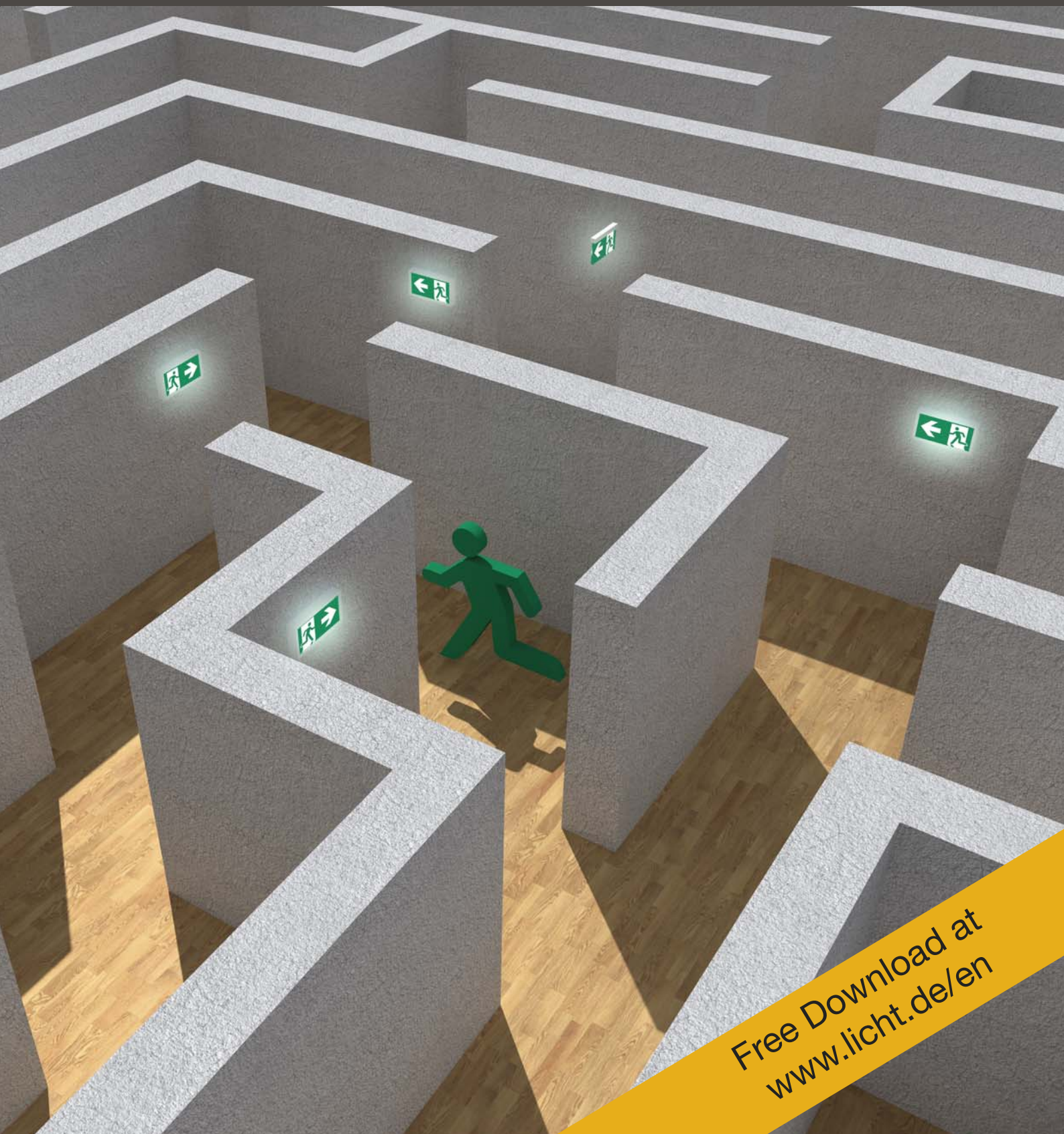


licht.wissen 10

Emergency Lighting, Safety Lighting



Free Download at
www.licht.de/en





Editorial

Light and safety are closely linked. General lighting – lighting that is dependent on regular mains electricity – is widely understood by operators and users, and is documented accordingly in the relevant regulations and guidelines. In the case of mains-independent emergency lighting – lighting which is activated only after a drop in, or failure of, the mains voltage – the same level of understanding cannot be expected.

Understanding emergency lighting is made more difficult by the multiplicity of standards, stipulations and guidelines relating to it. There has been widespread harmonization in national and international standards here in recent years – especially with regard to terminology. Emergency lighting is the umbrella term. It denotes lighting that is activated when general lighting fails. Emergency lighting which is used to allow a building to be evacuated safely or to enable potentially hazardous work operations to be safely terminated (in the event of a mains power failure) is referred to as safety lighting. That is the main topic of this booklet.

The German Occupational Health and Safety Act (ArbSchG) requires employers to conduct a hazard assessment of all work premises and workplaces. A safety lighting system needs to be installed where this reveals that a power failure and the resulting failure of general lighting would present a hazard for employees. This booklet takes account of occupational health and safety requirements as stipulated in the new technical workplace regulations (ASRs) and the relevant rules of the employers' liability insurance associations. It also looks at the passages relating to safety lighting in building regulations and examines the contents of lighting and electrical standards.

The development of the LED has radically transformed the products used for safety lighting. In future, attention will need to be paid not only to these technological changes but also to barrier-free escape routes and dynamic guidance systems. Technical regulation is increasingly international. Europe will (have to) become even more closely integrated. The primary focus must always be on human needs and the overriding purpose of safety lighting must be to help human beings evacuate areas safely in the event of a failure of artificial lighting.

Prof. Dr. Bruno Weis

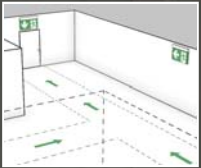
[Titel + 01] No electricity, no light: power failures knock out the lighting, too. Mains-independent safety lighting then needs to kick in immediately in hospitals, schools and places of assembly. It enables buildings to be evacuated safely, provides orientation and reduces the risk of accidents.



Safety lighting can save lives
Page 6



Light in a power cut
Page 8



Safety lighting
Page 10



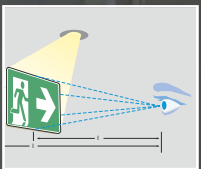
Escape routes
Page 12



Workplaces
Page 16



Anti-panic lighting
Page 20



Well-lit safety signs and escape routes
Page 22



**Advantages
of backlit escape
signs**
Page 24



**Luminaires
for safety lighting
systems**
Page 26



**Selection,
installation and
operation**
Page 30



**Building
regulation
requirements**
Page 35



Up or down?
Page 47



**Standards and
ordinances**
Page 48



**Series of
publications,
imprint**
Page 50





Home Video Themen Forum English DER SPIEGEL SPIEGEL TV Abo Shop Schlagzeilen Wetter TV-Programme Login / Registrieren

SPiegel ONLINE WIRTSCHAFT

Politik | Wirtschaft | Panorama | Sport | Kultur | Netzwerk | Wissenschaft | Gesundheit | einestages | Karriere | Uni | Reise | Auto | Stil

Nachrichten > Wirtschaft > Staat & Soziales > Energie/Erde: Tarnet warnt vor Stromausfall im Winter

Engpässe im Winter: Netzbetreiber warnt vor Stromausfall in Deutschland

Wacklige Leitungen und Engpässe könnten Deutschland im Winter einen flächendeckenden Stromausfall bescheren, warnt der Netzbetreiber TenneT. "Die Situation hat sich seit Frühjahr nicht entspannt", sagte Unternehmenschef Fuchs. Besonders an kalten Tagen könne es eng werden.

BR BAYERN 2

Wissen

BR.de > Radio > Bayern 2 > Wissen > IQ - Wissenschaft und Forschung > Technik > Blackout-Szenarien

★★★★☆ [2]

Blackout-Szenarien

Sind wir für den Stromausfall gerüstet?

Ein Stromausfall ist die Achillesferse unserer Zivilisation: Krankenhäuser, Wasserwerke, Telefonnetze brauchen Strom. Doch Forscher warnen: Auf lange, großflächige Blackouts sind wir nicht gut vorbereitet.

Von: ...

AKTUELLE THEMEN: Skandal um Volkswagen | Syrien-Konflikt | TTIP-Protest: Bürger gegen Fre...

DEUTSCHE WIRTSCHAFTS NACHRICHTEN

HOME DEUTSCHLAND MITTELSTAND WELT FINANZEN AUTO

INTERVIEW

Bundesamt warnt vor Panik bei Strom-Blackout in Großstädten

Deutsche Wirtschafts Nachrichten | veröffentlicht: 28.08.13, 02:10 Uhr | 33 Kommentare

Das Bundesamt für Bevölkerungsschutz und Katastrophenhilfe warnt vor Strom-Blackouts in Deutschland. Wetterveränderungen und die schlechte Infrastruktur nach Privatisierungen hätten das deutsche Stromnetz anfällig gemacht. Vor allem in Großstädten besteht dann bei langen Stromausfällen eine erhöhte Panikgefahr.

SPiegel ONLINE PANORAMA

Nachrichten > Panorama > Mega-Blackout: Europa im Dunkeln, Politiker in Panik

Mega-Blackout: Europa im Dunkeln, Politiker in Panik

Menschen blieben in Aufzügen und Seilbahnen stecken, Geschäfte wurden ausgeraubt, Rettungskräfte waren Dauereinsatz - so lautet die Bilanz des Mega-Stromausfalls, der Samstagnacht weite Teile Europas allem aber hat er die Frage aufgeworfen: Was, wenn so etwas an einem Wochentag pass...

03



Safety lighting can save lives

Power cuts – or blackouts – are not uncommon. And in an increasingly networked world, the risk of their occurrence will continue to grow. When general lighting fails due to a power cut, safety lighting kicks in. It guards against panic and accidents.

“Bottlenecks in winter: grid operators warning of power cuts in Germany”, “Chamber of Commerce fears electricity shortages as result of energy transition” – these are just two of many such headlines seen in recent years. There have been growing numbers of complaints about momentary power outages in Europe, and not only since the energy transition. Longer blackouts are also being reported. And it is not only natural disasters which cause interruptions to the energy supply. A technical defect in a substation or a short circuit in a transmission line can paralyze rail traffic, extinguish traffic lights and leave millions of people in the dark.

The causes of power failures are often complex and can be difficult to ascertain. The consequences, on the other hand, are all too familiar. Blackouts result in loss of economic power, while the risks for people increase.

No power, no light

The biggest concern during a power cut is that people start to panic. Sudden darkness quickly gives rise to fear because we receive 80 per cent of our information through our eyes. Poor vision is a problem for locals as well as visitors, although a lack of local knowledge will reinforce the fear. The result is a scarcely calculable risk in places containing large numbers of people.

Light provides safety and orientation

Safety lighting should come on during a power cut. It must work independently of the power supply of the building.

Signs and lighting

Information indicating the shortest path to the exit is of crucial importance during a power cut or building evacuation: safety signs for escape routes point the way using green and white pictograms. Escape sign luminaires must always be switched on dur-

ing working (or operation) hours and have a minimum brightness.

Illuminated indication of the direction to the exit is essential but so, too, is people's safety on the way there. Independent illumination of the escape route is indispensable for recognizing obstacles and steps etc., and for preventing accidents.

Carefully planned and professionally installed safety lighting relieves uncertainty and supports people in threatening situations – and sometimes it also save lives.

Good planning and selection

Relevant standards and regulations require sound and proper installation, but also regular maintenance to ensure that safety lighting actually works during a blackout. The owner of the property is ultimately responsible.

To meet the requirements and regulations, it is advisable and necessary to have safety lighting designed to the necessary standard by a specialist planner. S/he can plan appropriate safety lighting which is specially tailored to the needs of the property and find an energy-efficient solution based on the latest technology. Products made by reputable manufacturers ensure consistently high quality.

[02 – 04] As the headlines reveal: a power outage can paralyse whole regions: trams stop running, computers crash and lights are instantly extinguished.

Light in a power cut

The safety lighting system takes over when the general artificial lighting fails after a power outage. If the power failure could also result in a risk of accident, the safety lighting needs to activate to reduce the risk.

Safety lighting ensures that a minimum level of brightness is guaranteed if the general lighting fails. But it also helps in other emergencies. If a building needs to be evacuated, for example, it plays a key role in helping people unfamiliar with the building to find their bearings and make their way to safe areas using escape routes.

Emergency and safety lighting is covered by a variety of standards, regulations and guidelines. Employers, facility operators, electricians, lighting and electrical planners need to know and apply the relevant requirements.

