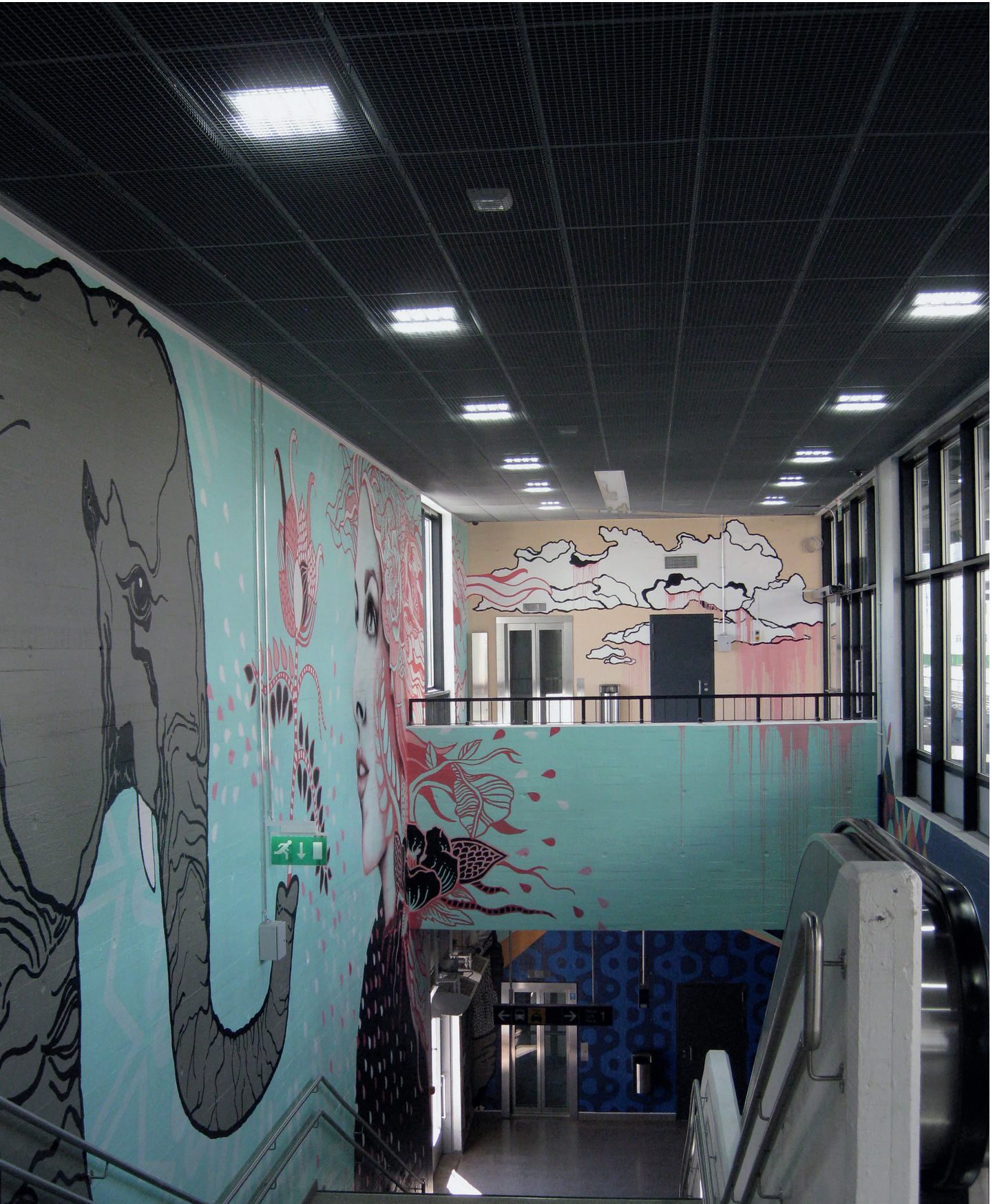


# DESIGN GUIDE FOR EMERGENCY LIGHTING SYSTEMS



**EMERGENCY LIGHTING  
HIGHLIGHTING  
SAFETY**







## CONTENTS

|   |    |
|---|----|
| INTRODUCTION.....                                     | 5  |
| SYSTEM DESIGN: THINGS TO CONSIDER.....                | 6  |
| EMERGENCY LIGHTING SYSTEM FEATURES .....              | 8  |
| SYSTEM DESIGN: EMERGENCY AND EXIT LIGHTS.....         | 9  |
| MARKINGS.....   | 10 |
| TERMINOLOGY AND STANDARDS.....                        | 11 |
| MANDATORY "POINTS OF EMPHASIS" .....                  | 12 |
| DURATION TIMES AND RESPONSE TIMES.....                | 13 |
| VIEWING DISTANCE.....                                 | 14 |
| THE PERFORMANCE REQUIREMENTS FOR THE EXIT LIGHTS..... | 15 |
| ILLUMINATION .....                                    | 16 |
| GLARE ZONE AND CONTRAST RATIO.....                    | 17 |
| TESTING AND MAINTENANCE.....                          | 18 |
| AUTOMATIC TESTING AND MONITORING.....                 | 19 |





## INTRODUCTION

Emergency lighting is a vital and effective life safety tool, providing reassurance and guidance to people at critical times when they need to escape quickly and safely from a building.

Specific requirements for emergency lighting are set out in law, and international standards.

This design guide will help you to

plan and implement an emergency lighting installation, that satisfies all the legal requirements, and ensures safe evacuation in the event of an emergency.

This guide is based on common European standards and practices.

Also, check the specific guidelines that refer to your own country. This Guide is based on common European regulations.



## Teknoware

With more than 40 years of experience, Teknoware is one of the leading emergency lighting manufacturers. We are a significant technological innovator of emergency lighting systems for buildings, ships and other locations. Our emergency lighting product range covers exit lights, emergency lights, central battery systems, emergency lighting monitoring systems and central monitoring softwares, control electronics, spare parts and much more.

