Fundamentals of emergency lighting

THIS WAY TO SAFETY
MAKE THE LEADER YOUR STARTING POINT

This new Eaton guide is a starting point for consultants, planners and building owners to have the conversation about an emergency lighting system, rather than a tool for specifying every detail. Six easy to navigate sections take you from “What is emergency lighting?” to “Creating an emergency lighting design”.

INTRODUCING EATON

Emergency lighting market leader Eaton offers more then 50 years of expertise built up through a brand heritage that embraces CEAG, Luminex, Blessing Menvier, JSB, Crompton and Univel.

We work closely with national and international industry organisations to achieve the highest standards of regulatory compliance, safety, reliability and efficiency.
WHAT IS EMERGENCY LIGHTING?

In this section learn about:

• The role of emergency lighting should a threatening event occur
• How it delivers peace of mind for building owners/operators as well as ensuring compliance
• How emergency lighting functions should power fail, and how it is vital in guiding people to safety when lighting is still present

1.1 Why is emergency lighting required?
1.2 Emergency lighting in action

‘By delivering essential illumination and guiding occupants via safe routes to exits and safety equipment, emergency lighting reduces panic and saves lives.’
1.1 WHY IS EMERGENCY LIGHTING REQUIRED?

Right across the world, environments are becoming increasingly urbanised and intricate, with a corresponding rise in associated safety threats. The challenge is multiplied when a proportion of visitors is not familiar with layout and procedures.

This is the case in large, highly-populated, high-risk or complex premises such as railway stations, shopping centres, airports, stadia, government buildings or leisure facilities – just as it also is in smaller locations with a simpler floor plan.

Emergency lighting is a lifeline in hazardous situations created by this complicated backdrop. Crucially, it enables the safe, prompt and efficient evacuation of spaces and buildings, not only in cases of blackout caused by power outage, but when sunlight and mains lighting may still be available. An effective emergency lighting system also guides people in and around enclosed and open environments, as well as helps them locate safety equipment plus refuge and assembly points.

By delivering essential illumination and guiding occupants to safe locations and safety equipment, emergency lighting reduces panic and saves lives.

IT’S ABOUT MORE THAN PEACE OF MIND

However, effective emergency lighting is not only essential for ensuring the peace of mind of those responsible for the safe infrastructure of public and commercial buildings – when six-figure fines and even prison are the price for getting things wrong. It’s also a legal imperative in most countries enforced both by the authorities and insurers. Emergency lighting is heavily governed and defined by product, application and installation legislation standards covering occupational safety and building regulations.

‘The calm, universal simplicity of the ‘green running man’ – a design classic – transcends language barriers to make it quickly understood’

BETTER BY DESIGN: THE ‘GREEN MAN’ IS BORN

One of the most well-recognised icons of emergency lighting is the green running man pictogram design adopted as the international standard ISO 7010 in 1985. It was the winner of a Japanese fire safety association competition in the late 1970s for designer Yukio Ota and has since been adopted and adapted in many countries worldwide. A design classic, its calm, universal simplicity transcends language barriers making it easily understood. Pictogram-based signs such as this take a cognitive approach and encourage a quicker response from people compared to written instructions.
EMERGENCY LIGHTING IN ACTION

In just a fraction of a second, the shift from bright, clear mains lighting to total blackout can cause maximum panic and confusion.

Exit signs can then support the safe, efficient evacuation of occupants by marking emergency exits, pathways, obstacles and changes of direction.

Escape route lighting also helps reduce panic and identify obstacles during evacuation in non-blackout scenarios – such as a fire, terror or other security incident – by ensuring a minimum illumination.

Not all evacuations take place following a power failure or blackout. Emergency lighting plays a vital role in supporting efficient evacuations even in sufficient lighting.

MAINS LIGHTING
This corridor shows mains lighting under normal operation.

BLACK OUT
A blackout occurs in the building and occupants require direction and light to evacuate the building.

BLACK OUT WITH EXIT SIGN LUMINAIRE AND SAFETY LUMINAIRES
Escape route lighting illuminates the floor and helps identify obstacles and safety equipment. It helps avoid panic by ensuring a sufficient illumination.

Exit signs provide safe and efficient evacuation of all occupants marking emergency exits, pathways and changes of direction.

Fundamentals of emergency lighting:
1. What is emergency lighting?
2. Understanding system approaches
3. Choosing products
4. Factors influencing system design
5. Planning for compliance
6. Creating an emergency lighting design
UNDERSTANDING SYSTEM APPROACHES

In this section learn about:

- The characteristics of two key emergency lighting technologies: self-contained (SC) and central battery system (CBS) – also known as central power supply ‘CPS’ or low-power supply ‘LPS’ systems
- Manual and automatic testing processes

2.1 Introducing self-contained and central battery systems
2.2 Manual and automatic testing: key differences
2.3 Manual testing process
2.4 Automatic testing process
2.5 Specifying products to meet system needs
Understanding the characteristics of self-contained (SC) and central battery systems (CBS) – emergency lighting’s two core technologies – is important for any building owner or operator planning their emergency lighting strategy.

Every building will have its own unique set of factors that will ultimately point to one or the other route as being the most appropriate. This section highlights the differences between SC and CBS approaches and some of their features.

**SELF-CONTAINED (SC)**

A self-contained emergency luminaire has its own battery. Under normal conditions, this remains permanently on charge via the mains lighting circuit until the power supply to the luminaire is lost and the battery takes over.

All elements of a SC luminaire micro-system, including battery, light source, control unit and any test or monitoring equipment, will either be located within the luminaire housing itself or in a directly adjacent enclosure, connected via short cabling (i.e. less than 1m).

**CENTRAL BATTERY SYSTEM (CBS)**

A central battery system (CBS) – also known as central power supply (CPS) or low-power supply (LPS) systems – supplies ‘slave’ emergency luminaires with no onboard battery. Instead, the luminaires automatically draw power from one centralised battery in the building, supported by a charger, change-over devices and alarms should mains lighting fail.

In some CBS installations several Low Power Supply systems (LPS) are distributed in the building to serve only individual floors or fire protection sections.