International standards and European directives use “emergency lighting” today as a generic term for mains-independent lighting. It is activated whenever mains voltage fails or falls. Emergency lighting includes

- Safety lighting and
- Standby lighting

Safety lighting

Using escape signs and additional emergency luminaires, the main task of safety lighting is

- to ensure that people/visitors in a building can be evacuated safely and without danger,
- to prevent panic
- to render any hazards on the escape route visible.

Under the German Occupational Health and Safety Act, employers are obliged to conduct a hazard assessment of their workplaces. If this reveals that a general lighting failure is likely to present a hazard, safety lighting must be installed.

Subdivisions of safety lighting

Safety lighting is divided, in turn, into:

- safety lighting for escape routes, including escape route signs,
- safety lighting for particularly hazardous work areas and
- anti-panic lighting.




[05 + 06] Mains-independent identification of escape routes and additional safety lighting are mandatory for many buildings.

05

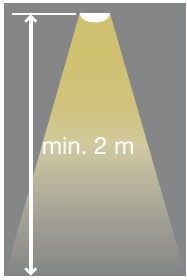
Standby lighting

Standby lighting is characterized by there being no hazard to employees in the event of a failure in the general lighting. If there is no risk to employees after a power failure, but an activity must be continued, the standby lighting cuts in and provides enough light.

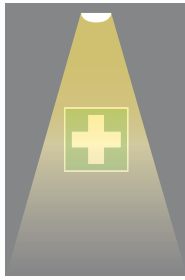
 Further information about standards and regulations can be found on page 49.



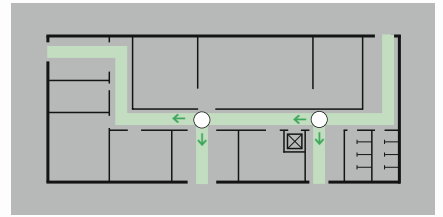
Areas /elements to be highlighted as per DIN EN 1838



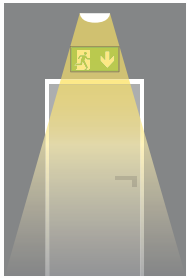
At least two metres above floor level



Near*¹ any first aid point*²



At any point where corridors or aisles cross

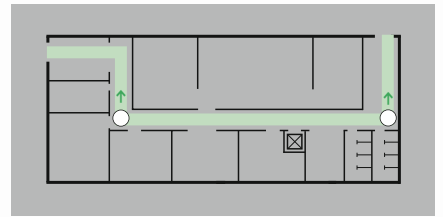


At each exit door to be used in an emergency.

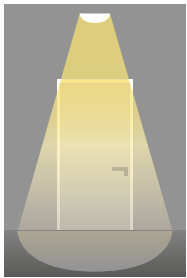
Safety and direction signs on escape routes must be illuminated or back-lit even with functioning general lighting.



Near*¹ all fire-fighting facilities or alarm devices*²



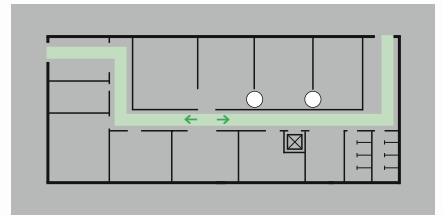
At each change of direction



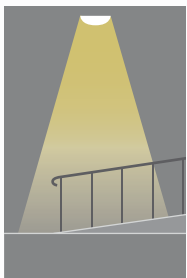
Outside and near*¹ each emergency exit leading to a safe area



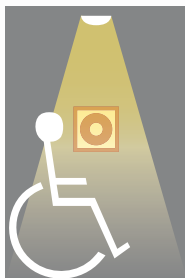
Near*¹ escape devices for people with disabilities



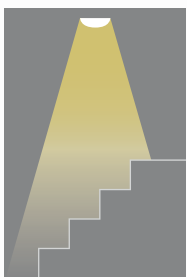
Anti-panic lighting on paths adjacent to areas where safety lighting is required, but not directly bordering an escape route.



Near*¹ each level change in the escape route, such as a ramp or a landing



Near*¹ protection areas for people with disability, call systems and communication facilities for these areas, as well as alarm devices in toilets for the disabled.



Near*¹ stairs, to illuminate each step directly.



Anti-panic lighting in toilets for people with disabilities

*¹ max. 2m distance in horizontal plane
*² vertical illuminance 5 lux

Safety lighting

Safety lighting must come on whenever a failure of general lighting occurs that may prevent the safe evacuation of a building and thus present a risk of accident.

Safety lighting ensures that work operations with a high accident risk potential can be terminated safely and that persons unfamiliar with the premises are able to exit the affected rooms and areas safely in the event of a general power failure. National building regulations as well as occupational health and safety rules need to be observed at the design and installation stages.

Safety lighting is divided into:

- safety lighting for escape routes
- safety lighting for particularly hazardous work areas
- anti-panic lighting and
- signs for escape routes

Features of safety lighting

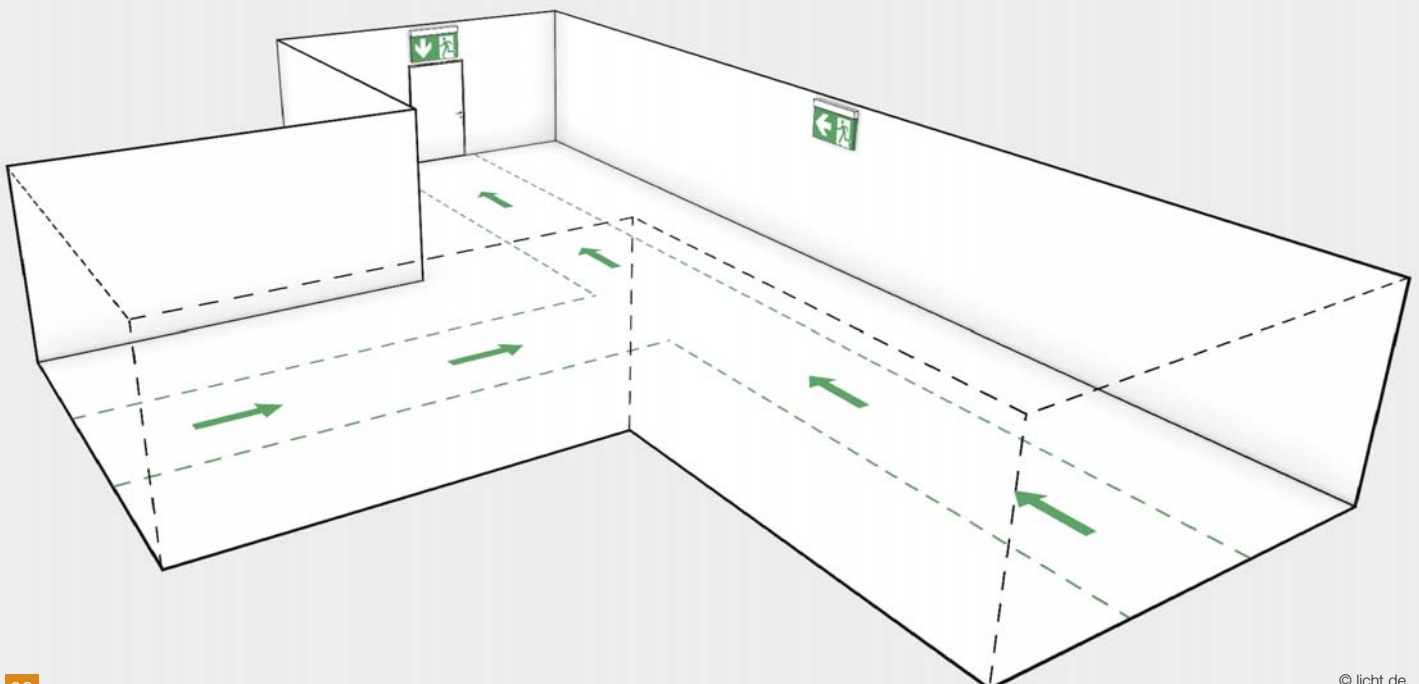
Luminaires for illuminating and identifying an escape route need to be mounted at least 2 metres above floor level to ensure sufficient illumination and visibility:

- All escape signs on emergency exits along escape routes must be illuminated or back-lit.
- Where an emergency exit is not directly visible, one or more illuminated and/or back-lit escape signs need to be positioned along the escape route.

The DIN EN 1838 standard requires good general illumination for more than just the escape routes. It stipulates that supplementary lighting should also be provided for other safety-relevant areas and potential hazard sites. Safety luminaires therefore also need to be positioned at specific points (see fig. 7 and 8).

[08] Changes of direction in the escape route must be marked.

Indicating changes of direction



Escape route safety lighting

Escape route safety lighting should ensure adequate conditions for visual orientation along escape routes and in adjoining areas of the building. Fire extinguishing and safety equipment needs to be easy to locate and use.

Escape routes must be illuminated and marked in compliance with the standards to ensure that employees and visitors can reach safety as quickly as possible in an emergency. This requires:

- Escape sign luminaires or illuminated escape signs to mark the escape route
- Luminaires to illuminate the escape routes.

All employers are also required to position escape plans where they are clearly visible: employees and visitors must be able to gain an overview of the escape routes, allowing them to find the emergency stairs and emergency exits at all times. Escape plans also serve as an orientation aid for rescue teams such as the fire service.

Lighting requirements

According to DIN EN 1838, escape route safety lighting is the “part of a safety lighting system that enables emergency facilities to be clearly identified and safely used where persons are present.” Workplace regulation ASR A2.3 also stipulates that “escape routes need to be fitted with safety lighting

where safe evacuation of the workplace is not guaranteed in the event of a general lighting failure.” The terms “Rettungswege” (rescue routes) and “Fluchtwege” (escape routes) are used in German regulations and standards. However, both terms are largely synonymous.

Where “escape routes” are referred to in a standard, these are always two metre-wide strips. Wider routes are defined as multiples of such two-metre strips.

The most important lighting requirements set out in DIN EN 1838 and Technical Regulations for Workplaces ASR A3.4/3 are:

- The horizontal illuminance along the central axis of an escape route needs to be at least one lux – measured at a point up to 20 centimetres (ASR), but preferably no more than two centimetres (DIN EN 1838), above floor level. The illuminance is allowed to decrease by 50 per cent at a distance of 50 centimetres to the left and right of the central axis.

[09] The ratio of highest to lowest illuminance along the central axis must not exceed 40:1. This avoids light/dark contrasts that interfere with the visual task.

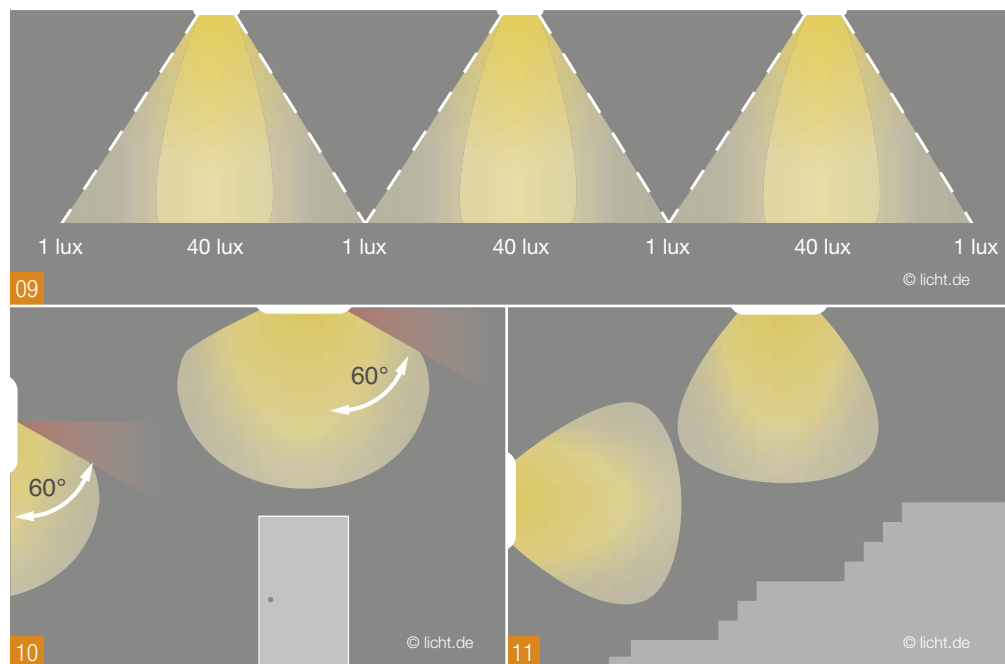
[10] In the case of horizontal escape routes, the luminous intensity must not exceed certain limits at any azimuth angle between 60° and 90° to the vertical (see the table on page 15).