We design and manufacture both the electronics and final products ourselves, which guarantees compatible and non-compromised solutions. We can even design and build customized emergency lighting products and systems for challenging environments, making sure that all our products

fulfill the relevant standards at all times. Our customers benefit from our extensive expertise and experience.

As a baseline, Teknoware's entire product range is designed to meet the requirements of the relevant European directives and standards.

## SYSTEM DESIGN: THINGS TO CONSIDER

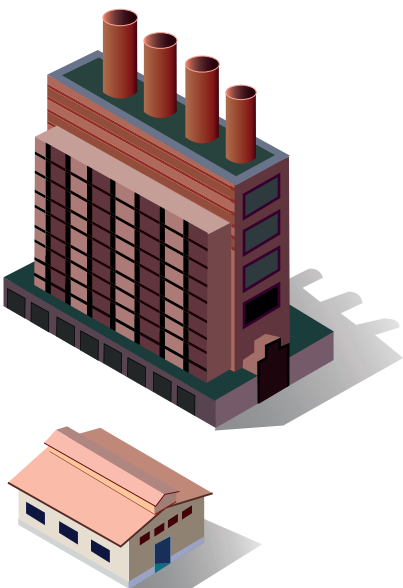
Emergency lighting can be implemented by two different ways:

- ▶ a centrally supplied emergency lighting system
- ▶ self-contained emergency and exit lights.

When determining the most suitable emergency lighting system for a building, the possible restrictions imposed by the installation environment need to be taken into account.

Things to consider when you choose the emergency lighting system:

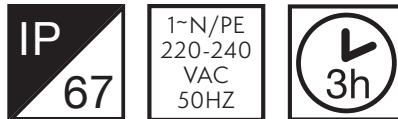
- ▶ the size of the building/site and the total number of emergency and exit lights



- ▶ the purpose of the building (e.g. back up power source, and back up time requirements)



- ▶ construction type (new construction, renovation or expansion)



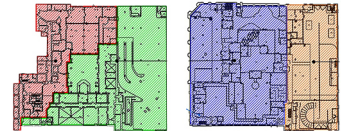
- ▶ technical performance level of the emergency lighting equipment



- ▶ anti-panic illumination of open areas

- ▶ high risk lighting requirements
- ▶ the acquisition cost (the equipment and the cabling, including the cost of installation)
- ▶ operating costs (maintenance and energy costs)
- ▶ control procedures of the system (automatic/manual testing)
- ▶ connecting to an existing system (system expansion)
- ▶ use of existing cabling for renovations
- ▶ architectural aspects, design of the luminaires
- ▶ fire zones