As each country has its preferences and regulatory frameworks, CBS can encompass multiple formats with varying features. These can include different testing approaches and functionalities as well as AC/DC power configurations.

**UNINTERRUPTIBLE POWER SUPPLY (UPS)**

Although UPS is not prohibited for emergency lighting systems, its use does require compliance with both UPS and CBS standards.

For further information, Eaton has a white paper on CBS selection. Similarly an Eaton expert will be happy to discuss this further.
MANUAL AND AUTOMATIC TESTING: KEY DIFFERENCES

Specific regulations and standards govern how all emergency lighting systems – whether self-contained or central battery unit – are tested to ensure they are functioning as they are meant to.

The owner or manager of the building has a moral responsibility to ensure a thorough risk assessment is conducted, acted upon and continually updated. In most countries, the obligation to implement such a process is enshrined in law.

Testing starts when a system is first commissioned following installation. It then continues periodically during the system’s working lifetime to protect against failure and minimise risk to life. Records that detail all testing events are needed to demonstrate compliance.

There are two main approaches to emergency lighting testing:

**MANUAL TESTING**

Simple, unmonitored luminaires need to be inspected visually. Centrally supplied (CBS) luminaires feature no indication of their status and the system needs to be switched manually to battery mode to check if the luminaires will light up.

A self-contained luminaire can use a simple green LED to indicate only that voltage is applied through the battery charge circuit. When the luminaire’s test button is activated, it simulates a mains lighting failure and the luminaire should light up. Inspection record books are managed manually.

**AUTOMATIC TESTING**

Also known as ‘addressable test’, ‘central addressable’, ‘automatic test’ and ‘emergency test and monitoring’ systems. These centrally monitored luminaires feature automatic testing and monitoring capability, notification functions and remote/web access.

Inspection record books are automatic/digital.

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**Fundamentals of emergency lighting:** Understanding system approaches

1. **What is emergency lighting?**
2. **Understanding system approaches**
3. **Choosing products**
4. **Factors influencing system design**
5. **Planning for compliance**
6. **Creating an emergency lighting design**

Relevant standards

EN 62034:2012 Automatic test systems for battery powered emergency escape lighting
2.3 MANUAL TESTING PROCESS

Manual testing should take place via a monthly “functional” test of short duration to verify if lamps illuminate from the battery source and batteries correctly recharge after the test.

Additionally, a “duration” test is undertaken annually to ensure the lamps illuminate for the full duration time and batteries correctly recharge after the test.

Establishing a schedule is important to make sure all tests take place when they should do. A minority of building owners and operators choose manual testing when they prioritise its low initial cost and simplicity over the higher initial investment, but lower lifetime total cost of ownership, of automatic testing alternatives.

MAINTAINING CONTINUITY

If the user performs an annual duration test on all emergency luminaires at the same time, the building cannot be occupied until the batteries are sufficiently recharged.

However, if alternative luminaires are tested, a level of emergency illumination will be provided in the event of a mains failure during the recharge period. In this scenario the building may be occupied during and immediately after a test.

Note: Self-contained
Although it is possible to test alternative luminaires manually via multiple key switches a simpler approach is to utilise Automatic testing where luminaire testing can be simply staggered via software.

Central Battery Units
It is not possible to test alternate luminaires when using a central battery unit. As a duration test needs to be undertaken in full load conditions.

Therefore, in a scenario where the building must be occupied continuously the following options are available:

- Dual parallel battery sets which can supply the full load. A fully charged battery set can then be connected immediately following a full duration test.
- Dual Central battery units powering half of the emergency luminaires. One system can then be relied upon to cover the recharge period of the other.

TYPICAL MANUAL USER TESTING PROCESS

ISOLATE
Simulate a mains failure to individual luminaires/grouped luminaires.
Self-contained > A key switch per room/area is typically used
Central Battery Systems > A push button on each field device or CBS is typically used

INSPECT
Ensure luminaires illuminate from the battery source for the duration of the test

RE-ENERGISE
Re-energise mains power to the luminaires via key-switches/push buttons

REPLACE
Arranging for replacement luminaires and/or batteries (depending on fault)

RECORD
Noting faulty luminaires in logbook (e.g. ‘did not illuminate’, ‘did not illuminate for full duration’, ‘charge indicator did not come on after reenergising’, ‘CBS failed to recharge etc’)

VERIFY
Check batteries are recharging.
Self-contained > The charge indicator is illuminated
Central Battery Systems > The system is indicating that it has a healthy supply and is in a charging state
AUTOMATIC TESTING PROCESS

The automatic option takes management time and hassle out of testing – also facilitating data connection between products to ensure fault-free performance.

It follows that more and more building owners and operators are finding automatic testing worth the higher initial investment. It not only reduces labour costs and enables flexible test scheduling, but streamlines testing management processes and simplifies compliance.

TYPICAL AUTOMATIC USER TESTING PROCESS

**MANUAL**

**APPOINTED PERSON**

Schedules tests, to be performed at most appropriate time to suit regulatory regime

**SYSTEM**

**AUTOMATICALLY POWERS**

Simulates a mains failure to the luminaires/central battery unit.

Powers all luminaires from the battery/s

**CHECKS**

Luminaire is illuminated for the whole test duration

**RE-ENERGISES**

Ends the simulation of a mains failure at the luminaires/central battery unit

**CHECKS**

Battery chargers functioning correctly

**CHECKS**

Luminaires powered from mains supply

**STORES**

Results in electronic log-book

**MANUAL**

**APPOINTED PERSON**

Arranges for replacement of any faulty units

DALI COMPLIANCE

Eaton offers a complete system – from panel through to luminaires – that features protocols specifically designed for emergency lighting and meets European regulations and standards. Should ‘open’ protocol Digital Addressable Lighting Interface (DALI) luminaires be used, the system designer will need to ensure compliance to EN 62034. DALI technology must be clearly separated from the mains lighting communication line, as detailed in IEC 60364-5-56.

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2.5 SPECIFYING PRODUCTS TO MEET SYSTEM NEEDS

This guide has so far explored a basic overview of self-contained and central battery frameworks, as well as manual and automatic testing. All offer the flexibility to incorporate additional features that address the specifics of building type, size, use and user profile bringing powerful capabilities.