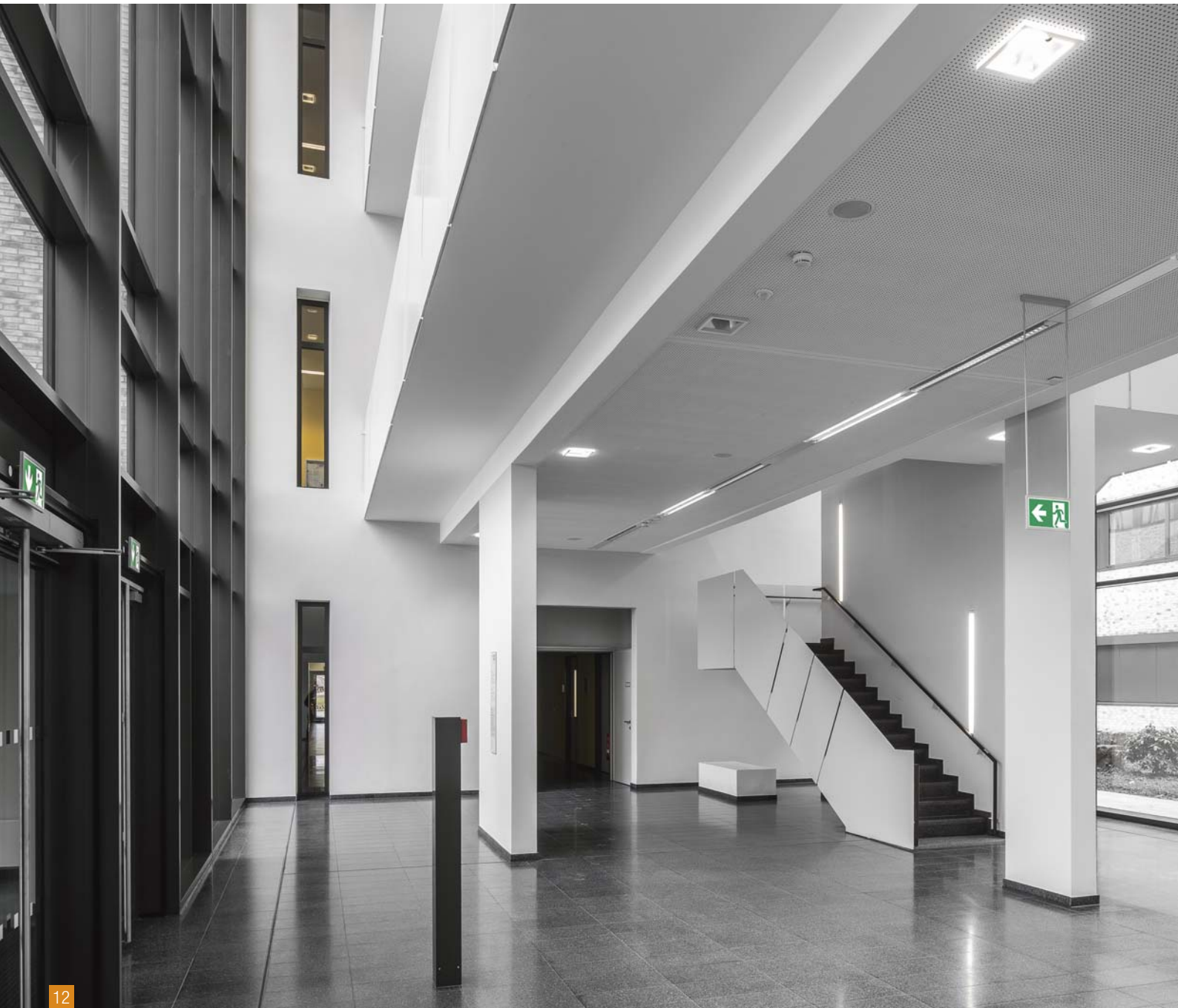
[11] For all other escape routes and zones, the limits must not be exceeded at any angle.

[12] Emergency signs must be clearly visible even in general lighting conditions.

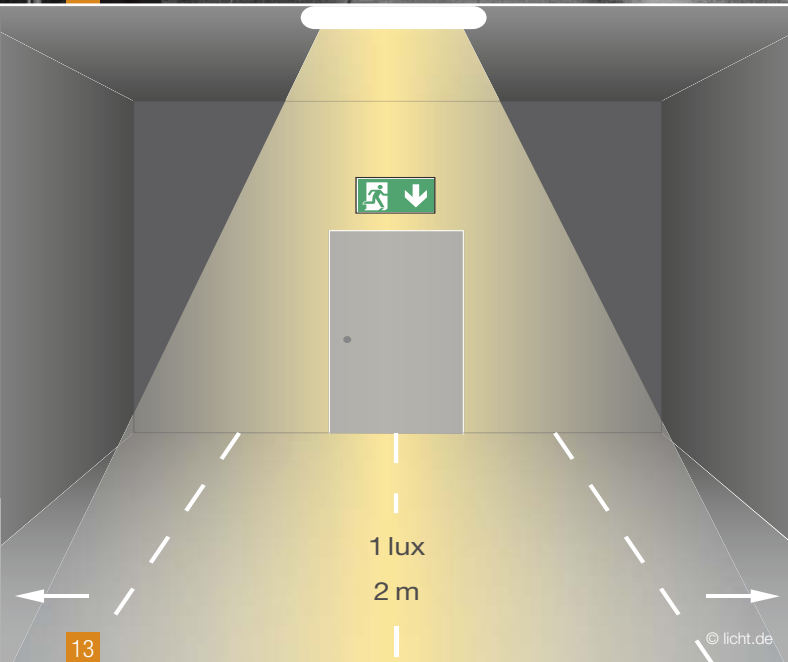
[13] On escape routes of up to two meters wide, the horizontal illuminance on the central axis must be at least one lux (measured 2 cm above floor level).

[14] At least one sign must be visible at all points along an escape route.





12



13

© licht.de



14

- Safety lighting must reach 100 per cent of its rated output within 15 seconds of the general lighting failing. Most combustion engine generating sets have a 15-second switchover time, however, meaning that battery-based systems are the only suitable power source.
- The minimum colour-rendering index for escape signs is R_a 40; this enables coloured escape signs to be recognized quickly and clearly.

Lighting uniformity

Furthermore, the ratio of highest to lowest illuminance along the central axis must not exceed 40:1, not even in the worst-case scenario, e.g. between two luminaires at the end of their rated operating time. This is because excessively bright/dark patches make obstacles and the escape route itself harder to discern on account of the time needed for the eyes to adjust.

The time between the moment the general artificial lighting fails at the start of a power outage and the moment the required illuminance is reached should be as short as possible. Safety lighting for work premises must be guaranteed to operate for at least one hour. The table on page 46 shows the stipulated times for other premises.

Glare limitation – an often underestimated factor

Excessively intense light can cause physiological (disability) glare. In escape route lighting, it presents a problem in that it prevents obstacles or escape signs being recognized. The risk is particularly acute where general diffuse lamps are used.

In the case of horizontal escape routes, the luminous intensity must not exceed certain limits at any azimuth angle between 60° and 90° to the vertical. For all other escape



routes and zones, the limits must not be exceeded at any angle (see illustrations on page 12).

Escape route signage is also important. The lighting requirements in the event of a power failure are set out in DIN EN 1838. It should also be noted that the escape sign luminaires defined in DIN 4844 must be clearly identifiable even under general lighting conditions and therefore need to be operated at a higher luminance level.

The luminance of the white contrast colour of backlit emergency signs located in areas with general lighting should be no less than the required 500 cd/m². Uniformity and contrast are further criteria for achieving the necessary recognition distance (see fig. 23).

Escape route safety lighting (DIN EN 1838)

Illuminance: $E_{\min} = 1 \text{ lx}$
 E_{\min} = minimum horizontal illuminance at floor level

Uniformity: $E_{\max} : E_{\min} \leq 40 : 1$

Glare limitation:

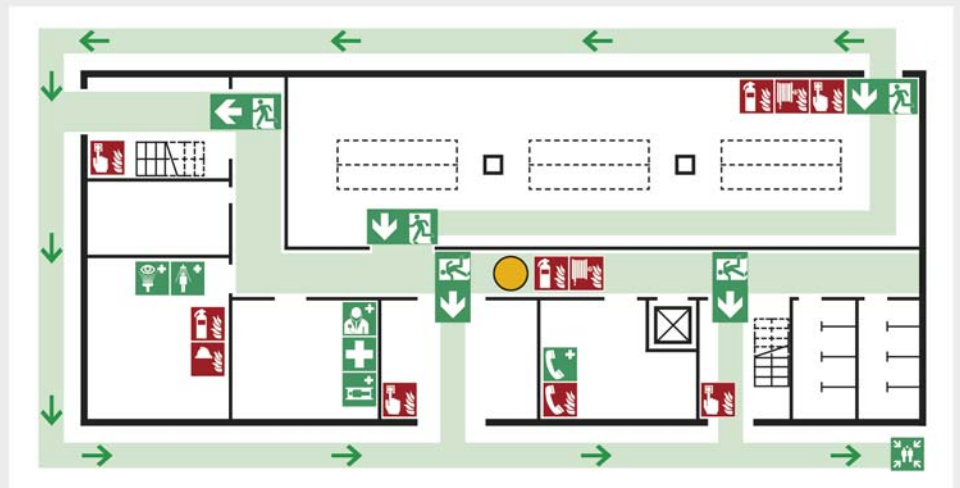
h/m	< 2.5	2.5 ≤ h < 3	3 ≤ h < 3.5	3.5 ≤ h < 4	4 ≤ h < 4.5	≥ 4.5
I_{\max}/cd	500	900	1,600	2,500	3,500	5,000

For horizontal escape routes, the values in this table must not be exceeded at any azimuth angle between 60° and 90° to the vertical.





Colour rendering: $R_a \geq 40$

Rated operating time for escape routes: 1 hour

Escape and rescue plan



© licht.de

-  Location
-  Fire extinguisher
-  Fire hose
-  Fire alarm, manual
-  Fire alarm phone
-  Fire-fighting media and equipment
-  Direction indication
-  Escape route/Emergency exit
-  Emergency phone
-  Emergency shower
-  Eye wash station
-  Doctor
-  Stretcher
-  Assembly point
-  First Aid

[15] Escape routes must be lit and marked in accordance with the relevant standards.

[16] This floor plan shows an example of an escape plan.

Safety lighting for work premises and particularly hazardous workplaces

Employers are obliged to protect the health and safety of their employees. This includes conducting a hazard assessment for all workplaces. One question it needs to address is whether all employees can safely evacuate their workplaces in the event of a lighting system failure.

Occupational health and safety for employees is governed by EU-wide regulations. In Germany, the relevant statute is the Occupational Health and Safety Act (Arbeitsschutzgesetz – ArbSchG). This forms the basis for statutory instruments such as the Arbeitsstättenverordnung (ArbStättV – Workplace ordinance) which sets out the basic health and safety requirements. Its individual stipulations are specified in technical workplace regulations (Technischen Regeln für Arbeitsstätten – previously Arbeitsstättenrichtlinien (ASRs)).

The regulations require employers to protect their employees from potential sources of harm at the workplace. This includes guarding against general accident risks. If lights go off as a result of a power failure, even a janitor may be exposed to danger if he cannot find the way out in the dark or if he falls and sustains injury on the escape route as a result of being unable to see. Safety lighting provides a safeguard here.

Responsibility resides with employers

Whether safety lighting is necessary or not needs to be established by employers on the basis of a hazard assessment (paragraph 5 ArbSchG). This and the measures subsequently taken need to be documented (paragraph 6 ArbSchG).

The key question is whether safe evacuation of the workplace is possible. And an affirmative answer to that question can normally be given only if sufficient light is available even in the event of a power failure – i.e. in work premises with windows or skylights during the day. During winter, however, it gets dark early, leaving insufficient light for orientation even in the afternoon, meaning that safety lighting is almost always necessary. It needs to deliver at least one lux illuminance. In rooms that can be

safely evacuated by every employee, only exits need to be marked.

Employers must also ensure that employees and visitors can safely evacuate the building after a power failure. Escape route safety lighting needs to be installed where there is a heightened risk of accidents – e.g. on stairs, in the event of obstacles that are hard to make out in darkness, or in the case of a complicated escape route.