FIRE ZONE PLAN



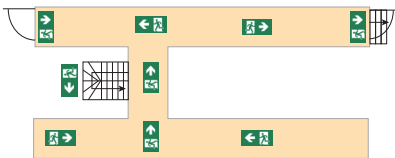
- ▶ the possibility of area monitoring
- ▶ environmental factors (recyclability, disposal of the parts and components, e.g. batteries)



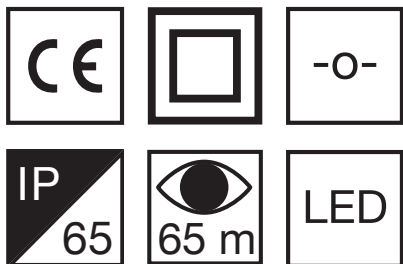


**Emergency lighting specification generally includes the following documents:**

- ▶ electrical evaluation report, which sets out a general description for the system and determines the equipment to be used
- ▶ drawing of the electrical plan, where the locations of the luminaires and the central battery systems are presented
- ▶ emergency lighting graph, where the system cabling is laid out



- ▶ table of luminaires, which defines the type of the emergency and exit lights
- ▶ the addresses for the luminaires (in addressable emergency lighting systems)
- ▶ maintenance plan and service and operational manual.



**Emergency lighting specification can be summarized using the following checklist:**

- ▶ choosing the luminaire types (viewing distance, IP classification, mounting height etc.)
- ▶ placement of luminaires (luminaire technical design)
- ▶ choosing the type of the system (central battery or self-contained)
- ▶ size of the batteries (required back up operation time)
- ▶ choosing the type of the cables for the system cabling
- ▶ cross section of the cabling, taking into account the loss of voltage and the minimum short circuit current (electrotechnical design).



## EMERGENCY LIGHTING SYSTEM FEATURES

Emergency lighting can be implemented by two different methods: either with self-contained emergency luminaires, or with a centrally supplied emergency lighting system.

Self-contained means, that the emergency lights contain their own backup power source, such as a battery. Centrally supplied means, that the back up power source is a central battery unit.

Teknoware offers emergency lighting products from both categories. From individually packed, self-contained luminaires, to centrally supplied and monitored systems, consisting of several thousand emergency lighting components. Product designs vary from stylish, high-end luminaires to robust emergency lighting products designed to withstand even the harshest and most challenging environments.

### Central Battery Systems

In short, central battery system for emergency lighting means, that the backup power source for the emergency and exit lights is provided centrally.

Teknoware's central battery system product portfolio include

- ▶ 24 V central battery systems

- ▶ Addressable 230 V central battery systems
- ▶ Non-addressable 230 V central battery systems.

### Central Monitoring Options for Central Battery Systems

A central monitoring system monitors all individual components of an emergency lighting system, and gathers all collected information to a single location. This makes monitoring the system fast and easy, no matter how complicated the location is. The system also records data about performed tests.

Teknoware offers several different options for monitoring of the addressable, centrally supplied luminaires.

For web-based central monitoring there is **Web Central Monitoring (WebCM)**, which enables the monitoring of the state of the addressable Tapsa Control central battery system via internet. WebCM also indicates test log information, and has the option of remotely run luminaire and battery tests. WebACM adds a map view to the system, which makes locating the luminaires fast and easy. **WebACM** is a user-based PC software, with several user levels, for locations, where there might be several people using the system.

Teknoware **Advanced Central Monitoring system (ACM)**, uses a separate network for addressable (Tapsa Control compatible) central battery units. ACM contains a map view, and a variety of options and functions for monitoring both the central battery units and the emergency and exit lights.

### Self-Contained Systems

In the self-contained systems, each emergency and exit light has its own backup power source, traditionally a **battery**. This kind of a system is the most applicable in such buildings, where the maintenance of the batteries, located in each luminaire, can be arranged with reasonable costs.

In **ESCAP** emergency and exit lights, the adaptability of the self-contained luminaires is combined with environmental friendliness, and freedom from maintenance. Instead of a battery, in the luminaire there is a maintenance-free **Super capacitor**, the life-time of which exceeds 10 years.

### Central Monitoring for Self-Contained Systems

For the self-contained luminaires, there is a wireless monitoring system, Aalto Control. Aalto Control is a wireless system containing, user-based functionalities, reporting, system logs and much more.