Here are some example Eaton systems:

**SELF-CONTAINED WITH BUILT-IN AUTO TEST**

Simple and straightforward, all of Eaton’s new self-contained products come with latest Lithium-ion batteries and built-in ‘self test’ for the responsible person to manually inspect via a status indicator.

Product example: Flexitech SE

Lithium-ion battery offers 10-year battery life

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**SELF-CONTAINED SYSTEM WITH CENTRALLY MONITORED LUMINAIRES AND AUTOMATIC TESTING**

Modern self-contained systems with addressable automatic function and duration test help building managers ensure compliance without the hassle and cost of manually testing each luminaire.

Product example: CGLine+

- Automated testing and electronic log book functionality – time saving, secure and energy efficient
- Test specific/alternate luminaires (to maintain light levels and building operation)
- 3rd party certified to EN62034 (guaranteeing compatibility, performance and functionality)
- Suitable for small to large systems – easily expandable up to 800 luminaires

- Built with CyberSecurity in its DNA – Eaton’s cyber security centres of excellence, accredited laboratories, relationships with international standards bodies and universities enable Eaton to design and assess its products in line with the latest cybersecurity advancements
- Testing and monitoring displayed via web browser and/or integrated panel with email push notifications to specified users
- Visualise your systems status overlaid on your building layout

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**Product example:**

- **Flexitech ED**: Lithium-ion battery offers 10-year battery life
- **CGLine+ Web-Controller**: Enables remote monitoring and control of emergency lighting systems.
SPECIFYING PRODUCTS TO MEET SYSTEM NEEDS (CONTINUED)

CENTRAL BATTERY SYSTEM WITH CENTRALLY MONITORED LUMINAIREs AND AUTOMATIC TESTING

A modern central battery system with addressable automatic testing saves time, effort and resources – not only by supplying safety and escape sign luminaires with reliable power, but by automatically checking itself and all connected luminaires too.

Product example: DualGuard-S
• Automated testing and electronic log book functionality
• 3rd party certified to EN62034 and EN50171 (guaranteeing compatibility, performance and functionality)
• Enables flexibility with a wide range of cabinets, substations and luminaires allowing for scalability and efficient design

SAVING TIME AND EFFORT WITH EMERGENCY LIGHTING VISUALISATION SOFTWARE

Real-time visibility of multiple emergency lighting systems across a range of locations provides a simple way to efficiently monitor system status and manage, review and proactively service systems.

Product example: VisionGuard
• Monitor up to 500 individual emergency lighting systems with over a million light points via a single control room monitor
• Testing and monitoring displayed via web browser and/or integrated panel with email push notifications to specified users
• Latest battery and battery monitoring technology provides visibility of battery health, allowing for proactive system maintenance

Putting cybersecurity first across the product range
All Eaton systems are developed with cybersecurity built into their DNA. Our cybersecurity centres of excellence, accredited laboratories, relationships with international standards bodies and universities enable us to design and assess our products in line with the latest cybersecurity advancements.

Contact us to find out more about:
• Exploring your options with a consultation
• Resources
• Installer training

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CHOOSING PRODUCTS

3.1 Safety luminaires
All-in-one units with lamp: this general category is ideal for anti-panic, escape route or high risk tasks. Mains lighting LED conversion kits are a further option.

3.2 Exit signs
All-in-one units with lamp: this general category is ideal for anti-panic, escape route or high risk tasks. Mains lighting LED conversion kits are a further option.

3.3 Beam lights
Single and multiple movable lamps and optical elements offering directional luminance for long, narrow escape routes and larger, high risk areas.

3.4 Customised signage/pictograms
Customisation for paint colour, finish and pictograms offering identical levels of performance and compliance as standard range equivalents.

3.5 Advanced technology
A fast-expanding product range including increased affordance (IA) options that heighten engagement, and smart adaptive evacuation (AE) signage that can change indicated escape direction.
Breaking new ground
Discreet safety luminaires that combine LED high performance with a smaller footprint and clean, modern aesthetic are a popular choice in applications where low operating costs and discreet good looks are important. Alongside advanced optics that can deliver a range of distribution levels, efficient LED technology also reduces the unit size – adding to its appeal to system designers.

ʽAll-in-one units with lamp ideal for anti-panic, escape route or high risk tasks’

SAFETY LUMINAIRES

Safety luminaires represent a core category of emergency lighting for illuminating surfaces, as well as spaces. These all-in-one units include the lamp and other functional components and are ideal for anti-panic, escape route or high risk task emergency lighting. Many variants are available ranging from the ‘classic’ box-shaped standard safety luminaire through to discreet LED safety luminaires. Mains LED lighting systems can also convert to become emergency lighting using appropriate safety luminaires and control gear.

DISCREET SAFETY LUMINAIRES
Available as either recessed or surface mount, multifunctional discreet luminaires are easy to install (requiring no disassembly) and are suitable for both escape and open area anti-panic applications. Featuring a single lamp and optical control, they enable designers to distribute light in a variety of ways – maximising the latest LED and optics technology – and consume less power than old-tech luminaire types, such as fluorescent. High output variants can be used for applications involving high ceilings. Distribution options include:
• Symmetrical – for open areas
• Asymmetrical – for escape routes
• Focused – for high risk locations and dedicated equipment

STANDARD SAFETY LUMINAIRES
Built in a traditional ‘box’ shape, standard safety luminaires are typically surface-mounted and often used in linear arrangements for open areas, escape routes and high risk locations including dedicated safety equipment. They offer high integrity (IP) and robustness (IK Rating), with some variants combining LED efficiency with the ability to combine exit and safety lighting functions in one product. Distribution options include:
• Symmetrical – for open areas
• Asymmetrical – for escape routes
• Focused – for high risk locations and dedicated equipment

TYPICAL OPTICAL ARRANGEMENTS

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<tr>
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<td>For open areas</td>
<td>For escape routes</td>
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</table>

CONVERSION KITS
Conversion kits enable you to use almost any mains LED luminaire available today as an emergency light, as part of either a self-contained or central battery unit system. This approach uses compact emergency LED modules and control gear to convert linear and downlight mains LED applications. While the distribution of main luminaires is not optimally designed for emergency lighting, high luminous intensities can still be achieved through CBS conversions for some high risk locations.
3.2

‘Indicate escape direction clearly – even in changing emergency conditions’

EXIT SIGNS

Illuminated exit signs with a built-in lamp incorporate a pictogram – such as the iconic ‘green running man’ – indicate a fire exit or other safe escape direction. The pictogram is illuminated from behind to provide luminance to at least European requirements 60598-2-22 & EN 1838.

