
  - Other conditions (e.g. vibration)

Open area using the emergency version of standard luminaire



Emergency version of standard luminaire

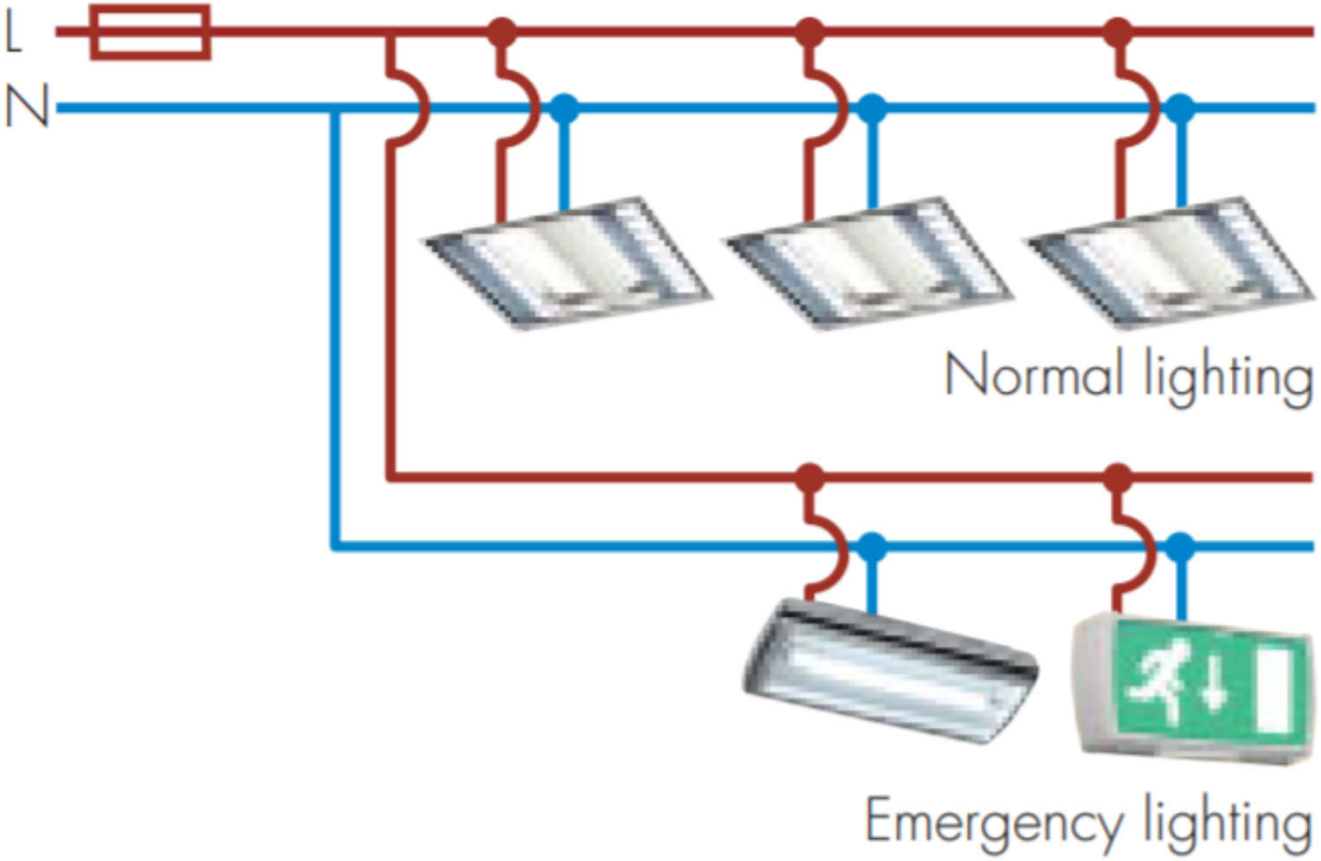
LED Indication	Condition
●	Battery charged and PSU OK
●	Emergency mode activated
●	Function Test
	Self-test
☀	Commissioning
☀	Fault - further troubleshooting required

(Source: Thorn Lighting)

System components

- The adoption of LED luminaires & the upgrading of battery technologies have opened the door to a new class of system that didn't exist before distributed central power supplies
  - Offer extensions in rated battery life from four to 10-plus years, with reduced spatial requirement & lower facility management & capital costs
  - LED luminaires are now often the first choice for emergency lighting, but there are pitfalls, e.g. the introduction of batteries & an inverter changing the ambient temperature within the luminaire

Control of luminaires for normal & emergency lighting



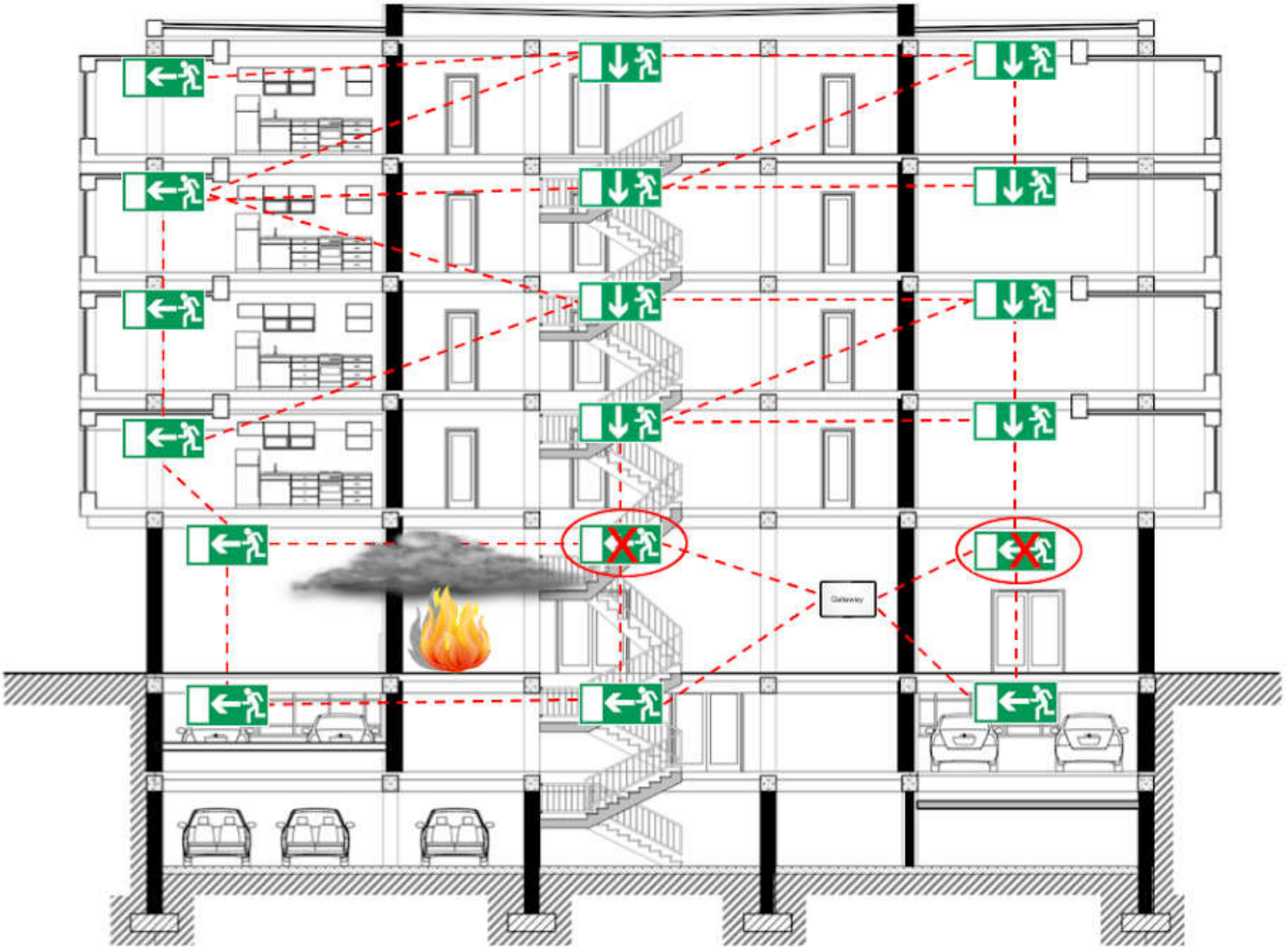
Network control of luminaires for emergency lighting