## SYSTEM DESIGN: EMERGENCY AND EXIT LIGHTS

### EXAMPLE OF SYSTEM DESIGN

#### Stage 1

Position the emergency and exit lights at points of emphasis on escape routes

- ▶ at each exit door
- ▶ to illuminate exit and safety signs
- ▶ near call points
- ▶ near each staircase
- ▶ change of direction
- ▶ near fire fighting equipment
- ▶ change of floor level
- ▶ near intersection of escape routes
- ▶ outside final exits
- ▶ near first aid points

#### Stage 2

Check that the maximum viewing distances are not exceeded. Even if the normal lighting is dimmed, e.g. in cinemas, the exit lights must still be permanently illuminated (maintained lighting).

#### Stage 3

Other areas, which require emergency lighting, but are not on the escape route area

- ▶ lift cars
- ▶ toilets and changing rooms etc. (larger than 8 m<sup>2</sup>)
- ▶ escalators and moving walkways
- ▶ motor and plant room
- ▶ pedestrian routes within covered car parks

#### Stage 4

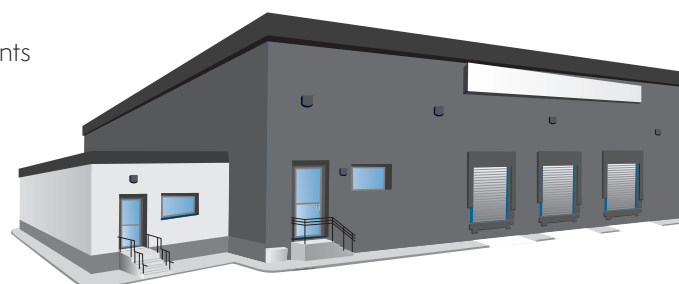
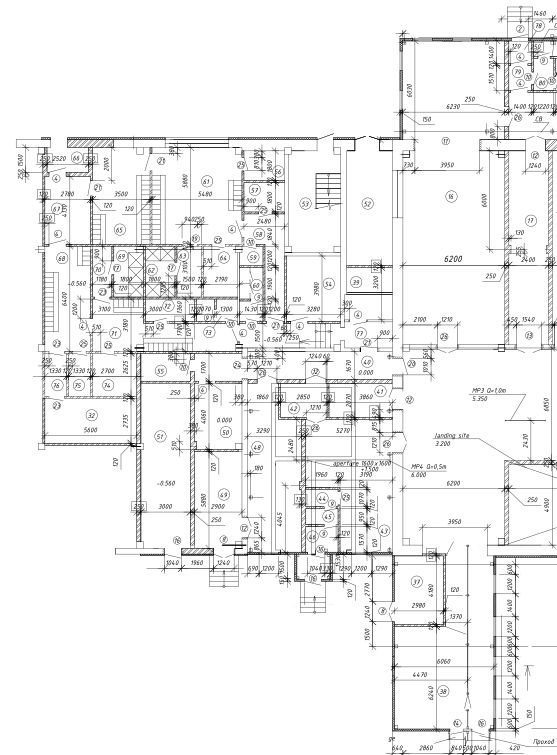
Check the minimum illuminance levels on the escape routes.

#### Stage 5


Anti-panic open areas apply to any areas over 60 m<sup>2</sup> floor area, or that have an escape route passing through them.

#### Stage 6


High risk lighting requirements



## MARKINGS

 = CE marking

 = SGS Finland marking (a 3<sup>rd</sup> party certification)

 = International standard IEC 60364-5-56, 560.9.15: Emergency lighting luminaires and associated circuit equipment shall be identified by a red label of at least 30 mm diameter. A=central battery unit, B= circuit, C=luminaire

|   |   |      |     |
|---|---|------|-----|
| X | 1 | *B*D | *60 |
| Z | 1 | **** |     |

= Luminaire classification label. According to the requirements of the standard EN 60598-2-22, the emergency luminaires shall be classified and marked according to their function and construction. Therefore, a sticker with four squares must be attached on the luminaire, in a visible place. The first square is already filled in at the factory, the rest of the squares are to be filled in after the installation.

a) First segment containing one position: TYPE (marked already in the factory)

- X self-contained luminaire
- Z centrally supplied luminaire

b) Second segment containing one position: MODE OF OPERATION:

- 0 non-maintained emergency luminaire
- 1 maintained emergency luminaire
- 2 combined non-maintained luminaire
- 3 combined maintained luminaire
- 4 compound non-maintained luminaire
- 5 compound maintained luminaire
- 6 satellite emergency luminaire

c) Third segment containing four positions: FACILITIES.