The risk of accident in a room suddenly plunged into darkness is considerably higher at particularly hazardous workplaces. Where such workplaces are present, safety lighting systems need to deliver at least 15 lux illuminance to enable work operations to be terminated safely. Where workplaces and designated escape routes could fill with smoke, there is an additional hazard in the event of a fire. An optical safety guidance system needs to be installed in such areas, in addition to safety lighting.

Secure against claims

An employer that complies with the relevant ASRs can show authorities – especially in the event of damage – that every requirement of the Workplace Ordinance has been observed. If the measures taken differ from those set out in the ASRs, the employer faces the much more complex task of proving that they were effective.

Particularly hazardous work areas


The risk of accident is especially high in “particularly hazardous work areas” (ASR A3.4/3 paragraph 4.2) and at “particularly hazardous workplaces” (DIN EN 1838). These include, for example:

- Laboratories with an acute risk during ongoing experiments. Acute risks may be explosions or fire, the release of



pathogens or toxic, highly toxic or radioactive substances in dangerous quantities.

- Workplaces that need to be kept dark for technical reasons.
- Electrical operating areas and building service rooms that need to be accessed in the event of the failure of artificial lighting.
- Areas with moving machinery that can continue running for a long time after a power failure. Examples include facing lathes.
- Control points for systems that require constant monitoring, such as control centres and control rooms for power stations, chemical and metallurgical plants as well as workplaces with isolating or regulating equipment that needs to be operated to interrupt or terminate production processes safely during normal or disrupted plant operations.
- Workplaces near hot baths or casting pits that cannot be properly secured by guard rails or barriers for production reasons.
- Areas around work pits that cannot be covered for operational reasons.
- Construction sites.

 *The publication licht.forum 56 contains additional information on the topic of safety lighting for workplaces.*

[17 + 18] Employers must ensure that employees and visitors are able to leave the building safely after a power failure. Safety lighting is mandatory for “particularly hazardous workplaces”.





19

Particularly hazardous workplaces (DIN EN 1838)

Illuminance: $E_{min} \geq$ minimum illuminance, but at least 15 lx

Uniformity: $E_{max} : E_{min} \leq 10 : 1$

Glare limitation:

h/m	< 2.5	$2.5 \leq h < 3$	$3 \leq h < 3.5$	$3.5 \leq h < 4$	$4 \leq h < 4.5$	≥ 4.5
I_{max}/cd	1,000	1,800	3,200	5,000	7,000	10,000

The values in this table must not be exceeded at any azimuth angle between 60° and 90° to the vertical.

Colour rendering: $R_a \geq 40$
Safety colours need to be clearly recognized.

Rated operating time for escape routes: as long as a hazard exists

Power-on delay: 0.5 Sek.

[19 + 20] Safety lighting at “particularly hazardous workplaces” is required to deliver at least 15 lux illuminance. Where there is a risk of workplaces and escape routes filling with smoke in the event of a fire, an optical safety guidance system must also be installed.

Particularly hazardous workplaces

Safety lighting in “particularly hazardous work areas” needs to meet higher requirements. Illuminance needs to be at least 15 lux. Technical workplace regulations and standards both stipulate this. A preferable level is 10 % of the illuminance of the normal general lighting – which is what the ASRs recommend – because the brighter the lighting, the less likely an accident is due to the prolonged darkness in the wake of a power failure.

This is also the reason for the stipulation that the required illuminance needs to be reached within 0.5 seconds. For many light sources, however, this is possible only with safety lighting in maintained operation. Lighting uniformity in these work areas should be lower than 10:1.


The nominal operating time needs to be at least as long as the hazard exposure after a power failure. This operating time is

established when a hazard assessment is conducted.

Construction sites

Construction sites are mentioned explicitly in ASR A3.4/3 because of their particularly hazardous nature as a workplace. The regulation states that safety lighting is absolutely essential where daylight fails to provide a minimum of one lux illuminance for escape route lighting and site workers thus cannot evacuate their workplace safely.

So any construction site where work continues into the evening or night must at least have escape route safety lighting installed. A higher lighting level is required for basement levels – e.g. a minimum of 15 lux illuminance, which ASR A3.4/3 also requires for tunnelling work.

 Further information on optical safety systems can be found in *licht.forum* 57.

Optical safety guidance systems

Safety lighting can usefully be supplemented by optical safety guidance systems. These facilitate escape if orientation in a room or along escape routes is impaired by smoke. It is important to note that optical guidance systems are not a substitute for standard-compliant safety lighting; they are installed in addition to it.

A distinction is made between:

- photoluminescent safety guidance systems (signs),
- electrical safety guidance systems (connected to a safety power source),
- dynamic safety guidance systems – ‘smart’ systems incorporating direction indicators that change according to the location of the hazard site.

Direction signs and other guidance systems are mounted on the wall at a maximum height of 40 centimetres above floor level. This type of marking makes it possible to identify escape routes with direction indicators. In comparison to escape sign luminaires, optical safety guidance systems have the disadvantage that they are not positioned at eye level. An evacuee’s view of the low level markers is obscured by the persons in front of them.

Where there is a risk of accidents, safety lighting is essential. This is the only factor which makes differences in level, stairs and obstacles on the escape route identifiable and thus guards against dangerous falls.





21

Anti-panic lighting

Anti-panic lighting is the third category of safety lighting alongside escape route safety lighting and safety lighting for particularly hazardous workplaces. The light it provides is intended to reduce hysteria and panic in an emergency.

Anti-panic lighting is the third category of safety lighting alongside escape route safety lighting and safety lighting for particularly hazardous workplaces. The light it provides is intended to reduce hysteria and panic in an emergency.

Panic can quickly arise if the lights suddenly go out as a result of a power failure at sporting events, rock concerts or major university lectures – wherever people assemble in large numbers. People seeking to escape may be injured or even killed in the ensuing crush.

Anti-panic lighting helps provide a greater sense of security. Its purpose is to reduce the likelihood of panic and create the visual conditions needed for people to reach es-

cape routes safely. In Germany, however, neither building nor workplace regulations set out specific requirements for the application of anti-panic lighting. As a general rule, anti-panic lighting in Germany is planned on the basis of one lux horizontal illuminance on the free floor area and a rated operating time of three hours.

Anti-panic lighting needs to be installed where escape routes are not clearly defined – in large halls, for example – or where the entire hall space may be used as an escape route. It is also required in conference rooms with an area of more than 60 square metres and no signed escape routes as well as in smaller enclosed spaces where crowding could give rise to panic. Such spaces include, for example, lift cabins.

Lighting criteria

Anti-panic lighting should be directed straight downwards and illuminate obstacles.

Furthermore, DIN EN 1838 stipulates that:

- the ratio of highest to lowest illuminance should be no greater than 40:1 because of the time needed for the eyes to adapt. This avoids excessive differences in brightness that interfere with the visual task.
- The minimum colour-rendering index for escape signs is R_a 40; this enables coloured escape signs to be recognized quickly and clearly.
- Glare limitation requirements are the same as for escape route safety lighting (see table on page 15).

[21 + 22] Anti-panic lighting helps prevent an outbreak of panic in the event of a power failure.



Well-lit safety signs and escape routes

Safety signs for escape routes can either be illuminated or back-lit. The external light sources of illuminated escape signs must be an integral part of the safety lighting.

Safety signs are a crucial part of safety lighting. Therefore they are mentioned explicitly in the preface of the latest version of DIN EN 1838 as part of the safety lighting for escape routes.

Emergencies in a building are not always accompanied by a power outage. The power supply is mostly maintained in other hazards such as fire, panic or evacuation. The escape signs must therefore be immediately recognized and understood even in general lighting. In this case the photometric values given in DIN 4844-1 apply.

Safety signs mark escape routes as well as fire protection and first aid facilities. According to DIN EN ISO 7010 a safety sign is a sign, "that makes a general or (through the addition of a graphic symbol) special safety statement by combining a specific colour with a geometric shape". ASR A1.3 contains a very similar definition. According to DIN ISO 3864-1, an escape sign is a "safety sign which marks an escape route or the location of first aid equipment, or identifies safe behaviour".

NB: The escape route must be clearly marked, and at least one escape sign must be visible at all points along the escape route, providing orientation on the escape route or marking doors or an emergency exit along the way.

DIN EN ISO 7010 covers all safety signs and was introduced in Germany in 2012. This contains emergency exit escape signs under the registration numbers E001 and E002. The workplace regulation ASR A1.3 from February 2013 adopted these signs. Escape signs must always have an additional character indicating the direction, namely arrow type D according to DIN ISO 3864-3.

The combination of escape sign and direction indication has a specific meaning which is described in detail in the "Marking of escape direction" publication of the German

Electrical and Electronic Manufacturers' Association (ZVEI). This is dealt with on page 47 of this brochure.

The old version as described in DIN 4844-2 from 2002 differs mainly in the angular limbs of the figure and the thinner arrow of the new safety sign according to DIN EN ISO 7010. The safety statement remains the same. According to the ZVEI, there is no necessity to replace the old signs. In new installations, however, the new DIN EN ISO 7010 escape sign must be used.

Lighting parameters

DIN EN 1838 and the latest version of DIN 4844-1 present different requirements for illuminated and back-lit safety signs in terms of the lighting parameters to be met for different operating conditions. For escape sign luminaires in emergency operation, DIN EN 1838 requires a much lower brightness for the sign as a whole than DIN 4844-1 does. DIN 4844-1 addresses nor-

mal operation and takes into account that when the general lighting is on, escape signs need to stand out against brightly lit surroundings, i.e. they need to be brighter than in emergency operation.

Luminance, uniformity of illumination and contrast are key criteria for judging a good escape route luminaire and thus the safety it affords. The table on page 23 summarizes the requirements of the two relevant standards. Further information about standards and regulations can be found on page 49.

Recognition distance

Because a back-lit sign is easier to recognize from a greater distance than a sign that is only illuminated, DIN EN 1838 and DIN 4844 stipulate that different distance factors need to be applied to establish the standard-compliant recognition distance (see Fig. 23). To be equally recognizable from the same distance, an illuminated escape sign needs to be twice as tall as a back-lit sign. Back-lit signs are always the better choice because they are also recognizable for much longer and from a greater distance if smoke is present. Illuminated or backlit escape signs should not be mounted more than 20 degrees above horizontal sight lines (measured at the maximum recognition distance). A supplement to DIN EN 1838 is currently (2016) in preparation on this subject.

Illuminated escape signs require safety luminaires

To ensure that an illuminated escape sign does not fall below the luminance level stipulated in DIN EN 1838, an illuminance of approximately 30 lux is required on the sign in emergency operation. To achieve this, each illuminated safety sign requires its own safety luminaire. These luminaires also meet the requirement of DIN 4844-1 for a preferred illuminance level of at least 80 lux on the escape sign in mains operation. The safety luminaires must therefore be in maintained operation.