(Source: https://hosting.iar.unicamp.br/lab/luz/ld/Seguran%E7a/emergency_lighting_design_guide.pdf)

Smart wireless systems to control emergency lighting

(Source: https://www.blelighting.co.uk/blog/blog/transforming-the-way-we-test-emergency-lighting)

Adaptive emergency lighting built with wireless mesh



(Source: https://lumenradio.com/the-future-of-emergency-lighting-go-wireless/)

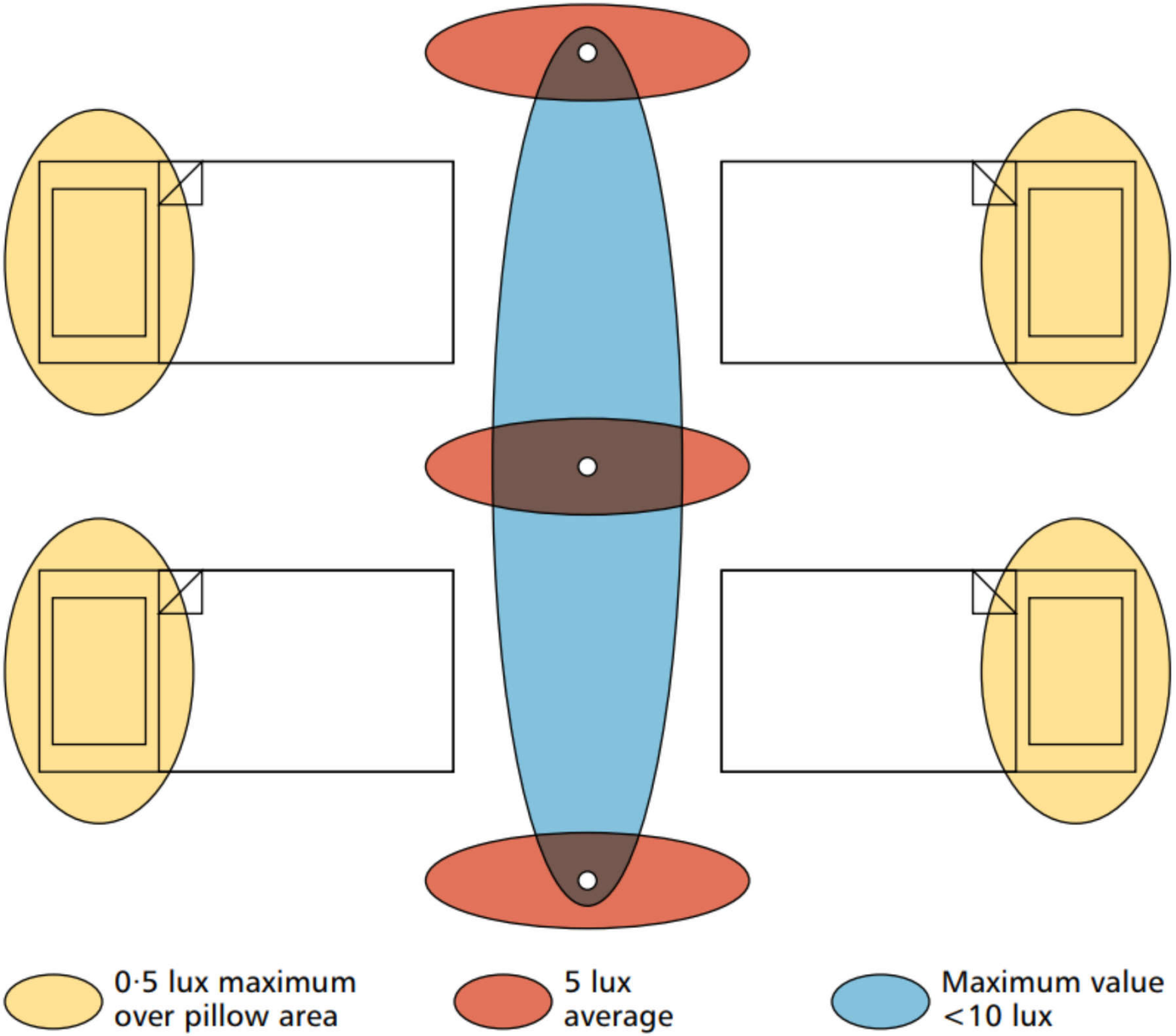
System design & operation

- Important design considerations
  - **1. Building user profiles**

    - (Commercial) buildings have a wide variety of users
    - Important risk factors that affect the ease of evacuation of these users include age, health & wellbeing, lifestyle & familiarity with the building
  - **2. Building type & usage**

    - How safely tasks can be stopped by people within a building impacted by a reduction in illuminance
    - Three categories: low risk, high risk & high risk+

Night lighting requirements in hospital ward areas



(Source: SLL, 2019. *Lighting for Healthcare Premises*, Lighting Guide 2, Society of Light and Lighting (SLL), London.)

System design & operation

- Important design considerations (cont'd)
  - **3. Building scale & complexity**

    - They can make evacuation difficult
    - A building's age may also present problems
    - Facilities with large public gatherings, high-rise buildings or phased evacuation buildings
  - **4. Life-cycle considerations**

    - Lifecycle total cost of ownership (TCO)
    - A trade-off between how much the system will initially cost to design & build and the operating costs involved over its lifetime

System design & operation

- Design procedure
  - 1. Determine requirements (e.g. escape routes)
  - 2. Design of illuminance (e.g. position, duration)
  - 3. Design of system (e.g. operation, wiring)
  - 4. Design of circuit protection & controls
  - 5. Installation, operating & commissioning
  - 6. Handover (e.g. system documentation, training)
- Certificates & log book
- Routine inspections & tests (monthly, annual)
- Servicing & repair (components, spares)

System design & operation

- Design checklist:
  - 1. Choose the luminaire types (viewing distance, IP classification, mounting height etc.)
  - 2. Placing of luminaires (luminaire technical design)
  - 3. Choose system type (central battery or self-contained)
  - 4. Size of the batteries (back up operation time)
  - 5. Type of the cables for the system cabling
  - 6. Cross section of the cabling, taking into account the loss of voltage & the minimum short circuit current (electrotechnical design)