- A including test device
- B including remote rest mode
- C including inhibiting mode
- D high-risk task-area luminaire
- E with non-replacable lamp(s) and/or battery
- F automatic test gear complying with IEC 61347-2-7 denoted EL-T
- G internally illuminated safety sign.

d) Fourth segment containing three positions: FOR SELF-CONTAINED LUMINAIRES to indicate the minimum DURATION of the emergency mode, expressed in minutes:

- \*10 10 min duration
- \*60 1 h duration
- 120 2 h duration
- 180 3 h duration



## TERMINOLOGY AND STANDARDS

**Emergency lighting** is one of the most important safety systems in a building. Emergency lighting makes it possible to safely stop working and to evacuate the building, by following the exit lights, in case of an emergency. Emergency lighting is a standalone backup system, which does not rely on the functionality of the general electrical distribution system in the building. It must always be operational and ready for use.

**Emergency exit route** is a continuous and unobstructed path of exit, from any point of the building, in the case of an emergency. This route isn't necessarily used everyday, but must be lit up by the appropriate warning and directional signs.

**Open (anti-panic) area lighting** is necessary to reduce confusion and panic, whilst ensuring visibility of the nearest exit route.

**Emergency light** is a luminaire which may or may not be provided with its own electrical source for safety services and which is used for safety or emergency lighting.

**Exit Light** is a luminaire, that indicates and assists the identification of escape routes.

**A non-maintained luminaire** operates only, when the mains

power fails. (=emergency light).

**A maintained luminaire** operates at all times, both when the mains fails, and when it is present light. (=exit light).

**High risk task areas** of high physical risk, or the control rooms of dangerous plant and production lines, need emergency lighting to enable them to be shut down safely.

**EN 1838** is an European Standard that specifies the luminous requirements for emergency escape lighting and standby lighting systems, installed in premises or locations, where such systems are required.

**EN 50171** is the standard relevant to central power supply units and systems, controlling their design, construction and performance requirements.

**EN 50172** standard includes the requirements for illumination lux levels for additional areas, and the requirements for service and maintenance.

**EN 60598-2-22** is the product standard for emergency lights. The standard ensures that the products are safe to use, and have been designed and manufactured for correct performance under emergency conditions. EN 60598 -2-22 also requires all

emergency lights to be marked with information relevant to type, performance and manufacture.

The **CE mark** is a mandatory requirement for all luminaires for sale in Europe. This marking is placed on the product by the manufacturer and proves that the product conforms to all relevant safety standards.

**Response time** is a time that elapses between the failure of the normal power supply, and the auxiliary power supply energizing the equipment.

## MANDATORY “POINTS OF EMPHASIS”

Any point on an escape route, or leading to it, must have an exit sign, so that the direction of travel is not in doubt. Exit signs should clearly identify the full extent of the escape route, including any changes of direction. Emergency Lighting must be provided along escape routes, and in the open areas leading to them, to enable people to move quickly and safely to an exit.

Specific locations where emergency lighting must be provided are:



Exit door



Stairs



Change of direction



Change of floor level



Open areas



At each intersection of corridors



Highlighting fire fighting and first aid equipment



High Risk task areas



Outside and near each final exit



## DURATION TIMES AND RESPONSE TIMES

In emergency conditions, light must be provided for a certain minimum amount of time, to effectively achieve evacuation, and/or complete certain essential tasks. "Duration" is the minimum period of time that the emergency luminaire remains lit, after a mains failure. Various premises require different durations, from 1 to up to 8 hours, depending on the requirements of the local authorities.



### Response times

The requirement for escape routes and open areas is, that 50% of the illuminance must be available within 5 seconds, and the full value within 60 seconds of supply failure.

The requirement for **high risk task areas** is more critical, because a distribution may endanger life, while someone is working on a hazardous machine or process. Full emergency illuminance should therefore be provided within 0.5 seconds through to the end of the required duration.



## VIEWING DISTANCE

For all formats of exit lights and signs, the maximum viewing distances and luminance conditions are given in EN 1838: 2013.