Escape signs

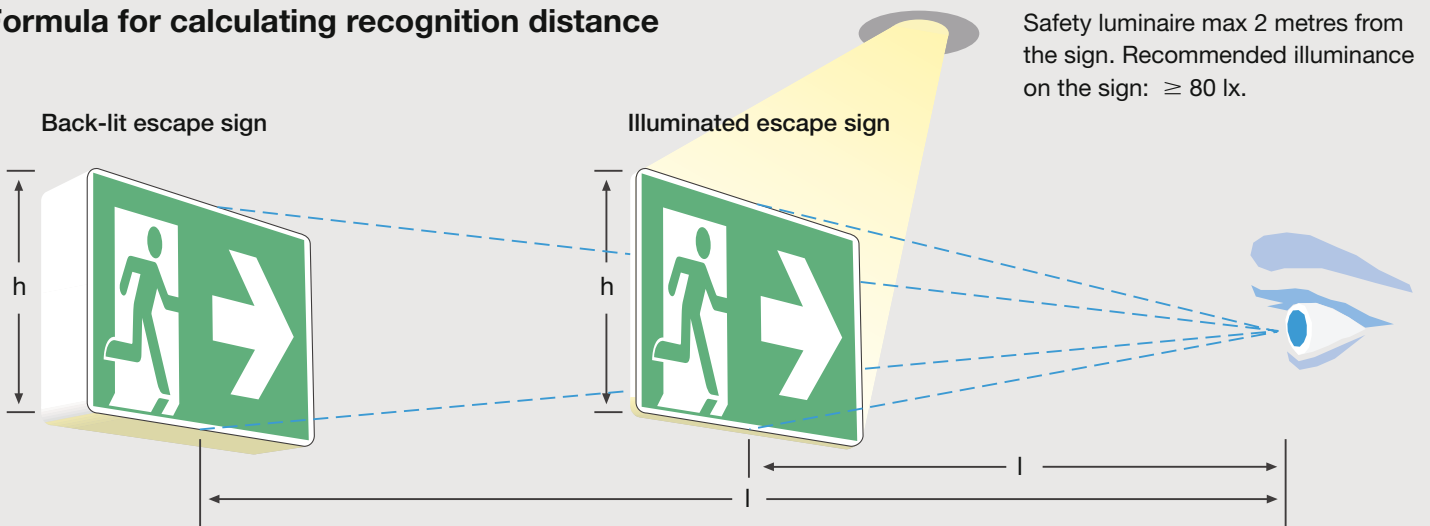


New escape sign according to DIN EN ISO 7010:2012-10 and ASR A1. 3:2013-02



Previous escape sign according to DIN 4844-2:2001-02

Formula for calculating recognition distance



The formula for calculating the recognition distance of *back-lit* signs:

$$I = h \cdot 200$$

e.g. height = 15 cm \triangle recognition distance 30 m

The formula for calculating the recognition distance of *illuminated* signs:

$$I = h \cdot 100$$

e.g. height = 15 cm \triangle recognition distance 15 m

Key: I = recognition distance h = height of the sign

23

© licht.de

Comparison of lighting requirements

	DIN 4844-1	DIN EN 1838
Area of use	Bright and dark Environment	Dark environment
Operating mode	Normal operation	Emergency operation
<i>Continuous operation</i>	Yes	Not specified
<i>Green safety colour</i>	acc. to DIN 4844-1	acc. to ISO 3864-4
<i>White contrast colour</i>	acc. to DIN 4844-1	acc. to ISO 3864-4
<i>Uniformity of green or white surfaces</i>	$g \geq \frac{L_{\min}}{L_{\max}} 0.2$	$g \geq \frac{L_{\min}}{L_{\max}} 0.1$
<i>Luminance contrast between green and white surfaces</i>	$k = \frac{L_{\text{white}}}{L_{\text{green}}} = 5:1 \text{ to } 15:1$	
Average luminance of <i>white</i> contrast colour	$\geq 500 \text{ cd/m}^2$	not specified
Luminance of <i>green</i> safety colour	not specified	$\geq 2 \text{ cd/m}^2$
Calculated average luminance of the <i>sign as a whole</i>	$\geq 200 \text{ cd/m}^2$	$\geq 5 \text{ cd/m}^2$
<i>Illuminance</i> of the illuminated sign	$\geq 50 \text{ lx}$ (preferably $\geq 80 \text{ lx}$)	not specified

[23] Safety signs clearly indicate the direction to take – providing the pictogram is correctly dimensioned for the required recognition distance.

Advantages of backlit escape signs

Luminescent escape signs are only allowed under DIN EN 1838 for safety lighting if they are illuminated with a safety luminaire, thereby ensuring that the safety colour green actually remains “green” in an emergency.

In escape sign luminaires, however, the safety colour green is clearly recognizable both in mains and in emergency operation – as required by DIN EN 1838. Standard signs with photoluminescent pigments, however, appear dark after a power failure: the white contrast colour generally has a yellowish-green appearance.

Because safety signs are illuminated or backlit in emergency operation, escape signs which feature the correct colour values for the safety and contrast colour as required by DIN EN 1838 must be used.

Effectiveness

Emergency powered luminaires operate regardless of the operational status of the general lighting. Photoluminescent materials, on the other hand, need to be sufficiently and continuously charged ahead of an emergency. Today’s energy-saving and lighting control systems (using time and motion-controlled luminaires) mean that this is not always the case. Not all lamps are suitable sources for charging on account of their spectrum (e.g. high-pressure sodium vapour lamps and some LEDs). The excitation illuminance and excitation spectrum should therefore always be measured and their effectiveness tested as recommended by ASR A3 4/3.

Luminance

Luminaires should emit a constant luminance level for the entire duration of operation. The impression of brightness created by a photoluminescent sign, however, diminishes within minutes. After 60 minutes of operation, the luminance of an escape sign luminaire is up to a thousand times greater than that of a photoluminescent sign.

Recognition distance

As the luminance of an escape sign decreases so, too, does visual acuity and identifiability. A 20 centimetre-tall illuminated escape sign is still clearly recogniza-

ble from a distance of 20 metres. An escape sign luminaire of the same height achieves the same degree of recognizability at twice that distance: it can be easily discerned from a distance of 40 metres. By contrast, the afterglow of a similarly sized photoluminescent sign weakens so fast that the recognition distance usually decreases to around five metres within 10 minutes. After 60 minutes, the content of the sign can generally be discerned only from immediately in front of it.

Photoluminescent signs

Photoluminescent signs have one disadvantage in comparison to illuminated escape signs: they need to be sufficiently and constantly illuminated before the emergency occurs. Despite receiving this excitation light, the time during which a photoluminescent sign is identifiable is limited. Its luminance – i.e. its brightness as perceived by the human eye – quickly diminishes. So the distance from which it is recognized decreases.

licht.de points out that, where a risk of accident exists, optical safety guidance systems may be used only to supplement signage and safety lighting with escape sign luminaires. Optical systems are mandatory – again as a supplementary measure – where the risk of smoke cannot be ruled out in the event of fire, and escape routes are wider than 3.6 metres.

„Photoluminescent safety guidance systems do not meet the colour rendering or illuminance requirements. They can only be used in conjunction with a standard-compliant safety lighting system, e.g. as floor markings, or as a supplementary safety measure in areas where safety lighting is not required.“

Runner 68 in Opfermann, Streit, Pernack commentary on the 2004 German Workplace Ordinance (ArbStättV)

[24] Escape sign luminaire in maintained operation

[25] ... 10 minutes after a power failure;

[26] ... 30 minutes after a power failure;

[27] ... minutes after a power failure. The minimum luminance of the white contrast colour is 10 cd/m², as required by DIN EN 1838.

[28] Standard photoluminescent sign exposed to a charging light source

[29] ... 10 minutes after a power failure;

[30] ... 30 minutes after a power failure;

[31] ... 60 minutes after a power failure. The minimum luminance of the white contrast colour is 0.012 cd/m², as required by ASR A3.4/3.



Optical safety guidance systems are covered in detail in licht.forum 57.



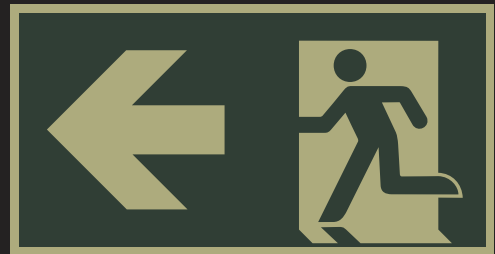
24



28



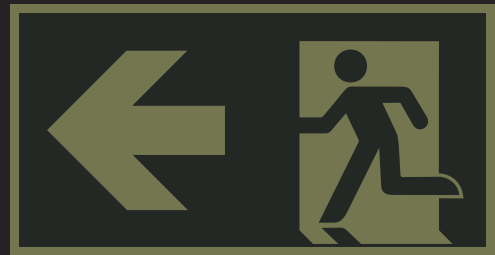
25



29



26



30



27



31

Luminaires for safety lighting systems

Safety lighting is safe only if the luminaires used are of the highest quality. Standard-compliant products and professional installation protect lives. This chapter provides information on luminaire types, classification and labelling.

CE marking, mandatory

The CE mark is not a test symbol but is mandatory for products marketed within the EU. In applying it, manufacturers and importers confirm that their products meet the “basic requirements” of various relevant EU directives. These include, for example, the Low Voltage and EMC directives. Manufacturers and importers must furnish evidence of conformity to the relevant authorities on request.

The design and operational reliability requirements for safety luminaires are set out in DIN EN 60598-1 “Luminaires – General requirements and tests”, DIN EN 60598-2-22 “Particular requirements – Luminaires for emergency lighting” and DIN EN 62034 “Automatic test systems for battery powered emergency escape lighting”.

ENEC test mark, optional

The ENEC mark (ENEC = European Norm Electrical Certification) shows that luminaires and built-in power supply units comply with current standards. The number after the mark identifies the test and certification institute responsible. In Europe, there are several independent institutes which test the products according to ENEC regulations. This also includes regular monitoring of the manufacturing of a product. (Figure 10 in the example stands for VDE).

Labelling of safety luminaires

For standard compliance, all safety luminaires need to be labelled in a particular way. A rectangular bar divided into three or four sections provides coded information on type (single battery or central supply), operating mode (e.g. 0 for safety luminaires

[32 – 35] The CE mark is required for all products placed on the market in the EU. In addition, all safety luminaires must be labelled in compliance with the standards.

Labelling of safety luminaires

Field 1: Design

The first field on the rating plate contains a letter of the alphabet indicating the design of the unit.

- X = with built-in single battery
- Z = for central power supply systems

Field 2: Operating mode

The second field on the rating plate contains a numeral indicating the operating mode of the unit.

- 0 = emergency luminaire in non-maintained operation
- 1 = emergency luminaire in maintained operation
- 2 = combined emergency luminaire in non-maintained operation
- 3 = combined emergency luminaire in maintained operation
- 4 = main/satellite emergency luminaire in non-maintained operation
- 5 = main/satellite emergency luminaire in maintained operation
- 6 = satellite emergency luminaire

Field 3: Equipment

The third field contains seven positions identifying the equipment. If necessary, code letters are added on installation.

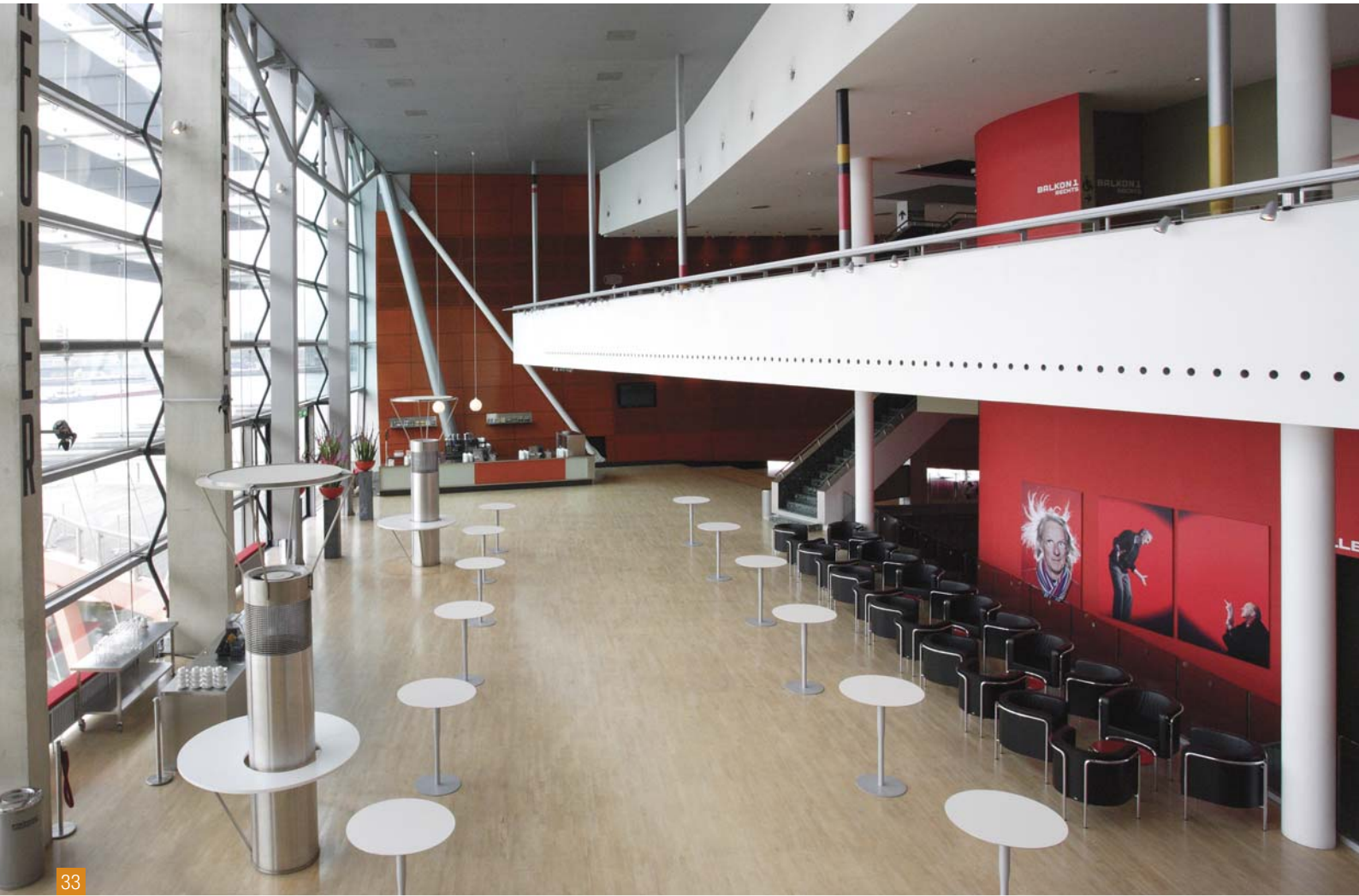
- A = includes test system
- B = includes remote control for idle time
- C = offers possibility of remote deactivation
- D = luminaire for particularly hazardous workplaces
- E = luminaire with non-replaceable lamp(s) and/or battery
- F = power supply unit with automatic test system as per IEC 61347-2-7, marked with EL-T
- G = internally illuminated safety sign

Field 4 (for emergency luminaires with single batteries)

The fourth field applies only to emergency luminaires with single batteries. It contains three positions and provides information about the maximum duration of emergency operation.