Emergency lighting design process

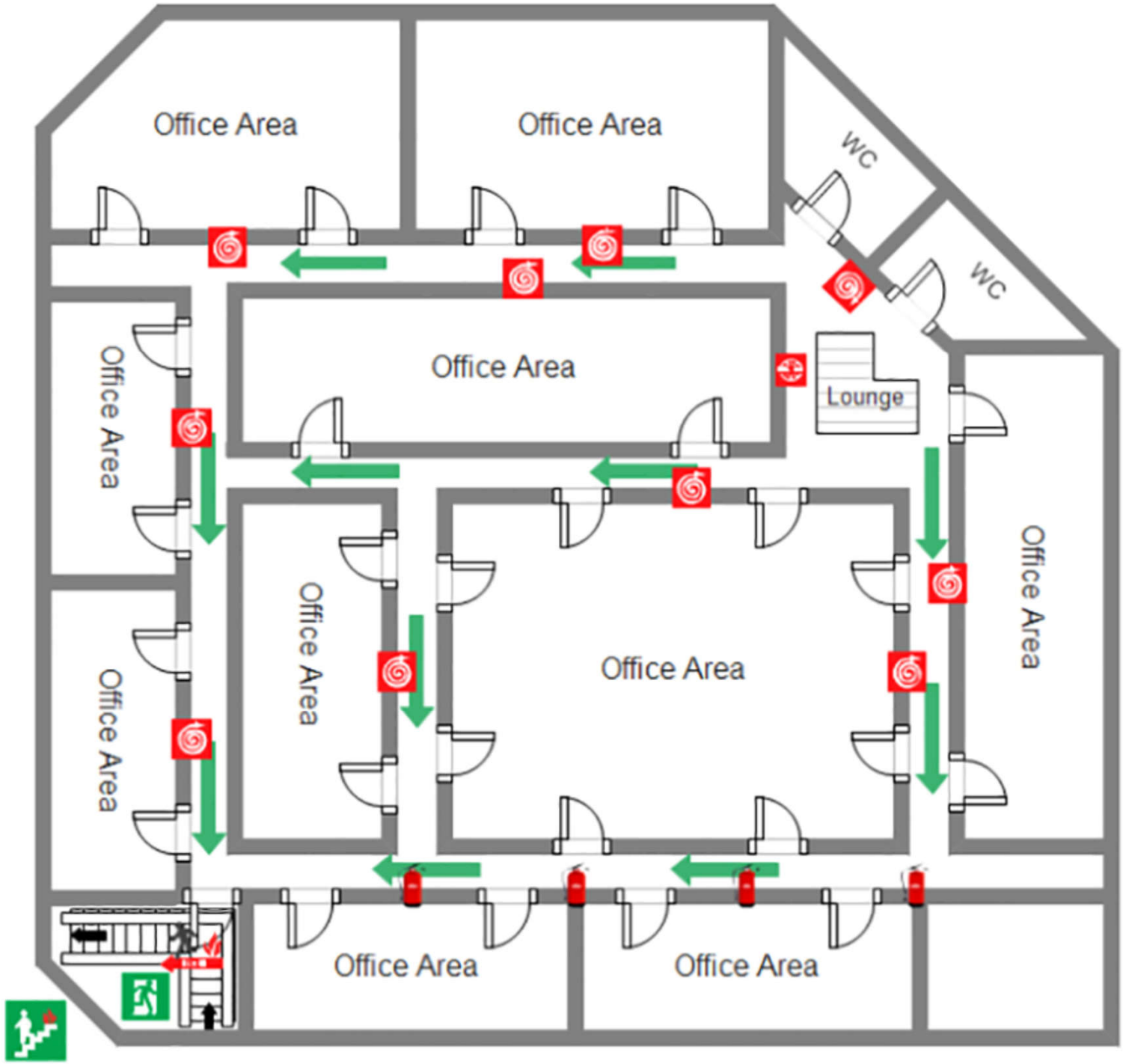
- Examination of the risk assessment
- Duration of the emergency lighting
- Identify emergency escape routes & take account of potential hazards
- Identify the locations of fire alarm call points, fire fighting equipment & fire safety signs
- Determine type of emergency lighting system
- Means of isolation for testing and/or maintenance
- Coordination/interface with luminaire manufacturers where main luminaires are to be converted into emergency lighting luminaires
- Identify the exit sign requirements
- Identify any high risk areas
- Open areas larger than 60 m^2 floor areas need to be identified
- Need for external illumination outside final exit doors & on a route to a place of safety

(Source: https://www.orlight.com/resources/docs/0abd9b639180/Emergency-Lighting-GuideMar2021.pdf)

System design & operation

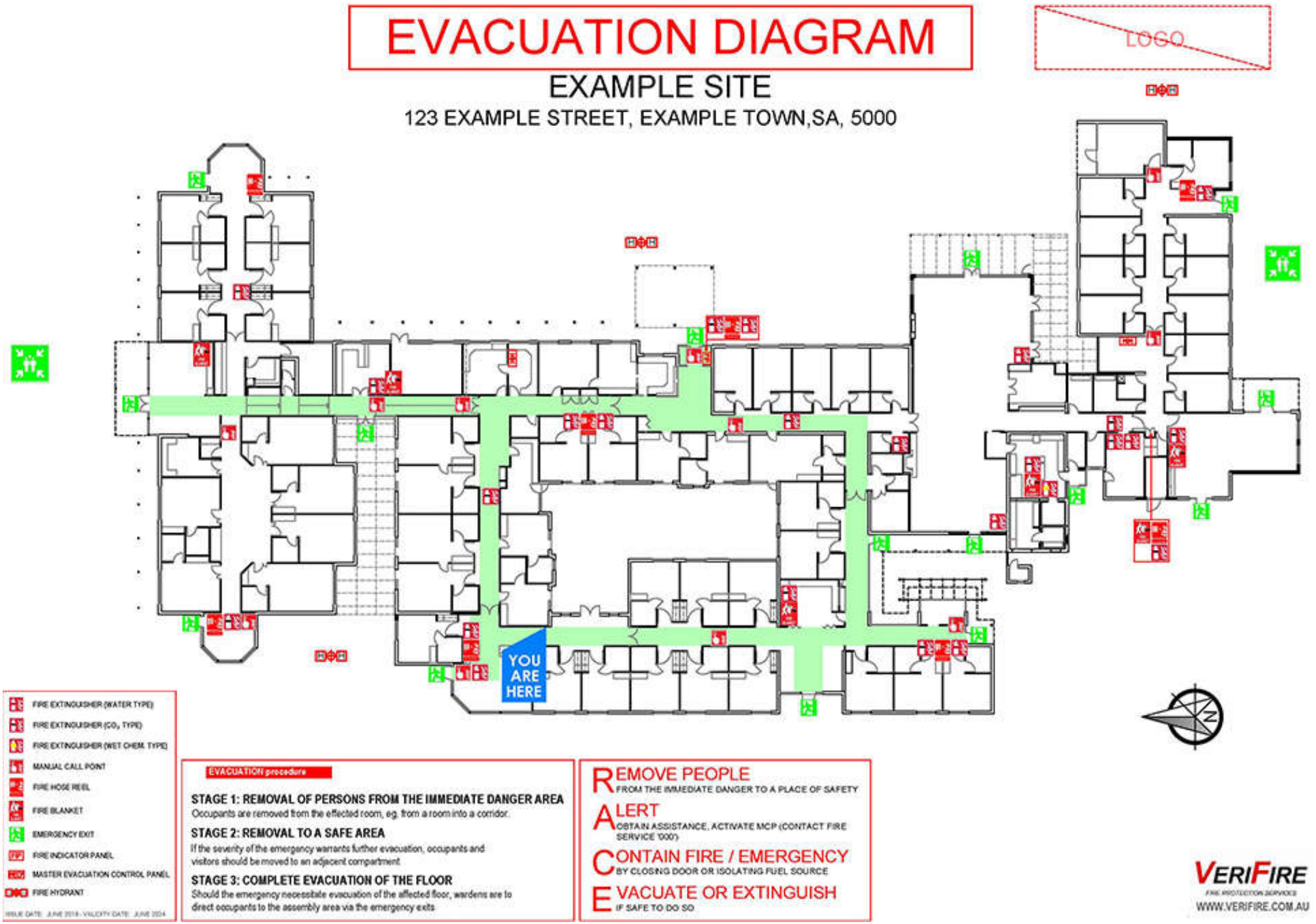
- Risk assessment
  - Evaluate potential risks to occupants in a building that could occur in the event of failure of the supply to the normal lighting, and determine suitable compensating safety provisions
  - Safe movement of people along escape routes
  - Report on the adequacy of the emergency lighting, fire alarms, extinguishers, etc.
  - Keep the occupants safe in a power supply failure
- Emergency lighting testing, maintenance, operation & update