Exit lights must be placed at any change in direction, to indicate the route to the final exit door.

The viewing distance is the distance, from which the sign can be clearly seen and understood.

The minimum height of the internally illuminated pictogram is calculated with the formula:  $d = 200 \times h$ , where  $d$  = viewing distance,  $h$  = height of the

pictogram in mm. For example a 100 mm high pictogram gives a viewing distance of 20 m.



## THE PERFORMANCE REQUIREMENTS FOR THE EXIT LIGHTS

Exit lights need to fulfil the performance requirements of the European standard EN 1838. This standard determines the requirements both for the luminance and the contrasts.

The minimum luminance in the green area is  $2 \text{ cd/m}^2$ .

The contrast between the white and the green area must be between 1:5 and 1:15.

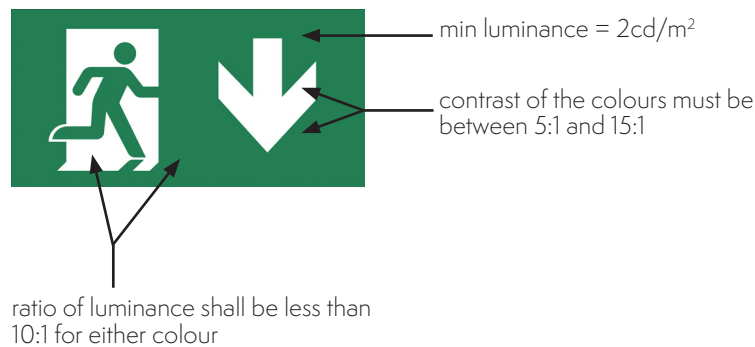
Within the same colour, the contrast must be less than 1:10.

These will guarantee the minimum observability for the pictogram. This is the most important feature of an exit light, and it cannot be neglected e.g. due to the quest for a lower energy consumption, or the product costs.

In the end, the owner of the building is responsible for the

emergency lighting system to be according to the relevant emergency lighting standards.

Since 2011, the pictogram format adopted both by BSI and EN standards, is ISO 7010.





## ILLUMINATION

Emergency lighting must be provided along escape routes, and in the open areas leading to them, to enable people to move quickly and safely to an exit.

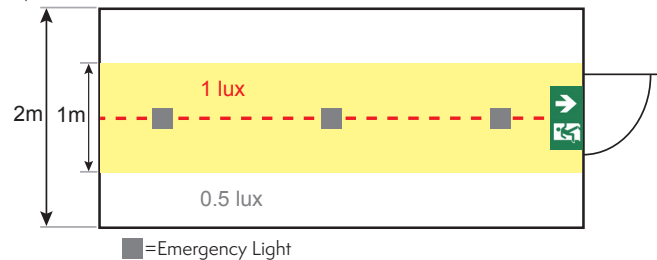
50 % of the illuminance must be available within 5 seconds and the full value within 60 seconds of supply failure in escape routes and open area.

### Escape route illumination

The illuminance required on the floor of a corridor-like escape route, up to 2 m wide, should be a minimum of 1 lux along the centre line, and a minimum of 0.5 lux in the 1 m wide central band.



Escape Route Illumination

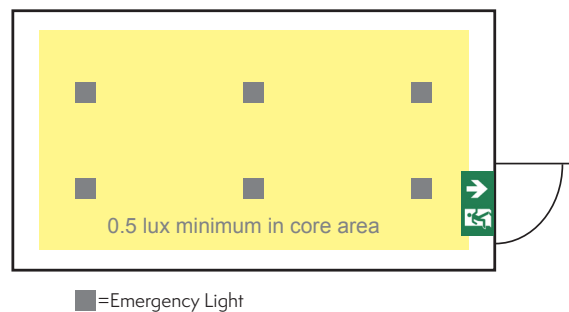


### Open area illumination

Any area larger than 60 m<sup>2</sup>, where people could find themselves in a emergency, is an open area requiring emergency lighting.