VARIATIONS

WALL-MOUNTED

Wall-mounted exit signs are available to cover a range of locations and in various mounting options, including surface, recessed and flag. Single- and double-sided variants, as well as different viewing distance specifications, make wall mounted signs a flexible option for a wide variety of room sizes and applications.

CEILING

The comprehensive range of exit sign luminaires suitable for ceilings includes surface-mounted, suspended and recessed units. Single- and double-sided variants, as well as different viewing distance specifications are also available for ceiling mounted signs.

COMBINATION SIGNS

Combination signs perform two functions: illuminating the safety sign pictogram on one or two sides, as well as surfaces and spaces.

Breaking new ground

There are a number of important developments in exit signs, from minimising their environmental impact to maximising their visibility. Adaptive technology now enables signs to dynamically change indicated direction to improve evacuation efficiency depending on conditions detected by the emergency lighting management system or control room operator. The bright, uniformly-lit appearance of today’s clean, flat profile designs with no visible screw heads enable designers to combine good looks with fail-safe functionality.

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‘Target light directionally – exactly where you need it’

BEAM LIGHTS

Beam lights with single and multiple movable lamps and optical elements enable you to direct light flow in high risk interior areas.

These include warehouses and high ceiling commercial areas such as large factory floors, shopping centres or entertainment venues. They also suit applications such as long, narrow escape routes where their 360° directional heads, and up and down adjustability, offer total flexibility. Safety equipment locations, as well as task locations that change, also benefit from beam lights’ high performance and directional functionality.

Breaking new ground

New, recessed beam lights now available combine directional flexibility with sleek aesthetics as their movable light heads remain the only visible part extending out from the unit’s flush fitting.

Eaton’s patented E-focus beam light technology allows you to select the most appropriate illumination for the application. Both wide area anti-panic lighting and narrow focused illumination is possible from the same fitting – simply selecting via the test point button.
3.4

‘Request location-specific colour and pictogram variants with unchanged certification features’

CUSTOMISED SIGNAGE AND PICTOGRAMS

With every building having its own unique set of requirements, customisation can satisfy needs that go beyond standard product ranges, while maintaining identical levels of performance and compliance.

CUSTOMISED PAINT FINISH OPTIONS

Colour/finish options can be used to integrate luminaires into their environment, helping architects and system designers to complement interior aesthetics.

BESPOKE PICTOGRAMS

The role of exit sign luminaires may not always be showing the escape route. There is a range of pictograms to address specific signage requirements such as routes to safety equipment, refuge locations and assembly points.

Fundamentals of emergency lighting: Choosing products

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‘Advanced tech emergency lighting is a fast-evolving solution for a complex world of growing threats’

ADVANCED TECHNOLOGY

In the decades since the iconic ‘green man’ arrived, emergency lighting has evolved into a sophisticated industry that is constantly refining existing technology, as well as innovating.

Inevitably its learning has been informed by landmark events such as London’s Kings Cross underground station fire in 1987, the departure hall blaze in Düsseldorf Airport in Germany in 1996, the Twin Towers disaster of 2001 and 2013’s Nairobi Westgate Mall terror attack. All such high profile incidents – and every smaller one too – sharpen the focus on making evacuation and emergency wayfinding faster, simpler and more effective.

The result is a fast-expanding range of advanced technology products including increased affordance options that heighten engagement by pulsing, and a new generation of ‘smart’, adaptive signage that responds to environmental changes to show a different escape direction. Advanced tech emergency lighting is a solution that more and more architects and building owners are choosing to make their spaces as safe as they can possibly be in a complex world of growing threats.

INCREASED AFFORDANCE

Making escape routes more recognisable

Evacuating commercial buildings can be made harder by people’s failure to notice standard emergency exit signs during an incident and a tendency to return to the point where they entered the building – a situation that can lead to overcrowding, congestion and delays when every second counts.

In fact research has shown that only 38% of people see conventional static exit signs when evacuating from an unfamiliar environment. Much of this in larger public spaces is down to distraction from branding, advertising and informational signage.

Increased affordance technology tackles this challenge by making signs much more visible to occupants during an emergency evacuation by flashing or pulsing, but never dipping below industry luminance required standards.

Luminance in the green zone of an IA luminaire (flashing or pulsing) compared with the minimum luminance in battery mode defined by EN1838

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The danger posed by fires, acts of terrorism and natural disasters will frequently change as the event unfolds. It means that static signage may no longer be showing the most appropriate exit route for the specific set of circumstances building occupants may find themselves facing.

Adaptive signage that can change is a solution – blocking unsafe escape routes and showing an alternative. Fully adaptive signs, meanwhile, can change to indicate a new direction, as well revert to their original route direction state once conditions permit. Both types enable building owners to direct people to safety in the safest way possible as the situation evolves.

Adaptive signage: responding to conditions as they change

Improving the evacuation of buildings
Building owners and managers should not assume the highest possible level of protection has been achieved by complying with legal standards and regulations. In some circumstances, advanced technology options should be considered to facilitate a safer evacuation.

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FACTORS INFLUENCING SYSTEM DESIGN

4.1 Building user profile(s)

While some buildings host a broadly homogenous user profile – say a student residence – others may be more mixed. Age, health and well-being, lifestyle and familiarity are all design factors to be taken into consideration.

4.2 Building type and usage

Three risk levels define how easily a task can be safely stopped and how this influences the most appropriate emergency lighting approach.

4.3 Building scale and complexity

The size, complexity and age of a building are all key factors impacting emergency lighting design.