Office building emergency evacuation plan



(Source: https://www.zenithfireprotection.com/emergency-lighting-exit-signs-inspection.php)

An example of evacuation diagram for emergency planning



(Source: https://verifire.com.au/product/evacuation-diagrams/)

System design & operation

- Design calculations
  - Must consider the emergency lighting ballast, the starting of the lamp, the reduction in light output as the battery discharges, and the reduced performance of the battery after a number of years of use
  - Practical emergency lamp flux (PELF)
    - Lowest luminous flux of the lamp observed during the rated duration of the emergency mode
    - PELF = LDL × EBLF
      - LDL is the initial lighting design lumens at 100 h as declared by the manufacturer
      - EBLF = Emergency ballast lumen factor

System design & operation

- Emergency ballast lumen factor (EBLF)
  - Ratio of the luminous flux of the lamp supplied by the emergency ballast to the luminous flux of the same lamp operated with the appropriate reference ballast at its rated voltage & frequency
    - EBLF is the minimum of the values measured at the appropriate time after failure of the normal supply & continuously to the end of the rated time
  - $EBLF = BLF \times F_{Time}$
    - BLF: Ballast lumen factor
    - F_{Time}: minimum light output values measured during the emergency operating time period

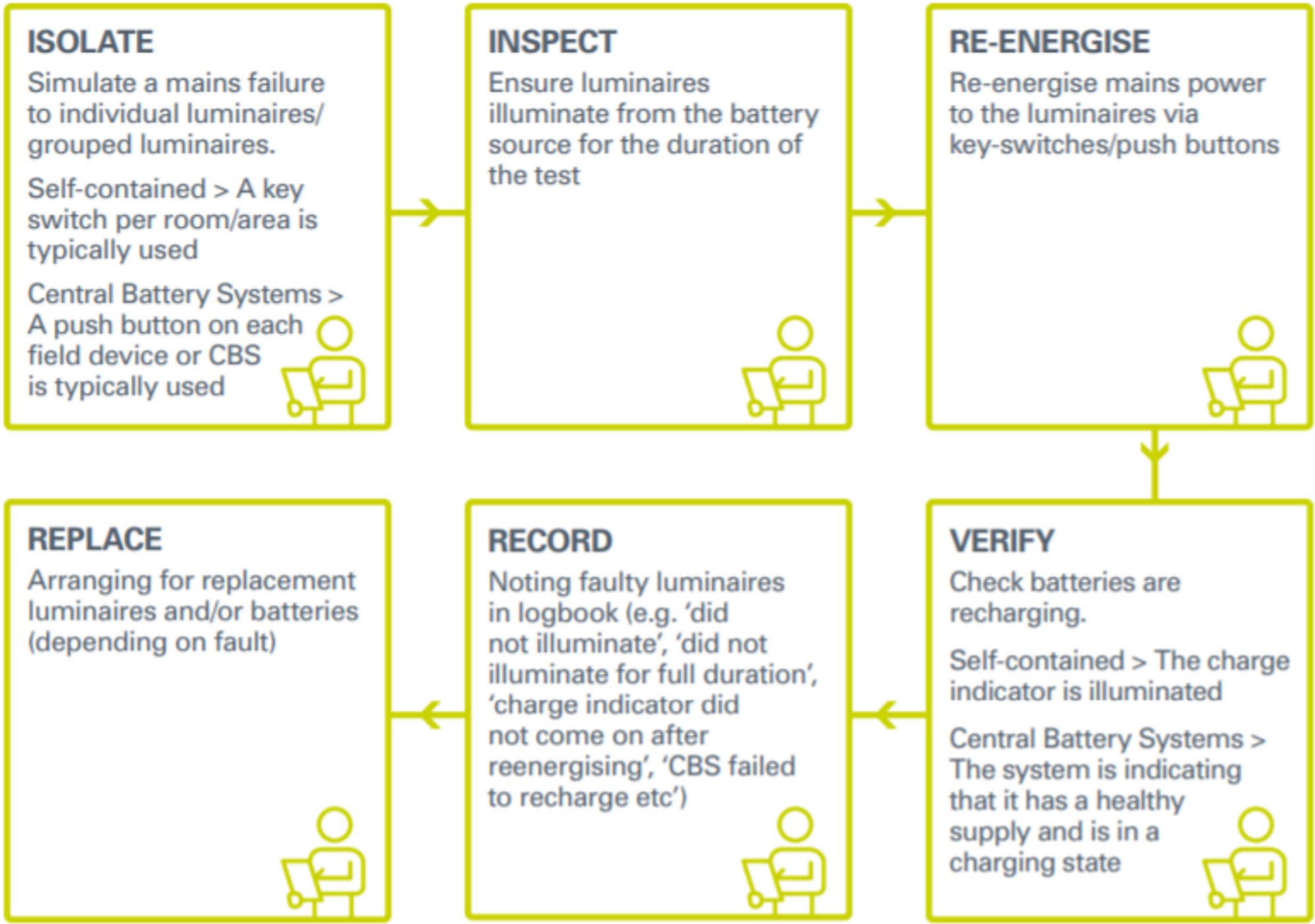
System design & operation

- Maintenance, commissioning & testing
  - Ensure that the system remains fully operational
  - Testing routine, consumable items & spare parts
- Facilities for testing & operation
  - 1. Luminaire with test device
  - 2. Luminaire with remote test device (centralised)
  - 3. Luminaire with inhibiting mode (to prevent the discharge of batteries at times when unoccupied)
  - 4. High risk areas & special occupancies (e.g. plantroom, health care)

System design & operation

- Commissioning certificate
  - Written declarations of compliance
  - 1. Installation quality
    - Conform to electrical & fire safety regulations
  - 2. Photometric performance
    - Evidence of compliance with light levels supplied by the system designer or contractor
  - 3. Declaration of a satisfactory test of operation
    - A log of all system tests & results, with commissioning forms, testing forms & instructions
- Manual & automatic testing