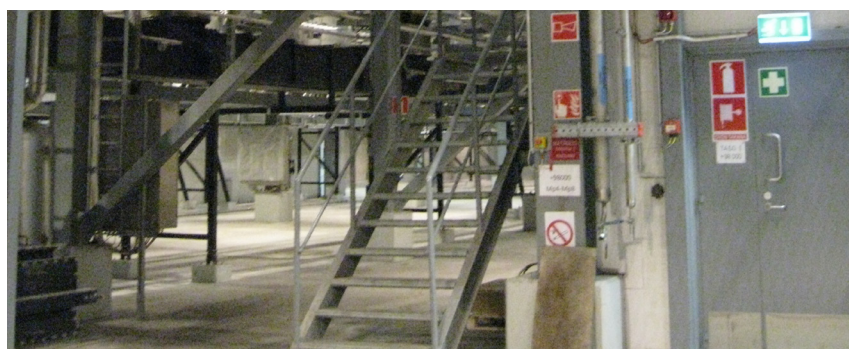
In open areas, illumination of 0,5 lux minimum should be provided.

Open Area Illumination



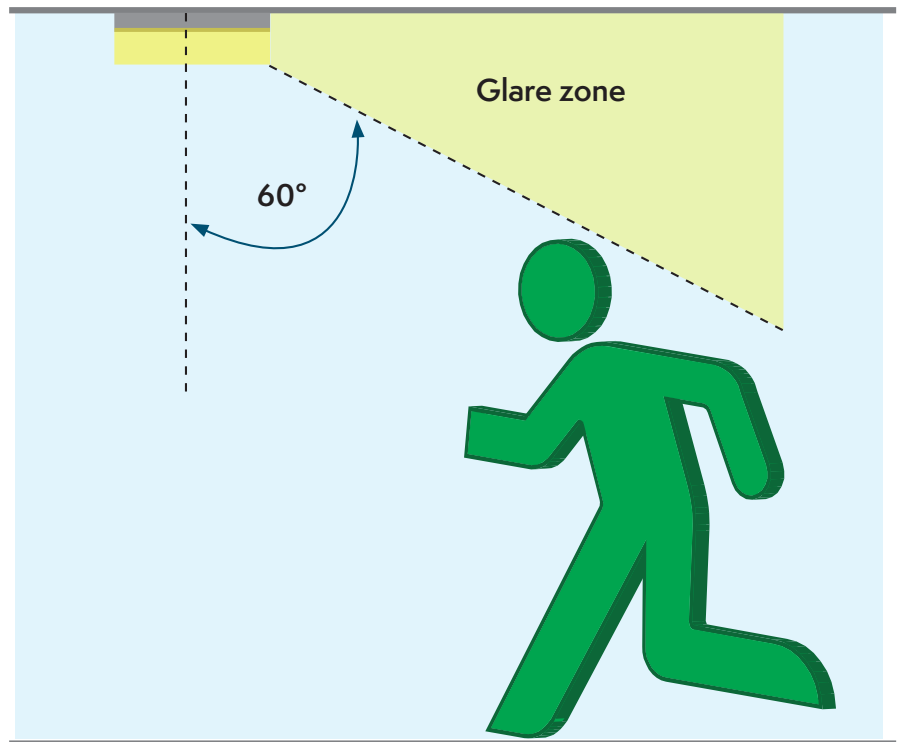
### High risk task area illumination

For high risk task areas the illuminance should generally be 10% of the normal mains illuminance or at least 15 Lux. This output must be fully achieved within 0.5 seconds.



## GLARE ZONE AND CONTRAST RATIO

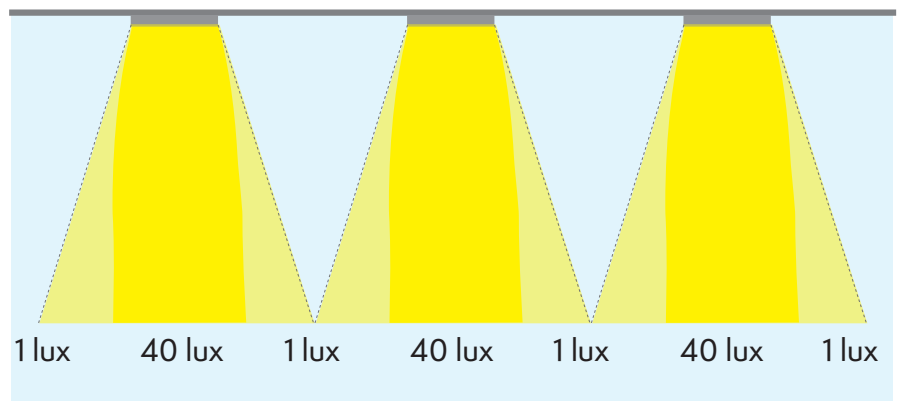
Glare zone of emergency lightings is regarded as angles above  $60^\circ$  from the vertical line. Typically, the emergency lights are mounted as high as possible. As the mounting height increases, so does the glare zone limit.