- 10 = for a specified operating time of 10 minutes
- 60 = for a specified operating time of 1 hour
- 120 = for a specified operating time of 2 hours
- 180 = for a specified operating time of 3 hours





33



34



35



36

Caution with retrofitting

If an existing system is retrofitted, the question arises of responsibility for the conformity of the retrofitted luminaires and the technical and safety-related consequences.

This also applies to the retrofitting or conversion of general lighting luminaires (Variant B/ Fig. 38) to luminaires with other components, such as for example the installation of:

- emergency EBs to reduce luminous flux and energy consumption in emergency operation,
- changeover modules for switching between mains and emergency power supply,
- individual battery packs as an emergency power source for the luminaire in the event of a power failure,
- LED retrofits or conversion LED lamps.

The conformity assessment (including the CE mark and any mark on the original luminaires) applies to the state of the product at the time of being placed

on the market and thus within the framework of the intended use as defined by the luminaire manufacturer, including the intended luminaire types. Both are normally described in datasheets or manuals.

A conversion constitutes a significant change to the luminaire which makes it a "new product".

Also, the photometric characteristics of the luminaire must be retained because of the safety aspect if an existing luminaire is converted to an LED retrofit or if conversion LED lamps are used.

The operator, or the party appointed by him to perform the conversion, is obliged to conduct the work professionally, using state-of-the-art technology to ensure the safety and electromagnetic compatibility (EMC) of the equipment. If necessary, evidence must be provided in the form of appropriate documentation. The type plates should be updated in all cases.

in non-maintained operation), built-in equipment (e.g. test system) and rated operating time in minutes. In the case of single-battery luminaires, for example, this is 60 for an operating time of one hour (see also Fig. 32).

This manufacturer-independent label needs to be affixed to the luminaire at a clearly visible point; labelling inside the luminaire is also permitted in the case of recessed luminaires. Supply voltage and IP class must also be indicated. The latter shows how well the luminaire's electrics are protected against touch, foreign particles (e.g. dust) and the ingress of water. The type plate also indicates the IK rating (impact resistance) of the housing and the luminous flux of the luminaire in emergency operation.

The example below shows the label of a single-battery luminaire in maintained operation with test system and remote control for standby mode. The operating time must be entered by the installer.



Example of a central battery luminaire in non-maintained/maintained operation:



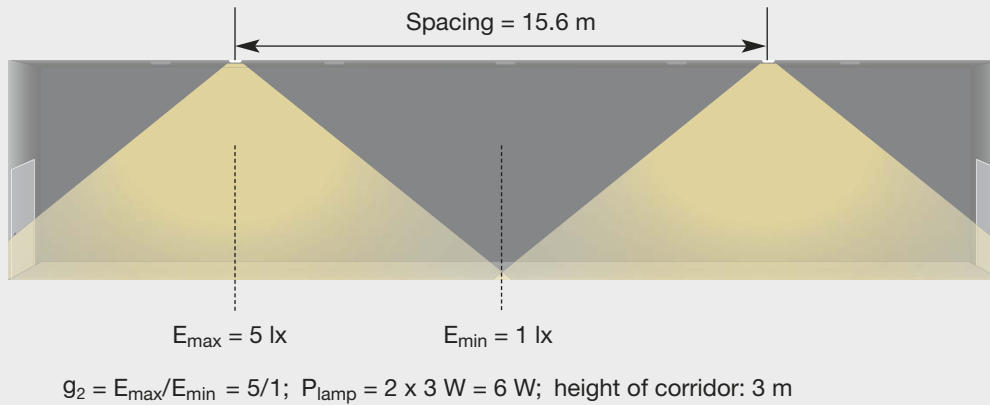
Quality luminaires and LEDs

A quality luminaire for safety lighting needs to qualify for a safety test symbol and meet the following criteria:

- reliable performance in an emergency,
- tailored light distribution to ensure optimal illumination of the escape sign or escape route,
- efficient low energy consumption during mains and emergency operation,
- easy mounting and maintenance with correspondingly low costs
- end-of-life recyclability.

Safety luminaires and escape signs are frequently in 24-hour operation. Here, long-life LED solutions are increasingly the option of choice. Low-load LED systems achieve very long lifespans assuming effective ther-

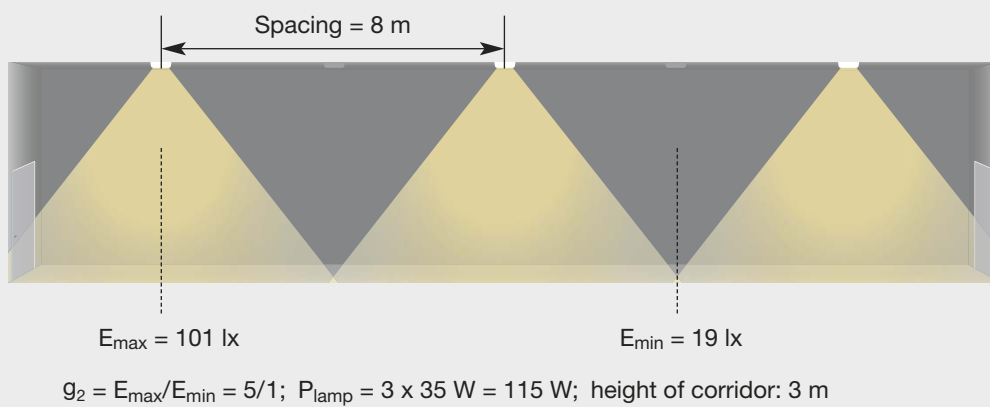
Variant A: dedicated LED safety luminaires



37 © licht.de



Variant B: general lighting luminaires as safety luminaires



38 © licht.de



mal management and the use of high-quality power supply units. This results in lower maintenance costs and helps save energy. In addition, the compact dimensions of LEDs permit visually unobtrusive escape sign luminaires of formally reduced design. To achieve optimal efficiency with LED luminaires, supplementary optics and reflectors may be required so that the number of luminaires installed can be reduced – while still ensuring that normative requirements are met.

Safety lighting variants

Escape routes require both escape signs for identification and safety luminaires for illumination. The required illumination can be realized in two ways:

- using dedicated safety luminaires with beam spreads tailored for the task
- with luminaires which are normally used for general lighting and which act as safety luminaires in the event of a power failure.

Dedicated safety luminaires (**variant A**, see Fig. 37). perform best. They satisfy all quality criteria:

- light is distributed in a wide-angled beam.
- the required uniformity is achieved even with luminaires at widely spaced mounting points.
- the power consumption of the lamps used – e.g. high-performance LEDs – is low.

Because installing separate safety luminaires means additional installation costs, some operators favour dual-purpose luminaires that provide both general and safety lighting – **Variant B** (see Fig. 38).

The disadvantages:

- These luminaires are not designed specifically for safety lighting as specified in DIN EN 1838, meaning that their light distribution is not optimized for illuminating escape routes.
- These luminaires also need to be more closely spaced to achieve the required lighting uniformity.
- Energy consumption – and therefore the emergency power capacity required – is also many times higher than in the case of Variant A.

[36] Escape sign and safety luminaires in operation after a power failure

[37] Safety lighting with dedicated safety luminaires

[38] The luminaires are general lighting lamps which are used as safety luminaires.

Selection, installation and operation

Safety lighting is mandatory wherever people are present in large numbers. Its moment comes when mains voltage fails. Safety lighting then needs to be activated immediately by a back-up power source.

Standby energy is obtained from a “power source for safety services”. Its purpose is to supply parts of an electrical safety system, including e.g. safety lighting. Suitable sources for standby energy are battery systems, generating sets or two separate and independent mains feeds. If only one power source is available for safety services, it must not be used for other purposes (ASR A3.4/3 para. 6.6).

Engineers make a distinction between a “power source for safety services” and a “standby power source”. The latter term also denotes a back-up source for supplying an electrical system in the event of a power failure; in this case, however, the power supply is not maintained for safety purposes.

Power source for safety services

Battery-powered central supply systems need to comply with DIN EN 50171, single battery luminaires with DIN EN 60598-2-22 and generating sets with DIN 6280-13 and

DIN 6280-14. Where separate and independent mains feeds are used, evidence needs to be furnished that the two power sources cannot fail simultaneously. This requires confirmation by the network operator.

Luminaires for safety lighting can be operated in three modes:

- Non-maintained operation – The safety luminaires are activated only in the event of a power failure. This mode may be used for escape route lighting in all types of building.
- Maintained operation – The safety luminaires are permanently activated. With few exceptions, maintained operation is the only option allowed for escape sign luminaires.
- Switched maintained operation – The safety luminaires are activated and deactivated with the general lighting luminaires.

The switch-over from normal operation to the power source for safety lighting must

trigger if the line voltage falls 40 % below the nominal rated voltage for more than 0.5 seconds. When mains power returns, the luminaires in non-maintained operation must be automatically deactivated. At the same time, it needs to be ensured that the general lighting switches automatically to the required brightness. Otherwise, the safety lighting should be automatically deactivated only after an appropriate reset delay or, in rooms that are darkened for operational reasons (e.g. in cinemas), should be deactivated manually by a reset button.

Batteries

In line with the German Battery Act (BattG – Act Concerning the Placing on the Market, Collection and Environmentally Compatible Waste Management of Batteries and Accumulators), spent disposable and rechargeable batteries need to be treated as recyclable waste. These batteries, displaying both the recycling symbol and the crossed-out waste bin, must not

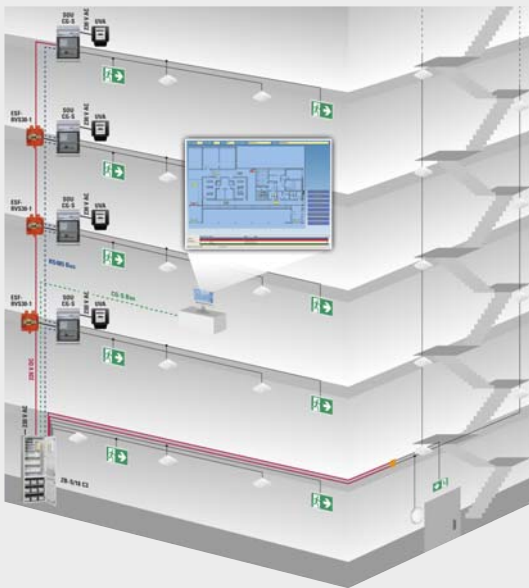
	Battery power supply
Central power supply system with non-limited output (CPS)	Any battery voltage, preferably 216 V Lead: 2.0 V/cell Design life: 10 years at 20° C ambient temperature
Central power supply system with limited output (LPS)	Any battery voltage, preferably 24 or 48 V Lead: 2.0 V/cell Design life: min. 5 years/recommended: 10 years at 20° C ambient temperature Max 1,500 W for 1 hour Max. 500 W for 3 hours
Single battery	Li-Ion: 3.6 V/cell NiMh: 1.2 V/cell NiCd: 1.2 V/cell Design life: 4 years



39



40



41



42



43

[39] Inter-fire compartment installation with central emergency power source (battery)

[40] Inter-fire compartment installation with central emergency power source (battery) and decentralized subdistribution

[41] Inter-fire compartment installation with central emergency power source (battery) and compartment-based installation of small subdistributors