Typical manual testing process for emergency lighting



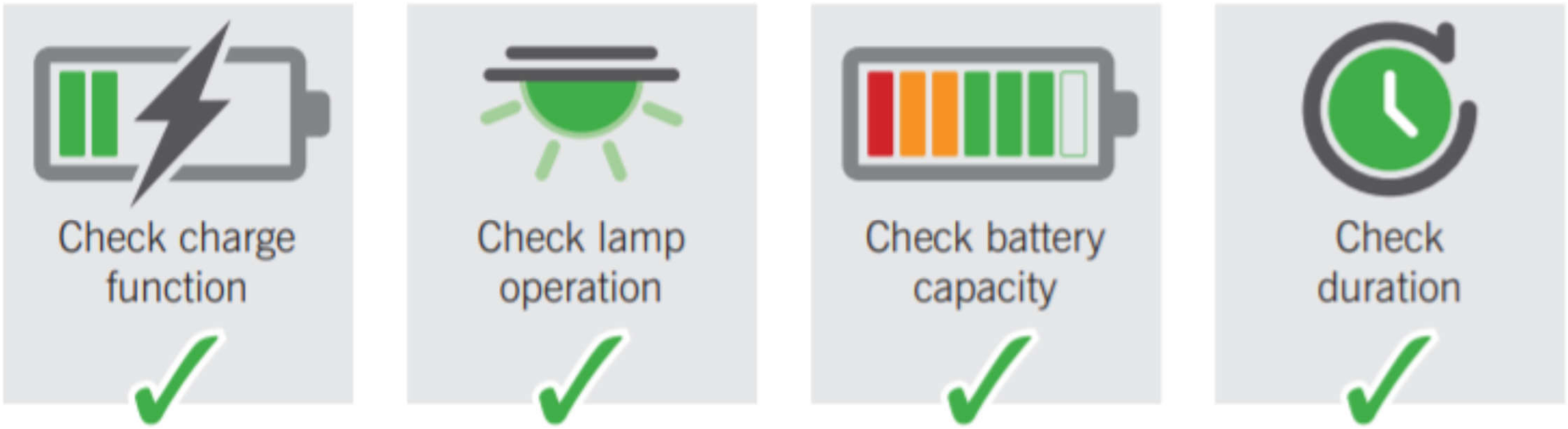
(Source: https://www.eaton.com/content/dam/eaton/markets/buildings/fundamentals-of-emergency-lighting-guide.pdf)

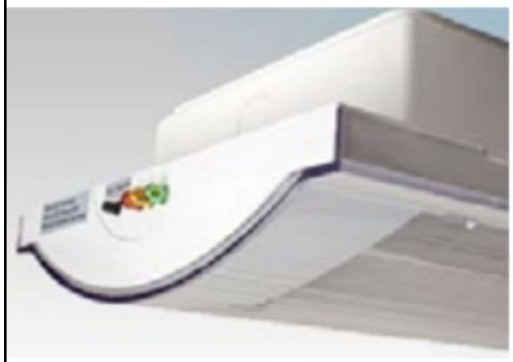
System design & operation

- Testing requirements & record logs
  - Function test (once per month)

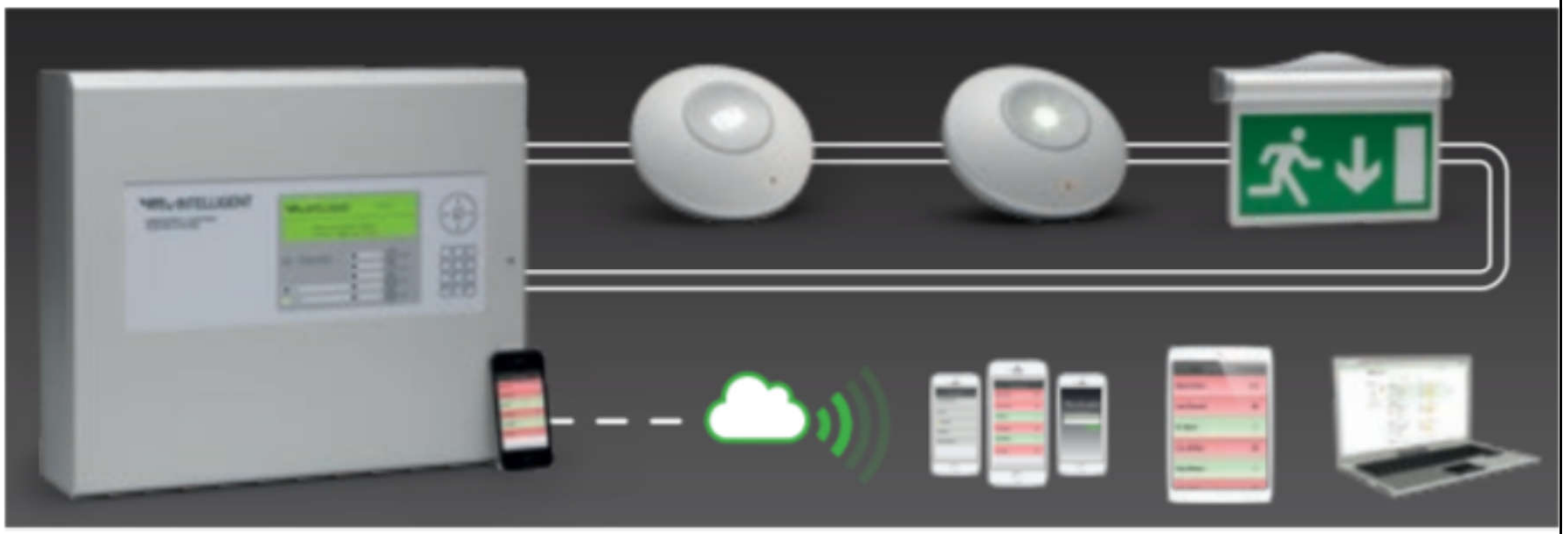
    - Breaking the supply to them & checking that they operate satisfactorily
    - The supply must then be restored & the charging indicators must be seen to be operating correctly
  - Discharge test (annually)
    - The luminaires must be tested for their full rated duration period & checked for satisfactory operation
    - The supply must then be restored & the charging indicators rechecked
    - Done outside normal working hours, or by phase

Emergency lighting testing & automatic testing systems





Self-testing



Automatic addressable testing system

(Source: https://www.iheem.org.uk/wp-content/uploads/2021/04/Emergency_Lighting_Pocket_Guide_June_2021.pdf)

System design & operation

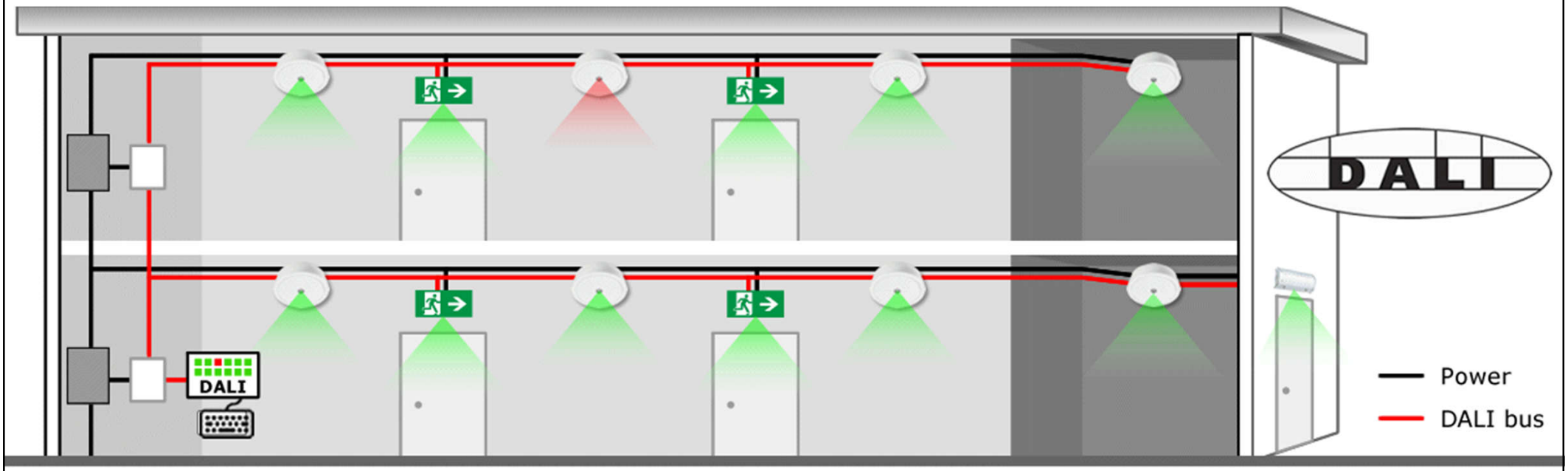
- Automatic testing system
  - Self monitoring/diagnostic
    - Timing circuit
    - Charging
    - Lamp
    - Communications
  - Testing schedule
  - Test result status indication
  - Minimise risk by randomising/staggering testing
  - Stand-alone luminaires (each device tests itself) & network systems (linked to central monitoring)