4.4 Lifecycle costs

Explore how different system approaches can impact your project’s initial investment and longer term operating costs.

4.5 Maintenance and servicing

Whether it deploys manual or automatic testing, every system requires the security of an effective maintenance and servicing regime.

4.6 Choosing the right system: examples

Four contrasting building types demonstrate how risk has been taken into account.

In this section learn about:

• Building, user and task risk factors
• Considerations around lifecycle costs and maintenance
• Example systems illustrating risk mitigation
### BUILDING USER PROFILES

Building user age, health and wellbeing, lifestyle and familiarity are just some of the risk factors that come into play when considering emergency lighting system design. Here’s a summary of how need translates into solutions.

<table>
<thead>
<tr>
<th>Profile</th>
<th>Need</th>
<th>Solution</th>
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<tbody>
<tr>
<td><strong>AGE</strong></td>
<td>Older people: Eyesight is known to deteriorate with age, thus reducing the speed at which signage can be identified.</td>
<td>Careful consideration of lighting placement throughout building – consider higher, uniform illumination throughout. Give extra-thought to hazards like stairs.</td>
</tr>
<tr>
<td><strong>HEALTH AND WELLBEING</strong></td>
<td>Physically disabled: may be less mobile and/or less able in other ways.</td>
<td>Consider higher illumination, particularly at potential hazards and building intersections, to support with more complex evacuation.</td>
</tr>
<tr>
<td><strong>LIFESTYLE</strong></td>
<td>Cognitive disabilities: A dramatic reduction of lighting could cause panic and uncertainty</td>
<td>Maintaining 100% of light levels in an emergency could help reduce stress and shock.</td>
</tr>
<tr>
<td><strong>FAMILIARITY</strong></td>
<td>General public: Unfamiliar with a new space, they may panic or cause crush scenarios if they simply follow the crowd or escape the same way they went in.</td>
<td>May require maintained (always on) emergency lighting to ensure that escape routes and exits are clearly lit at all times. As well as familiarisation, this is critical to aid safe evacuations where there is no power failure.</td>
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**Fundamentals of emergency lighting:** Factors influencing system design

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How safely tasks can be stopped by those within a building impacted by a reduction in illuminance is a key influence in emergency lighting system design.

We’ve broken this down into three risk categories:

<table>
<thead>
<tr>
<th>Risk Level</th>
<th>Description</th>
<th>illumination type typically needed: <strong>escape, anti-panic</strong></th>
<th><strong>high risk</strong></th>
<th><strong>High risk (+)</strong></th>
</tr>
</thead>
</table>
| LOW RISK    | Tasks can be safely stopped under reduction of illuminance to very low levels (typically 0.5Lux from 300-500 depending on the task). | - Offices  
- Circulation  
- Commercial spaces  
- Retail  
- Services sector | **high risk** | **High risk (+)** |

**Tasks can be safely stopped at practically any time by interacting with a control panel. Illumination is typically required on both the control panel and task to safely stop and evacuate.**

Illumination type typically needed: **high risk**

- Warehouses (moving trucks need to stop/be safely parked)
- Café/kitchens (Turn gas/electrical appliances off, put down hot food)
- Swimming pool
- Light industrial work (Safely finish with a power tool and store safely)
- First aid/eyewash stations

**Tasks cannot be immediately stopped or take a long time to do so. Full illumination over a whole area may be necessary.**

Illumination type typically needed: **standby** (which allows a process to continue at full efficiency).

- Foundry
- Operating theatres/spaces
- Airport control towers
The scale and/or complexity of a building can make evacuation difficult. And in some cases age may present problems, for example some older buildings only having one major escape route. London’s Grenfell tower block disaster in June 2017 is an example of this.

### VAST SCALE: STADIUMS/ THEATRES/LARGE PUBLIC GATHERINGS

**Risk:**
- Crush
- Terrorism
- Overall time for evacuation increased

**Implications:**
While the tasks may not be inherently dangerous, a high level of maintained emergency lighting is advised to illuminate all available escape routes and exit points, and to reduce panic.

Adaptive or increased affordance exit signs may be needed.

### HIGH RISE

**Risk:**
- High overall time for evacuation

**Implications:**
Despite no inherently dangerous tasks, longer durations may be necessary to provide ample time for a safe evacuation.

Fully enclosed staircases in most applications (a fire barrier) could be a reason to consider higher illumination levels, as could the fatigue of people leaving the building.

### OLDER DESIGN/ CONSTRUCTION METHODS

**Risk:**
- May not be sufficient escape routes/escape routes of sufficient width (according to newer building regulations)
- May use flammable construction materials e.g. thatch or wall coverings

**Implications:**
Higher illumination levels may be proposed to reduce panic

Longer durations may also be necessary

Adaptive evacuation could be used to direct people to safety and/or control the flow of people using escape routes.
Lifecycle total cost of ownership (TCO) is key for any building owner or operator installing an emergency lighting system. Like many commercial investments, it’s a trade-off between how much the system will initially cost to design and build (CAPEX) and the operating costs (OPEX) involved over its lifetime.

The following example – based on a real UK university – shows how a self-contained system with manual testing would incur considerably lower initial spend but cost more than double a centrally monitored (automatic testing) central battery system (CBS) or self-contained system over ten years. Both CBS and self-contained with automatic test solutions would involve a higher CAPEX outlay but deliver broadly similar TCO figures in that time.

This scenario takes into account:
- Monthly checks and testing
- Annual full discharge testing
- Recording of all results for legal compliance declaration and demonstration
- Proactive maintenance including battery replacement costs annualised over the system lifecycle
- Assumed replacement battery costs
- Assumed maintenance labour costs

The bar chart shows how CAPEX, installation, testing/inspection and battery replacement costs break out as a percentage of TCO when comparing self-contained manual and self-test systems with a CBS solution with integrated automatic testing over 25 years.
While some builder owners may choose to take on testing/maintenance responsibilities and arrange simple repair or replacement themselves, most – especially when it comes to larger systems – will choose an annual service contract with their emergency lighting supplier company. This approach ensures that competent, fully trained engineers manage all aspects of testing and maintenance, as well as arrange any repairs or replacements using OEM components to high compliance standards.