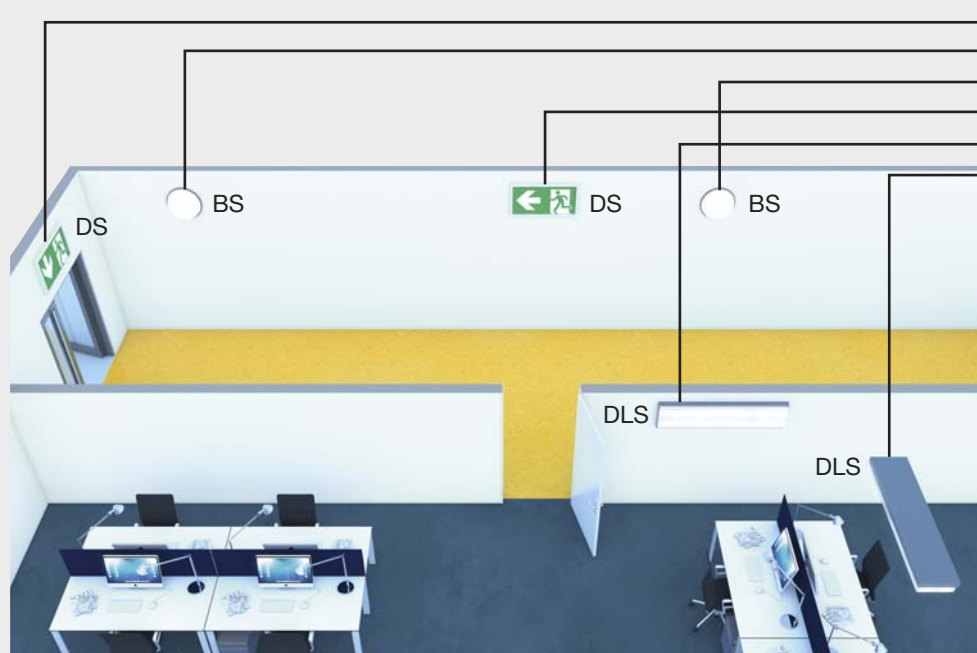
[42] Fire compartment-based installation of emergency power source (battery)

[43] Central battery system



44

Conventional installation



- Maintained light 1
- Non-maintained light
- Non-maintained light 2
- Maintained light 2
- Switched maintained light 1
- Switched maintained light 2

- Each type of switching mode requires two circuits
- Only one type of switching mode is possible per circuit
- Modifications later involve a considerable amount of installation work and expense

45

be disposed of as residual waste. They need to be collected separately, e.g. under the Joint Collection Scheme (Gemeinsames Rücknahmesystem für Gerätealtbatterien [GRS]) or under producer-specific collection schemes. Spent batteries are thus recycled and possible pollutants are recovered and can be made available for manufacturing operations.

Deep discharge protection prevents a battery being completely drained and thus damaged through use. When the minimum permissible voltage is reached, the consumer is automatically disconnected.

Power failure simulation

A power failure simulation test button or a connection to a remote test system needs to be located on every single-battery luminaire or on the central power source for safety services. Manually operated test buttons must automatically return to their original position.

Status displays

Status displays and monitoring devices depend on the type of emergency lighting system installed. An indicator light shows when single-battery luminaires are being charged. For central battery systems, vari-

ous status displays are required to provide information on battery voltage, charging current, load current, power source and malfunctions.

Special features

A central remote control facility prevents batteries for single-battery luminaires and central supply systems being drained when idle. Safety lighting management and BUS systems need to operate independently of management and BUS systems for general lighting (cf. e.g. DIN V VDE V 0108-100, section 4.5).

Inspection, maintenance and overhaul of safety lighting

The law states that all safety systems must be inspected, maintained and overhauled at regular intervals. And safety lighting is no exception because, depending on the premises concerned (e.g. a non-daylit stairwell), even the failure of a single safety or escape sign luminaire presents a serious risk of accident. In the event of damage, the operator bears the burden of proof concerning the proper condition and operation of this safety installation.

Equipment may only be inspected, maintained and overhauled by specialist person-

[44] Regular review, maintenance and overhaul of the safety lighting required by law.

All switching modes in a single circuit (mixed mode)



All switching modes
All switching modes

- Only two outgoing circuits for all types of switching mode
- Maintained light, non-maintained light and switched maintained light are possible in one common circuit
- A change of switching mode later is easily possible.

nel according to DIN VDE 0105-100, DIN VDE 1000-10 or the Technical Regulations for Operational Safety (TRBS) 1203.

Therefore, we recommend having this work carried out by the manufacturer of the safety lighting system.

The safety lighting inspection regime must include the following:

- Daily visual examination of the central power supply unit,
- In the case of a battery-based system, at least weekly inspection of the safety lighting with the power source for safety services connected. A function check needs to be carried out on every luminaire (individual luminaire monitoring);
- Monthly power failure simulation to check the changeover to the power source for safety services. During the simulation, a function check needs to be carried out on every luminaire (individual luminaire monitoring). Generating sets additionally need to be inspected in accordance with DIN 6280-13.
- Annual check of the power source for safety services over the entire rated operating time with all connected consumers activated. Generating sets additionally need to be inspected in accordance with DIN 6280-13 and batteries in accordance with DIN EN 50272-2.
- Logs of the regular inspections need to be kept to permit retroactive monitoring over at least four years. This can be done in the form of a handwritten log or with the aid of an automated test system according to DIN EN 62034 (see ZVEI "Automatic Test Systems" position paper).

The operator of the facility must designate a person who is responsible for keeping the test log.

It thus makes sense to incorporate the results of the automated weekly and monthly checks in a detailed centralized visualization.

Central monitoring systems

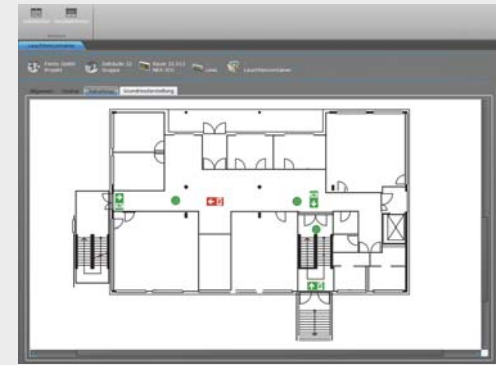
Depending on the manufacturer, the signals from individual monitored luminaires are transmitted via a special BUS line or directly via the power supply line.

Where the power supply line provides the link, special electronic ballasts (EBs) transmit a noise-free pulse straight to a central monitoring unit integrated in the power source for safety services. Where standard EBs are used, this task can be performed by a separate monitoring module in the luminaire.

The central monitoring system thus enables the functional status of luminaires, including a description of their location, cable routes, subdistribution boards and battery systems to be presented in a visual display. Depending on the design of the monitoring system, the display can include a plan of the building with a graphic representation of each individual luminaire. A standard-compliant electronic log of the automatic verifications carried out is maintained at this central location. Even remote monitoring via intranet or Internet presents no problems.

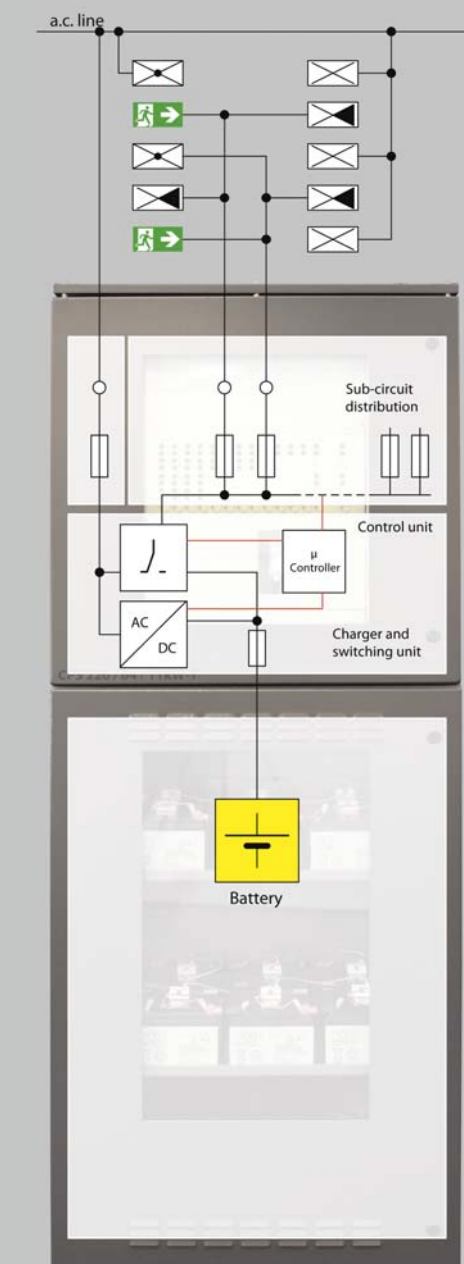
In larger buildings, central monitoring of all luminaires is recommended for reasons of economy. Reputable manufacturers offer systems which can be adapted on a project by project basis to suit the number and type of luminaires deployed as well as the power source for safety services used.

Floor plan



47

Block diagram



- Escape sign luminaire
- Safety luminaire
- Switched safety luminaire
- General lighting

48

[47] Some software systems also include a ground plan for quick orientation, including luminaire status.

[48] The monitoring data from the luminaires is transmitted via a special BUS line or directly via the power supply line.



49

Building regulation requirements for safety lighting and its implementation

All ordinances, guidelines and regulations require safety lighting if there is a foreseeable risk of accident in the event of a general lighting failure.

Ordinances, guidelines and regulations set out only minimum (although legally binding) requirements. All experts agree, however, that safety lighting should be installed wherever there is a risk of accident.

In Germany, safety lighting is governed by the building regulations of the federal states. They stipulate where safety lighting needs to be installed. In certain cases, additional requirements may need to be met to secure planning permission, or other official approvals and expert opinions may need to be obtained, e.g. on fire protection or panic risk.

The application examples on the following pages present solutions based on model ordinances and guidelines whose contents may differ from the federal state ordinances

and guidelines in force. They are also based on the DIN EN 1838 standard, which applies throughout Europe, as well as the pre-standard DIN V VDE V 0108-100, which is also advisable to observe.

Places of assembly

The Model Ordinance Governing Places of Assembly (MVStättV) adopted in July 2014 defines places of assembly as facilities or parts of facilities built to accommodate large numbers of people simultaneously attending events – especially educational, commercial, social, cultural, artistic, political, sports or entertainment events – as well as catering establishments. Sports facilities (see page 38) and restaurants (page 40) are dealt with separately in this booklet because they each have additional requirements.

[49] Escape route marking and safety lighting in places of assembly reduce the risk of accidents in the wake of a general lighting failure.



A place of assembly may also consist of a number of assembly rooms where these are connected within a building by doors or shared escape routes. Areas that are not accessible to visitors are not included in the calculation.

The MVStättV covers

- assembly rooms which singly or jointly accommodate at least 200 persons, e.g. assembly halls, foyers, lecture theatres, cinemas and studios, but not school classrooms;
- places of assembly for at least 1,000 persons with open performance areas (areas less than 20 m² are not classed as performance areas);
- sports stadiums accommodating more than 5,000 spectators with stands for visitors and with non-roofed sports areas (see page 38).

The MVStättV does not cover rooms reserved for religious services, museum exhibition rooms or temporary buildings.

Visitor numbers are calculated on the basis of established formulas:

- for seating at tables: one visitor per m² of assembly room floor area
- for seating in rows and for standing space: two visitors per m² of assembly room floor area
- for standing space on terraces: two visitors per metre of terrace length
- for exhibition rooms: one visitor per m² of assembly room floor area.

Safety lighting

Safety lighting needs to be provided

- in necessary stairwells, in rooms between necessary stairwells and external exits, and in necessary corridors;

- in assembly rooms as well as in all other rooms for visitors (e.g. foyer, cloakroom, toilets);
- for stages and performance areas;
- in rooms for participants and employees with a floor area of more than 20 m², excluding offices;
- in electrical operating areas, in rooms for building service installations as well as in lighting and projector rooms;
- in outdoor places of assembly and sports stadiums used at night;
- for safety signs marking exits and escape routes;
- for step lighting, but not in the case of corridors in assembly rooms with changeable seating configurations or in the case of sports stadiums with safety lighting.

In assembly rooms that are darkened for operational purposes, on stages and in performance areas, safety lighting needs to be available in non-maintained operation.

What DIN VDE 0108 set out as a mandatory requirement is still recommended (DIN V VDE V 0108-100): non maintained safety lighting should not automatically switch off when mains power returns. Systems installed in rooms that are darkened for operational purposes are required to have a manual reset on the safety lighting control panel and at another point in the control room. The safety lighting in intentionally darkened rooms should not be deactivated until sufficient general lighting has been restored.