MEANING OF THE INDICATOR LED			
GREEN		RED	
	Mains operation No fault		Duration battery fault
	Blinking Functional test		Blinking Lamp / Changeover fault
	Flashing Annual duration test		Flashing Battery / Charging fault
	Mains failure + Emergency light operation		

System design & operation

- Examples of automatic testing
  - Self-contained with built-in auto test
  - Self-contained system with centrally monitored luminaires & automatic testing (addressable)
  - Central battery system with centrally monitored luminaires & automatic testing (addressable)
- Automated testing & electronic logbook (web-based or on integrated panels)
- Visualise the system status on layout plans
- Real-time monitoring of multiple systems

Automatic testing of emergency lighting equipment for self-contained stand-alone luminaires (Self-Test) & self-contained centrally monitored luminaires using Digital Addressable Lighting Interface (DALI)

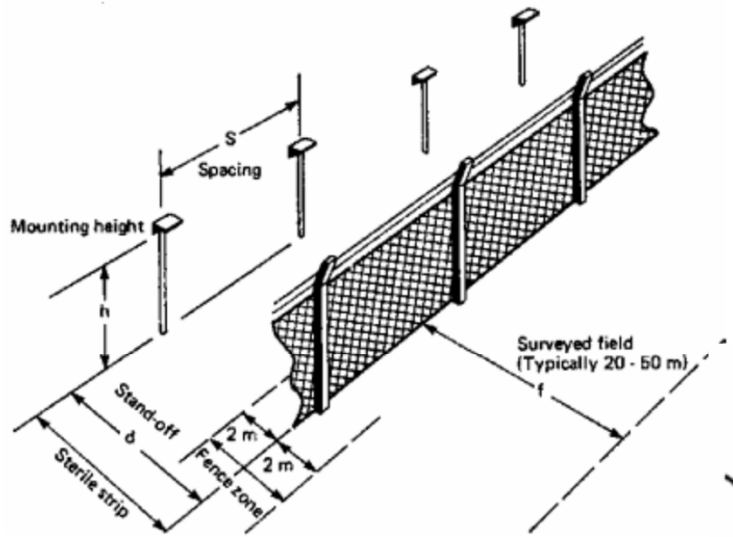


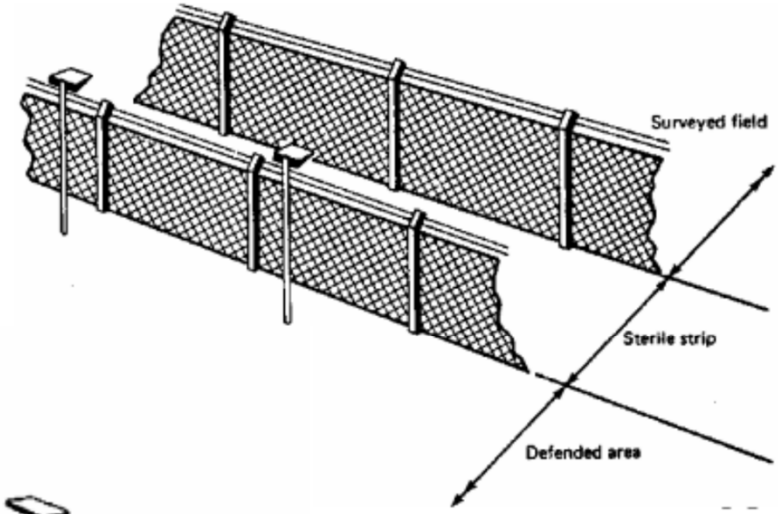
(Source: https://www.elp.uk.com/dali-and-self-test/)

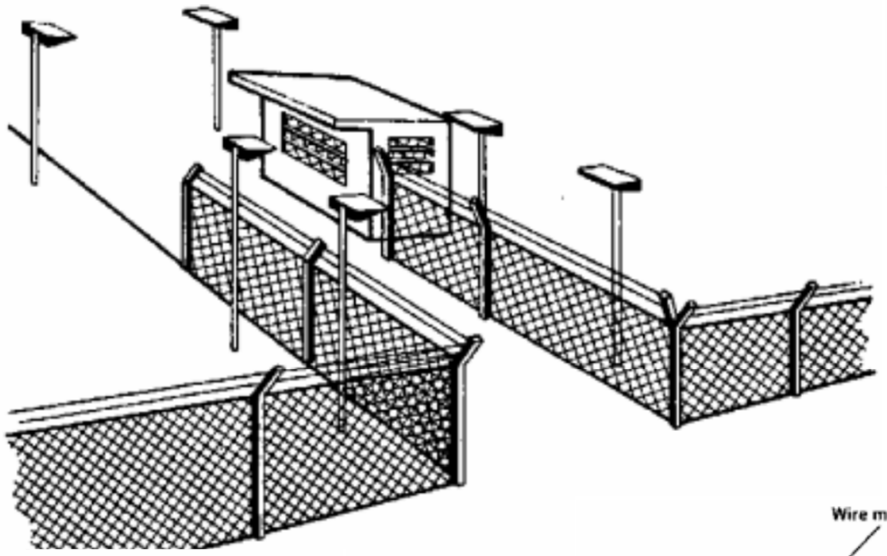
Security lighting

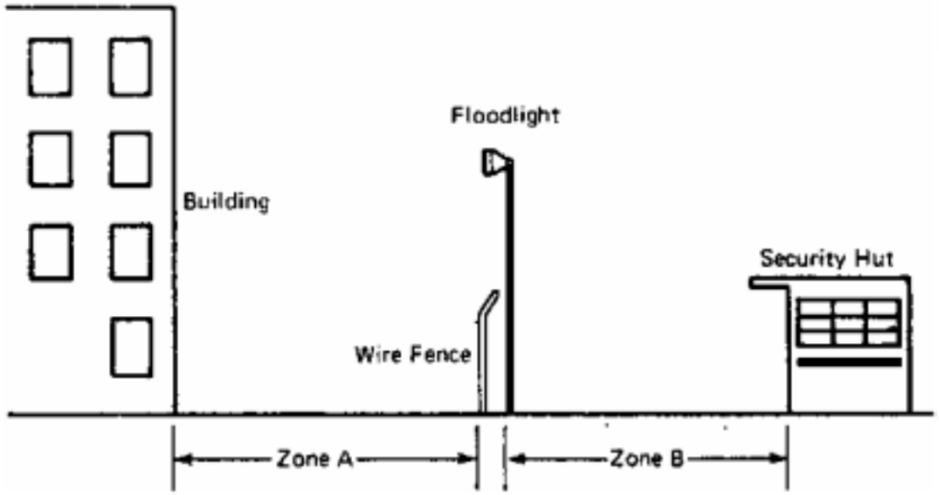
- Primary objectives: to deter, detect & prevent criminal activities; also give a feeling of safety & well being
- Five basic lighting techniques:
  - 1. Perimeter lighting (fence zone)
  - 2. Checkpoint lighting (gatehouse)
  - 3. Area lighting (luminaires mounted on adjacent buildings or on columns or high masts)
  - 4. Floodlighting (intruder may be readily seen)
  - 5. Toping up (avoid hiding of an intruder)