Simply testing an emergency lighting system – whether manually or by using automatic technology – does not constitute a maintenance programme sufficient to ensure people can evacuate safely, as well as meet compliance standards. Building owners and operators need robust processes in place so that faulty equipment is quickly repaired or replaced, and that any new products or components needed deliver the necessary performance and satisfy all regulations.
CHOOSING THE RIGHT SYSTEM: EXAMPLES

From user profile and task risk through to building scale and complexity, we’ve explored a range of physical factors that influence emergency lighting system design.

The following examples show some considerations for three typical building types:

- Small office
- University lecture theatre
- Manufacturing plant

**SMALL OFFICE**

This is likely to be a low risk setting with most tasks easily stopped safely with a low level of luminance. A combination of escape and anti-panic luminaires would be appropriate, with additional lighting recommended should the office receive frequent visitors unfamiliar with its layout.

**UNIVERSITY LECTURE THEATRE**

While the lecture theatre is also likely to be low risk from a task perspective, its users are mainly students. While they may be familiar with its layout, a risk assessment has indicated the potential for them to respond more slowly in the event of an emergency incident. 'Pulsing' increased affordance escape and anti-panic luminaires may be the solution in this scenario to aid fast recognition of exit signs.

**MANUFACTURING PLANT**

Although materials and goods production at normal lighting levels may be fairly low risk, the sudden loss of general lighting and luminance reduction to escape levels could disorientate workers and result in injury from power tools, lines or conveyors and forklift trucks etc. High risk task illumination to 10% of general lighting conditions in suitable locations enables tasks to be safely halted. Dangerous heavy industry environments with continuous processes not easily shut down – like foundries – will require a generator with battery backup to provide almost indefinite run times.

**DID YOU KNOW?**

Every application of emergency lighting presents unique challenges with the final system design underpinned by a full risk assessment. Here are just some of the background and legislative details system designers need to take into account:

- **Legislated areas**: These include: places of assembly, workplaces, shopping areas, accommodation, car parks, high-rise buildings, educational buildings, hospitals
- **Core principle: highest level applies**. If two or more guidelines or regulations apply to a building
- **Sport facilities**: Emergency lighting must be sufficient to enable the safe abandonment of the sporting event – for example a % of mains luminance for a specific period of time. This can differ between sports based on their settings and requirements.
- **Shopping mall**: This is defined as a shopping facility with sales areas and mall corridors of more than a specific m² dependent on local regulations.
- **Accommodation**: Emergency lighting applies to virtually anywhere a person may be expected to sleep apart from their own home.
- **High rise or ‘skyscraper’**: This is defined as a building with a height of more than 22m.

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**1. What is emergency lighting?**
**2. Understanding system approaches**
**3. Choosing products**
**4. Factors influencing system design**
**5. Planning for compliance**
**6. Creating an emergency lighting design**
PLANNING FOR COMPLIANCE

5.0

In this section learn about:
• The core EU compliance framework
• Specifics around sign and luminaire specification, location and viewing distances

PLANNING FOR COMPLIANCE

5.1 The standards framework
5.2 Exit sign format
5.3 Sign colour and illumination
5.4 Locating luminaires at points of emphasis
5.5 Maximum viewing distances
5.6 Escape routes
5.7 Open (anti-panic) core areas
5.8 High task risk locations

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5.1 THE STANDARDS FRAMEWORK

To ensure that emergency lighting is fit for purpose a combination of standards and regulations covers all aspects of its safety. Using a third party to certify a system is an effective way of helping to ensure quality, reliability and conformity.

A key element of the compliance landscape is the EN50172 standard. This sets out the requirements for emergency lighting when the supply to all or part of the normal lighting in occupied premises fails. It states that emergency lighting shall:

- indicate escape routes clearly and unambiguously
- provide illumination along such routes to allow safe movement towards and through the exits provided
- ensure that fire alarm call points and firefighting equipment provided along escape routes can be readily located
- permit operations concerned with safety measures.

The EN50172 standard – which also applies to standby lighting used as emergency escape lighting – recommends that discussions should be held pre-design to establish the areas to be covered, method of operation, testing regime and most suitable system type. These discussions should include the owner or occupier of the premises plus the system designer, installer, equipment supplier and fire authority.

To ensure that emergency lighting is fit for purpose a combination of standards and regulations covers all aspects of its safety. Using a third party to certify a system is an effective way of helping to ensure quality, reliability and conformity.

### Example of European standards framework

<table>
<thead>
<tr>
<th>Legislation</th>
<th>Example of European standards framework</th>
</tr>
</thead>
<tbody>
<tr>
<td>National fire safety legislation</td>
<td>EN 50172 Emergency escape systems</td>
</tr>
<tr>
<td>EN 1838 Lighting applications, emergency lighting</td>
<td></td>
</tr>
<tr>
<td>EN 60598-2-22 Luminaires for emergency lighting</td>
<td>EN 60235 Automatic test systems</td>
</tr>
<tr>
<td>EN 50172 Central power supply systems</td>
<td></td>
</tr>
</tbody>
</table>

### Harmonised EU Application standards (Shall)

- EN 50172 Emergency escape systems
- EN 1838 Lighting applications, emergency lighting
- EN 60598-2-22 Luminaires for emergency lighting
- EN 60235 Automatic test systems
- EN 50172 Central power supply systems

### Harmonised EU Product Standards (Shall)

- EN 50172 Emergency escape systems
- EN 1838 Lighting applications, emergency lighting
- EN 60598-2-22 Luminaires for emergency lighting
- EN 60235 Automatic test systems
- EN 50172 Central power supply systems

### Fundamentals of emergency lighting: Planning for compliance

1. What is emergency lighting?
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5.2 EXIT SIGN FORMAT

Where there is no direct sight of an emergency exit, an illuminated directional sign or series of signs must be provided to help people make their way to the emergency exit.

The single pictogram format specified in ISO 7010 and adopted by many national standards bodies from 2011 onwards is current best practice.

Most countries have adopted pictogram style signs, or are in the process of updating local guidelines.

The most notable exception is the USA where green or red glowing 'EXIT' letters are commonplace.