### Contrast ratio

Both for escape routes and open areas, the contrast ratio should not exceed 40:1, meaning that, if the minimum value is 1 lux, the maximum cannot exceed 40 lux.

Teknoware provides Eulumdat files for all its emergency lightings, for designing calculating and visualizing their photometric data, eg. in DIALux lighting design software.



## TESTING AND MAINTENANCE

Central battery unit and emergency exit lights shall be maintained regularly, to secure trouble-free operation.

Teknoware recommends, that the central battery system should be tested and maintained according to the standard EN 50172, as follows:

### Testing

The operation of the luminaire shall be verified according to the requirements of the authorities.

The battery mode duration of the self-contained types can be tested by

- ▶ switching off the mains supply voltage
- ▶ using self-testing feature such as Lumi Test, or
- ▶ using a central monitoring software, such as Aalto Control, which also record the test results.

### Periodical checks and maintenance

The condition of the emergency lighting system shall be ensured by regular maintenance, according to the regulations of local authorities.

The maintenance of the emergency lighting system is to

be carried out according to the standard EN 50172.

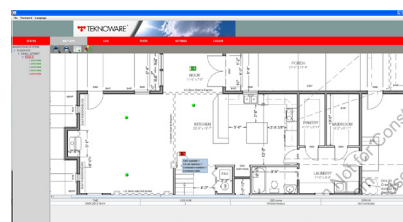
- ▶ the indicators of the emergency lighting central battery system must be visually inspected on a daily basis
- ▶ the emergency mode of each luminaire is tested monthly, by switching the luminaire to battery feed, either manually, or automatically
- ▶ once per year, the full duration test of 1 h, or a determined longer time, is to be made, by switching the system to battery feed, for the entire duration time
- ▶ all the tests and results shall be recorded in the logbook of the emergency lighting system and when asked, it shall be presented to the authorities for inspection
- ▶ in addition, a daily visual inspection of the maintained exit lights is recommended.



### Automatic testing systems

Teknoware provides automatic testing for both centrally supplied and self-contained emergency lighting systems.

Teknoware's central monitoring and self-testing systems take care of the required light source and duration tests automatically.





## AUTOMATIC TESTING AND MONITORING

**Teknoware Tapsa Control - central monitoring for the addressable, centrally supplied emergency and exit lights**



Tapsa Control central battery unit includes the following monitoring, testing and reporting functions:

- ▶ testing the luminaires either through addressable monitoring, or by measuring the circuit current
- ▶ monitoring the condition of the batteries
- ▶ testing the capacity of the batteries
- ▶ indicating the address of the faulty circuit and luminaire
- ▶ a short operation test time can be set to take place after each 1..7 days
- ▶ battery test every 6 months



**Teknoware Aalto Control - wireless central monitoring for the self-contained emergency and exit lights**



Aalto Control provides a wireless central monitoring for self-contained emergency and exit lights. There is no need to connect the luminaires with data cables. The only requirement is, that each individual luminaire has a local power supply, like any standard self-contained luminaires. All the benefits of the self-contained luminaires are preserved, and each luminaire functions independently.

Installation is simple, and the luminaires can be easily positioned, even during renovations. Each luminaire is a node, receiving and transmitting the signal to other luminaires. The signal penetrates normal walls, doors and floors easily, and climbs stairways. The network is used only for collecting information and does not affect the operation of the luminaires. For this reason, Aalto Control is as robust and resistant to failures as any other self-contained system.

Aalto Control PC system can include up to 5000 self-contained emergency and exit lights.

**Teknoware Lumi Test - automatic self-testing for the self-contained emergency and exit lights**



Lumi Test self-diagnosis, which is available for self-contained luminaires, automatically tracks and tests the reliable operation of the luminaires. LED indicators (one green and one red) display the status of the luminaires. Red LED indicates fault. The luminaire's functionality and light source are tested daily. Full emergency mode duration is tested every 6 months.

All Aalto Control emergency and exit lights also include Lumi Test.



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