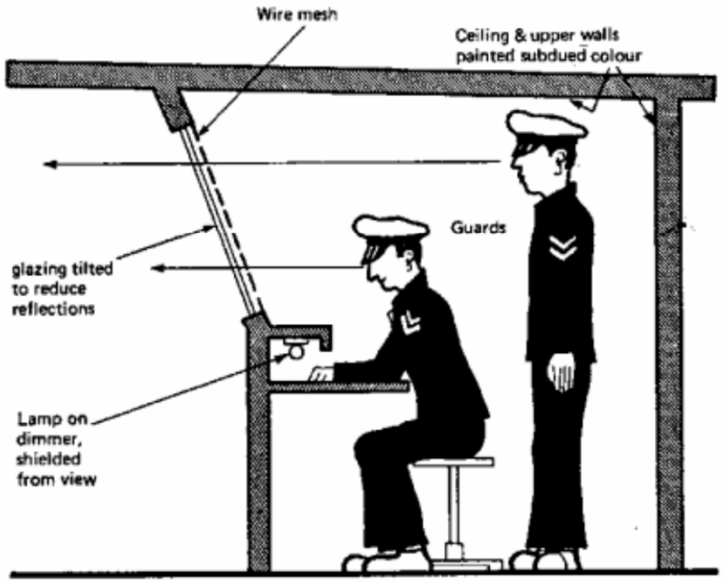
Perimeter lighting, checkpoint lighting, area lighting & floodlighting







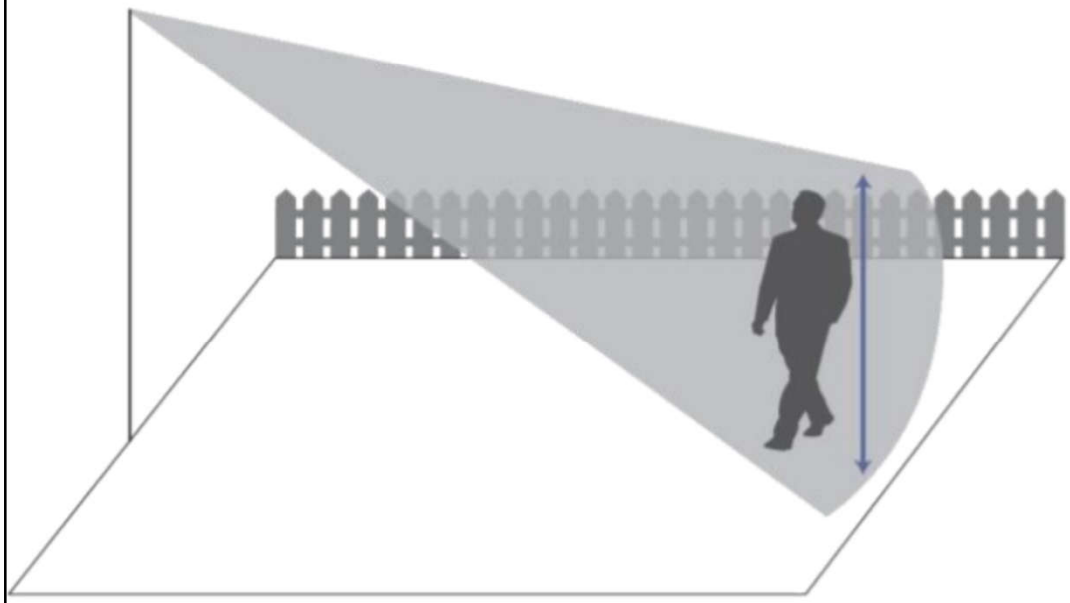




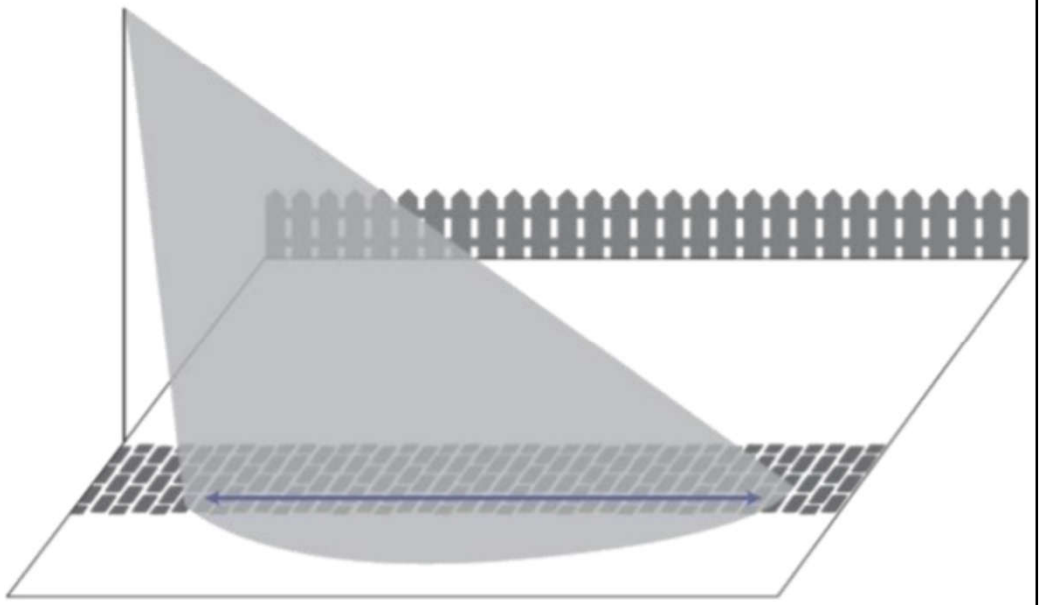
(Source: Thorn Lighting)

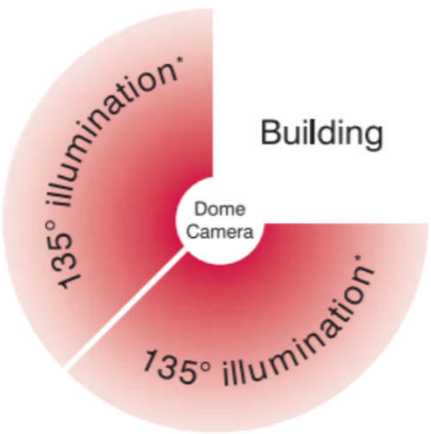
Illuminating on different planes for different purposes significantly alters the amount of light required

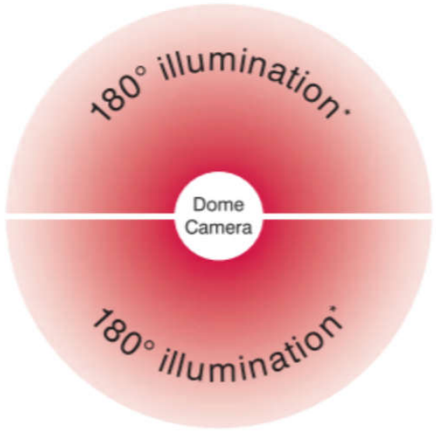
Vertical Plane
(CCTV Lighting Usage)



Horizontal Plane
(General Area Lighting Usage)