Time is of the essence during evacuation and this means it is critical that all escape route signage can be quickly seen, understood and followed. Section 4.1 of EN1838:2013 details this point stating that 'Signs which are provided at all exits intended to be used in an emergency and along escape routes shall be illuminated to indicate unambiguously the route of escape to a point of safety'.

### Recommended signage

### Accepted signage
While other formats such as these with supplemented text are accepted, signage formats should never be mixed within a building.

### Legacy signs
Pre-existing regulations/directives are no longer recommended. However, they may still be seen in some buildings to avoid mixed format signage.
5.3

SIGN COLOUR AND ILLUMINATION

Sign colours are specified by ISO 3864 which states that exit and first aid signs must be white, with green as the contrast colour. The white to green luminance ratio must be between 5:1 and 15:1. The minimum luminance of any 10mm patch area on the sign must be greater than 2cd/m² and the ratio of maximum to minimum luminance must be less than 10:1 for either colour.

- Min luminance = 2cd/m²
- Contrast of the colours must be between 5:1 and 15:1
- Ratio of luminance shall be less than 10:1 for either colour

Well illuminated exit sign

Badly illuminated escape sign
LOCATING LUMINAIRES AT POINTS OF EMPHASIS

Every system design must correctly locate luminaires to reveal specific hazards and highlight safety equipment and signs – known as points of emphasis – whether it is for an emergency escape route or open (anti-panic) area. The design must also take into account the type of luminaire needed and its light output as detailed by EN 1838: 2013 and EN 60598-2-22.

The following representation highlights key points of emphasis requiring a luminaire:

- At each change in direction
- All safety exit signs
- Near each first aid post
- Near each piece of fire fighting equipment and call point
- At each intersection of corridors
- Near stairs so that each tread receives direct light. Also near any change of floor level
- At designated exits and outside to a place of safety
Maximum viewing distances and luminance conditions are detailed for all safety sign formats in EN 1838: 2013. Signs can either be internally illuminated – such as exit boxes or edge-lit emergency luminaires with a screened sign that have a controlled illuminance – or be of a non-powered type.

While internally illuminated exit signs that meet EN 60598-2-22 are pre-tested to ensure compliance, extra care must be taken if the sign is designed to be externally illuminated. An emergency luminaire must be sited within 2 metres of the sign and the multiplication factor is only 100. The sign must be illuminated to a minimum lux on any part of its face in emergency conditions.

Distances are as shown here:

- Internally illuminated signs – 200 x the panel height
- Externally illuminated signs – 100 x the panel height

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Once the points of emphasis have been covered, designers must consider if any additional luminaires are needed to ensure minimum illuminance levels so that routes can be used safely. Every escape route compartment must have at least two luminaires in case one should fail.

**LIGHTING LEVEL REQUIREMENTS**

A minimum lux is required on the escape route centre line as detailed by EN 1838: 2013 4.2. A uniformity ratio of 40:1 maximum to minimum must not be exceeded. This illuminance must be provided for the full duration and life of the system. A % of the illuminance must be available within five seconds and full illumination must then be supplied within a specified time period following supply failure.

**PHOTOMETRIC DESIGN**

Authenticated spacing tables or a suitable computer program are used to determine whether luminaires are needed beyond those at points of emphasis to provide the minimum required level of illumination on escape routes.

To ensure that the design will meet the required levels at all times the data is ‘de-rated’ – as required by the standard – to take into account:

- light reduction as battery voltage reduces during discharge
- ageing of lamps in maintained circuits
- the effects of dirt

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An ‘open (anti-panic) area’ is so defined if it is larger than 60m², has an escape route passing through it or it features hazards identified by the building risk assessment.

The current standard makes it straightforward to design and verify systems that provide good uniformity, rather than using a small number of large-output luminaires.

### LIGHT LEVEL REQUIREMENTS

A 0.5 lux minimum of the empty core area – which excludes a 0.5m border of its perimeter – is detailed by EN 1838:2013 – 4.3.

Spacing table (example below) or a suitable computer program are similarly used to generate data. This is then de-rated in the same way as it is for escape route lighting to determine luminaire location.

### SPACING DATA

Spacing tables provide photometric data which can be used to help ensure that the emergency lighting system has been designed correctly and meets the required illumination levels.

### Luminaire spacing in open (anti-panic) core areas:

<table>
<thead>
<tr>
<th>Model</th>
<th>Lux level directly under</th>
<th>Escape Route</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non</td>
<td></td>
<td></td>
</tr>
<tr>
<td>maintained</td>
<td>3.0 22.5</td>
<td>N/A 12.7</td>
</tr>
<tr>
<td></td>
<td>4.0 12.5</td>
<td>N/A 14.6</td>
</tr>
<tr>
<td></td>
<td>5.0 8.0</td>
<td>N/A 16.0</td>
</tr>
</tbody>
</table>

0.5 metre border (core area exclude a border of 0.5m of the perimeter of the area)

Minimum points – at which 0.5 lux is obtained
HIGH RISK LOCATIONS

The risk assessment will identify any locations needing special consideration. For example, these might include plant and production lines deemed to be high risk or control rooms that manage dangerous processes.

For these high risk areas, EN 1838: 2013 details that the maintained illuminance on the reference plane shall not be less than 10% of the required maintained illuminance for that task and never less than 15 lux.

DESIGN IMPLICATIONS

When designing for areas that require enhanced levels of emergency illumination, it’s important to consider all the options which may include converted mains lighting, self-contained or CBS-powered luminaires. In most cases the solution will also have higher Ballast Lumen Factors (BLF).