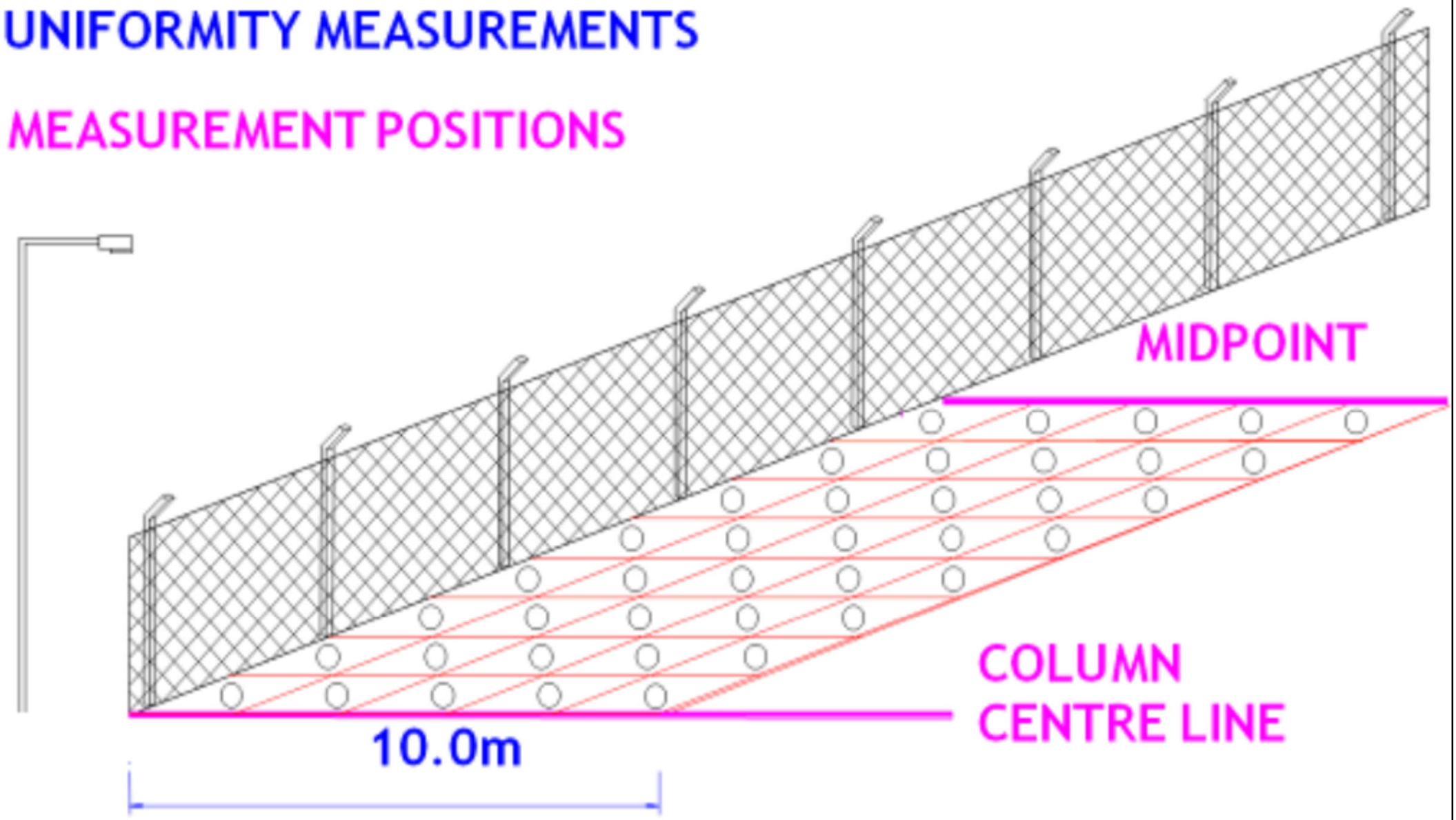




CCTV dome camera

(Source: https://www.accu-tech.com/hs-fs/hub/54495/file-223248737-pdf/docs/an-sm-080_lighting_for_perimeter_security_applications_rev._a__7-13.pdf)

Illumination measurement positions in the centre of the squares



(Source: Security lighting - Guidance for Security Managers https://www.cpni.gov.uk/security-lighting)

Security lighting

- Types of security lighting:
  - Continuous lighting (at boundaries, e.g. in prisons)
  - Standby lighting (supplement continuous systems)
  - Movable (portable) lighting (temporary)
  - Emergency lighting (for use when normal light fail)
- Lighting for closed circuit television (CCTV)
  - White light & infra-red (IR), facial recognition
  - Distance, angle, mounting position
  - Camera & lens (wide area, target/local area)
  - Photocell to trigger day/night camera switching

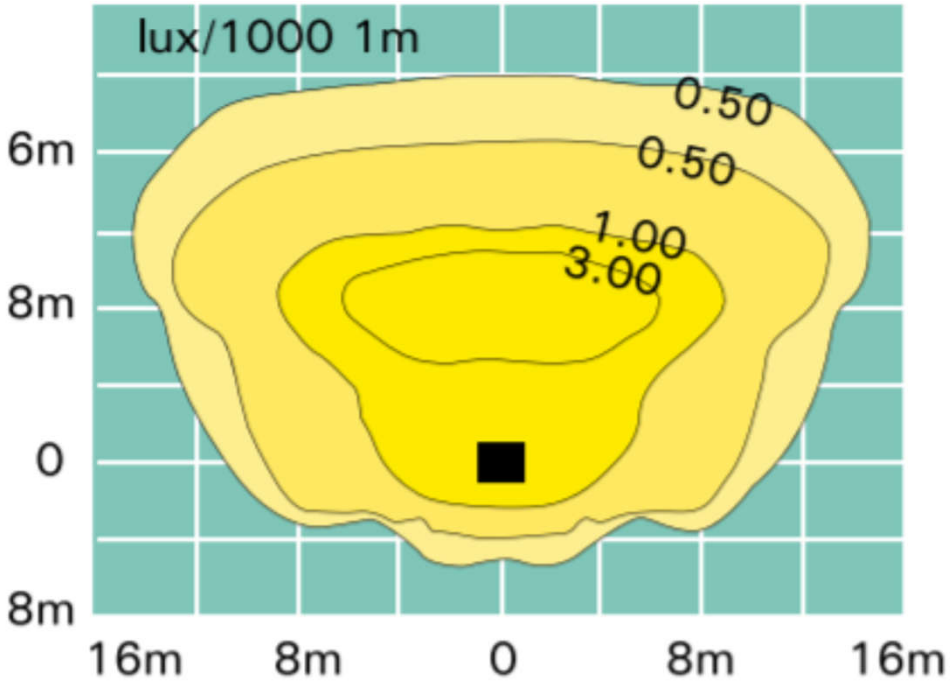
Recommended lighting levels for closed circuit television (CCTV)

Camera	Minimum illuminance in Lux	Overall uniformity not less than	Threshold increment not less than (%)
Monochrome	5	0.4	10
Colour	15	0.4	10

Level of dimming with typical lamps for street lighting

SON	100% - 20%
Metal halide	100% - 50%
Fluorescent	100% - 1%
LEDs	100% - 0%

IsoLux diagrams of a floodlight



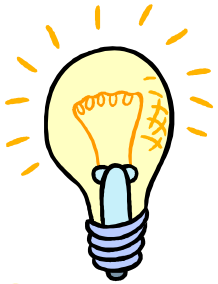
(Source: https://theilp.org.uk/publication/lighting-against-crime/)

Security lighting

- Planning security lighting:
  - Criminal history
  - Nature of the site
  - Degree of obstruction
  - Ambience luminance of the surrounding area
- Visibility concerns
  - Illuminance, glare, light pollution, coverage factor
- Security zones
  - Perimeter, pedestrian, vehicle, building, restricted

(Source: Guide for Security Lighting for People, Property, and Critical Infrastructure, IES G-1-16)

Further Reading



- Emergency Lighting http://ibse.hk/IBTM6010J/Emergency_Lighting.pdf
- Fundamentals of emergency lighting https://www.eaton.com/content/dam/eaton/markets/buildings/fundamentals-of-emergency-lighting-guide.pdf