Emergency response time is another critical factor for high risk locations. This may require emergency luminaires to be operated in maintained mode or alternatively the use of tungsten projector units. Should the latter be chosen, it’s important to bear in mind the need to maintain a reasonable level of uniformity.
In this section learn about:
• How individual components combine to create a complete system
• How to check your understanding of emergency lighting
• Next steps required to develop your knowledge and emergency lighting projects

CREATING AN EMERGENCY LIGHTING DESIGN

6.1 POINTS OF EMPHASIS
Change of direction/intersection or levels change

6.2 POINTS OF EMPHASIS
Near each piece of fire fighting equipment, manual call point and exit door

6.3 POINTS OF EMPHASIS
First aid and refuge areas

6.4 POINTS OF EMPHASIS
Outside the building and to a place of safety

6.5 Open areas

6.6 Escape routes

6.7 High risk locations

6.8 Exit signs

6.9 A complete emergency lighting design

6.10 SUMMARY Emergency lighting: Knowledge checklist

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6.1

POINTS OF EMPHASIS

CHANGE OF DIRECTION/INTERSECTION
OR LEVELS CHANGE

Key:
- Safety luminaire with open area optic
- Call point
- Handrail luminaire for escape route
- Fire extinguisher
- Fire alarm panel
- Refuge area

Changes of direction or intersections require a luminaire to illuminate in both/all directions. The use of an ‘open-optic’ emergency luminaire at these locations is therefore necessary.

Changes of level (primarily staircases) require a luminaire. While in this example a ‘handrail’ luminaire has been chosen, a ceiling mounted luminaire could also be used.

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6.2

POINTS OF EMPHASIS

NEAR EACH PIECE OF FIRE FIGHTING EQUIPMENT/ CALL POINT AND NEAR EACH EXIT DOOR

Firefighting equipment, such as control panels, manual call points and fire extinguishers, require emergency illumination enabling occupants to use them when power is lost. An emergency luminaire with a specific optic has therefore been chosen here.

Emergency luminaires must be sited near each exit door. The design process may highlight that these locations are covered with a luminaire for another function (*1), such as change of direction. In this case a single luminaire can be used for both purposes.

Key:
- Safety luminaire with focused optic
- Call point
- Fire extinguisher
- Fire alarm panel
- Refuge area

Fundamentals of emergency lighting: Creating an emergency lighting design

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**POINTS OF EMPHASIS**

**FIRST AID AND DISABLED REFUGES**

First aid posts require vertical illumination on the box to ensure that occupants can identify and use the equipment they contain if power is lost.

Disabled refuges and call points require emergency illumination on the floor, as well as on the call point itself, to enable the user to operate equipment and await assistance.
Points of emphasis

External (outside the building and to a place of safety)

A luminaire is required externally at each final exit. Emergency illumination in these locations can be achieved using an IP65 external wall-mounted luminaire.

Occupants may also need to escape further away from the building to a ‘place of safety’. In this case, an external luminaire such as a bollard or floodlight could be converted for this purpose.
6.5

OPEN AREAS

Key:
- Safety luminaire with open area optic
- Open area identified (See Section 5.7)
- Call point
- Fire extinguisher
- Fire alarm panel
- Refuge area

Open areas require illumination across the space to 0.5lux, with some examples identified in the diagram. National standards define open areas including the minimum area (m²).

The reception admin area in this example forms part of the escape route for the reception and must be illuminated.

National standards may mandate two luminaires per compartment.

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ESCAPE ROUTES

Key:
- Safety luminaire with escape route optic
- Call point
- Fire extinguisher
- Fire alarm panel
- Refuge area

Fundamentals of emergency lighting: Creating an emergency lighting design

1. What is emergency lighting?
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6.7 HIGH RISK LOCATIONS

Key:
- Safety luminaire with high-output focussed optic
- High degree of protection safety luminaire with high-output focussed optic
- High risk location identified (see Section 5.8)
- Call point
- Fire extinguisher
- Fire alarm panel
- Refuge area

High risk areas require 10% of the general illumination in supply loss conditions, with a minimum of 15lux. Illumination may only be necessary in the ‘task’ location rather than whole space.

In addition to high risk locations identified in a client risk assessment, national standards may pre-identify locations to cover to higher standards.
EXIT SIGNS

These are visible at all points along the escape route. Combinational signs provide both an internally illuminated exit and a usable downward light element. They may be suitable to replace some luminaires which have been previously placed.

It’s important to note, however, that the downwards element may not be sufficient to cover previous elements (e.g. points of emphasis).

This example show only a few signs changed to combinational.
A COMPLETE EMERGENCY LIGHTING DESIGN

Help, every step of the way
Eaton offers a variety of support tools, templates and programs for architects, designers, builders, installers and engineers including, videos, technical install guides, lighting design software and 3D BIM CAD models to model every detail of a building with Building Information Modeling.

Key:
- Safety luminaire with open area optic
- Handrail luminaire for escape route
- Safety luminaire with focused optic
- Outdoor lighting
- Bollard lighting
- Exit lighting

- Call point
- Fire extinguisher
- Fire alarm panel

Open area identified (See Section 5.7)
Escape route identified (See Section 5.6)
Escape route identified (see Section 5.8)
EMERGENCY LIGHTING: KNOWLEDGE CHECKLIST

UNDERSTANDING SYSTEM APPROACHES

• Are you up to speed on the differences between self-contained and Central Battery Unit system design?
• And the key features of manual and automatic system testing?

CHOOSING PRODUCTS

• Are you familiar with the core emergency lighting product portfolio including safety luminaires, exit signs, beam lights and customised signage/pictograms?
• Do you understand the advantages that advanced technology can bring including high affordance products that increase engagement plus ‘smart’ adaptive signage that responds to changing conditions?

FACTORS INFLUENCING SYSTEM DESIGN

• Do you know how building type, usage and user profile contribute to risk levels that feed into system design?
• Have you considered your priorities when it comes to balancing CAPEX and OPEX over a system’s lifecycle?
• Are you familiar with the advantages of a supplier or third-party delivered maintenance and servicing plan?

PLANNING FOR COMPLIANCE

• Do you know the importance of the core European compliance framework?
• And its role specifying standards for exit signs, sign colour and illumination, luminaire location (in low and high task risk settings) and viewing distances?

CREATING AN EMERGENCY LIGHTING DESIGN

• Have you explored how a complete system comes together – in this case for an example for a high rise building – taking into account its points of emphasis, open (anti panic) areas, escape routes, exit signs and high-risk locations?

Identify any gaps in your emergency lighting knowledge with our handy checklist. Then close them by reviewing the relevant guide section or talking to an Eaton expert.