Exits, corridors and steps in an assembly room must be identifiable even when the room is darkened, regardless of whether other safety lighting is activated or not.

[50] A place of assembly may also consist of a number of assembly rooms where these are connected within a building by doors or shared escape routes.

[51 – 53] Standards-compliant safety lighting is required in exhibition halls and cinemas.





54



55

Sport facilities

Sports facilities fall within the scope of the Model Ordinance Governing Places of Assembly (MVStättV) adopted in July 2014. Sports stadiums are places of assembly with stands for visitors and non-covered areas for sporting activities. The MVStättV applies to sports stadiums designed to accommodate more than 5,000 visitors.

Because the distinction between 'sport' and 'performance' is becoming increasingly blurred, the requirements may also apply to outdoor sports facilities if they

- are designed to accommodate more than 1,000 visitors,
- feature performance areas and
- have a visitor area consisting entirely or partly of built structures.

Visitor areas bounded by barriers consist "entirely or partly of built structures" and thus fulfil this criterion.

Safety lighting

Sports facilities are governed by the requirements of the MVStättV, but also by DIN EN 12193. This standard requires safety lighting for participants in sporting events.

The safety of participants is assured if an event can be brought to an orderly conclusion. Ending it without lighting entails considerable risk of accident. The safety lighting thus required needs to respond instantly.

The level of prescribed safety lighting depends on the type of sport in question; it is

expressed as a percentage of the lighting level normally required for the sport:

- swimming – five per cent for at least 30 seconds
- gymnastics, indoor facility – five per cent for at least 30 seconds
- equestrian sports, indoor and outdoor facility – five per cent for at least 120 seconds
- speed skating – five per cent for at least 30 seconds
- bobsleigh and luge – ten per cent for at least 120 seconds
- ski-jumping, take-off and landing zone – ten per cent for at least 30 seconds
- downhill skiing – ten per cent for at least 30 seconds
- cycling (track racing) – ten per cent for at least 60 seconds.

Swimming pools

The Pool Construction Guideline (2013) requires safety lighting to provide 15 lux illuminance at the water surface in swimming pools with a depth of 1.35 m or more.

The latest version of health and safety rule BGR/GUV-R 107-001 “Operation of Pools” from June 2011 requires safety lighting that delivers one per cent of the illuminance of the general lighting – but no less than one lux – where there is a potential risk of accident in the event of a failure of the general lighting. It applies, for example, in indoor pools, at pool edges, in shower and changing rooms, in plant rooms, along escape routes of course, on spectator stands and in outdoor pool plant rooms if safe evacuation of the plant room is not guaranteed in the event of a failure of the general lighting.

[54 + 55] Safety lighting for sports facilities falls within the scope of the Ordinance Governing Places of Assembly as well as DIN EN 12193.

[56] Swimming pools in Germany need to operate in compliance with the Pool Construction Guideline (Richtlinie für den Bäderbau) as well as BGR/GUV-R 107-001 from 2011-06.





57

Restaurants and bars

The Model Ordinance Governing Places of Assembly (MVStättV) adopted in July 2014 also covers catering establishments such as bars or restaurants accommodating more than 200 guests which need to meet the same safety lighting requirements as other places of assembly (see page 35).

The number of guests that can be accommodated is calculated on the basis of the following formulas:

- for establishments with seating: one visitor per m² of public room floor area (excluding counter area); i.e. from 200 m² floor area upwards.
- for establishments with standing space, e.g. discotheques: two visitors per m² of floor area, i.e. from 100 m² floor area upwards.

Safety lighting

Safety lighting needs to be provided

- in necessary stairwells, in rooms between necessary stairwells and external exits, and in necessary corridors;
- in public rooms as well as in all other rooms for visitors, e.g. foyer, cloakroom and toilets;
- in rooms for operators and staff with a floor area of more than 20 m², excluding offices;
- in electrical operating areas and in rooms for building service installations;
- in outdoor bars and restaurants that are used at night;
- for safety signs marking exits and escape routes;
- for step lighting, but not in the case of corridors in public rooms with flexible seating configurations.

[57] Bars and restaurants are places of assembly; as such, they are also covered by the MVStättV.



Accommodation establishments

The Model Ordinance Governing Accommodation Establishments (MBeVO) adopted in May 2014 defines accommodation establishments as all buildings with more than 12 beds for guests. The MBeVO does not apply to accommodation establishments in high-rise buildings (see page 45).

Safety lighting

Safety lighting needs to be provided

- in necessary corridors and necessary stairwells;
- in rooms between necessary stairwells and external exits;
- for safety signs indicating exits, and
- for steps in necessary corridors.

DIN V VDE V 0108-100 requires that where the rated operating time of the power

source for safety services is only three hours, switched maintained operation should be provided in conjunction with illuminated pushbutton switches and timed lighting. The safety lighting must automatically switch off after the pre-defined time has elapsed.

If this is not the case, the capacity of the power source for safety services needs to be designed for eight hours operation.

[58 + 59] Accommodation establishments: safety lighting is required for all buildings with more than 12 beds for guests.



60

Sales premises

Sales premises – often referred to as stores in earlier standards – are defined in the Model Ordinance Governing Sales Premises (MVkVO) adopted in July 2014 as buildings or parts of buildings which

- are used wholly or partially for the sale of merchandise,
- have at least one salesroom and
- are not trade fair buildings.

The MVkVO covers all sales premises (retail and wholesale), including department stores, supermarkets or shopping centres which incorporate salesrooms and shopping streets (including their built structures) with a total area of more than 2,000 m². Shopping streets are defined as enclosed or covered areas that are flanked by salesrooms and act as circulating areas for shoppers.

Safety lighting is also mandatory in Austria for sales premises with a total area of more than 2,000 m².

General regulations apply, however, in Belgium, Finland and Sweden. A European comparison shows that Germany rarely stipulates safety lighting, and the limits



61

above which safety lighting is required are relatively generous.

Safety lighting

Safety lighting needs to be provided up to the public thoroughfares:

- in salesrooms and all other rooms over 50 m² for visitors,
- in necessary stairwells, in rooms between necessary stairwells and external exits and in necessary corridors;
- in rooms for employees with a floor area of more than 20 m² (excluding offices),
- in toilet facilities with a floor area of more than 50 m² (in toilet facilities of any size in Bavaria and Brandenburg);
- in electrical operating areas and in rooms for building service installations;
- for signs indicating exits and for step lighting.

Schools

The Model Guideline for School Buildings (MSchulbauR) adopted in April 2009 applies to general and vocational schools, provided they are not used exclusively for adult education. However, the guideline does not cover universities, higher technical colleges, academies, adult education centres, music, dance or driving schools or

educational establishments of a comparable nature.

Safety lighting is required in halls through which escape routes run, in necessary corridors, necessary stairwells and windowless common rooms.

Hospitals

There are only few specific requirements for hospitals in the building codes of the federal Länder; accordingly attention is drawn here to DIN VDE 0100-710. DIN VDE 0100-710 requires safety lighting for various areas in hospitals and clinics, sanatoria and convalescent hospitals, medical centres, polyclinics, outpatient centres, in areas for medical treatment, in retirement and nursing homes and in outpatient facilities (for occupational health, sports and other physicians).

Safety lighting is necessary for

- escape routes,
- rooms with switch and control gear for safety generator sets, for main distribution boards, and for main distributors of the power source for safety services,
- rooms where vital services are maintained,

- Group 1 and 2 rooms: Group 1 rooms include examination and treatment rooms, Group 2 rooms are operating theatres and intensive care units. For some of the luminaires, at least two different power sources need to be available with two circuits; one of the circuits must be connected to the power source for safety services. In Group 2 areas, at least 50 per cent of the lighting equipment must be supplied by the safety lighting system.
- Central fire alarm system and monitoring equipment points.



62

[60] Safety lighting is required for sales premises with an area of more than 2.000 m².

[61] The Model Guideline for School Buildings (MSchulbauR) applies to general and vocational schools.

[62] In some federal states there are further requirements for hospitals and clinics in addition to those stipulated in DIN VDE 0100-710.



Tall and high-rise buildings

The Model Building Regulations (MBO) adopted in September 2012 define high-rise buildings as buildings which are higher than 22 metres. "Height" is measured from the ground level to the finished floor level of the highest storey suitable for accommodation.

Safety lighting

The MBO requires safety lighting for interior staircases in buildings of a height of 13 metres or more [§ 35 (7)].

The Model Guideline for High-Rise Buildings (April 2008) also requires safety lighting (in addition to escape routes and safety signs) for elevator lounges.

In high-rise residential buildings, DIN V VDE V 0108-100 requires that where the rated operating time of the power source for safety services is only three hours, switched maintained operation should be provided to-

gether with illuminated pushbutton switches and timed lighting. The safety lighting must automatically switch off after the pre-defined time has elapsed. Otherwise, the capacity of the power source for safety services needs to be designed for eight hours operation.

Aside from these stipulations, various federal states in Germany have regulations setting out special or more stringent requirements for high-rise buildings.


Enclosed parking facilities

The Model Ordinance Governing Parking Facilities (MGarVO) adopted in May 2008 requires safety lighting for all indoor parking facilities with a net area of more than 1,000 m² except for single-storey parking facilities with regular users. The net area of a parking facility is the sum of all interconnecting parking spaces plus circulation areas.

Escape routes generally include:

- driving lanes

- pathways alongside vehicle entrances and exits
- staircases and routes leading to pedestrian exits.

 Regarding the combination of escape signs and direction indications, see also pages 22 and 47.

[63] High-rise buildings (over 22 metres high) require safety lighting regardless of whether they are designed for office or residential occupancy.

[64] Safe parking: safety lighting is required for enclosed parking facilities (> 1.000 m² net area).



Requirements to be met by electrical installations for safety lighting

according to DIN V VDE V 0108-100 (prestandard)

Application of this prestandard is recommended by UK 221.3 of the DKE.

Examples of communal facilities	Requirements										
	Illuminance, lx	Switch-over time, s max.	Rated operating time of power source for safety services, in h	Illuminated or back-lit safety signs in maintained operation	Central power supply system – CPS	Power supply system with limited output – LPS	Single-battery system	Generating set, no interruption (0 s)	Generating set, short interruption ($\leq 0,5$ s)	Generating set, moderate interruption (≤ 15 s)	Specially secured network
Places of assembly (excluding temporary buildings), theatres, cinemas	2)	1	3	•	•	•	•	•	•	–	–
Temporary buildings used as places of assembly	2)	1	3	•	•	•	•	•	•	–	–
Exhibition halls	2)	1	3	•	•	•	•	•	•	–	–
Sales premises	2)	1	3	•	•	•	•	•	•	–	–
Restaurants	2)	1	3	•	•	•	•	•	•	–	–
Accommodation establishments, residential homes	2)	1 1)	8 5)	•	•	•	•	•	•	•	–
Schools	2)	1 1)	3	•	•	•	•	•	•	•	–
Indoor car-parks, underground parking facilities	2)	15	1	•	•	•	•	•	•	•	–
Airports, railway stations	2)	1	3 6)	•	•	•	•	•	•	–	–
High-rise buildings	2)	1 1)	8/3 4)	•	•	•	•	•	•	•	–
Escape routes on work premises	2)	15	1	• 7)	•	•	•	•	•	•	•
Particularly hazardous workplaces	2)	0,5	3)	•	•	•	•	•	•	–	•
Stages	3	1	3	•	•	•	•	•	•	–	–

1) From 1 to 15 second(s), depending on panic risk

2) Safety lighting illuminance acc. to DIN EN 1838

3) Duration of risk for persons present

4) 8 hours (h) for high-rise residential buildings if not operated acc. to 4.4.8

5) 3 h sufficient if operated acc. to 4.4.8

6) 1 h also permissible for overground areas of stations, depending on evacuation concept

7) Not required for escape routes on work premises

• = permissible – = not permissible

Note: Operation acc. to 4.4.8 DIN V VDE V 0108-100 – In high-rise buildings as well as in accommodation establishments and residential homes, safety lighting in maintained operation is required to be operated with the general lighting if the rated operating time of the power source for safety services acc. to Table A.1 is only 3 hrs. Illuminated pushbutton switches must be installed for local switching and positioned so that at least one switch is identifiable from any point in the event of a general lighting failure. The safety lighting must switch off automatically after a pre-set time of being supplied by the power source for safety services.

Up or down?

There are currently moves to establish internationally standardized markings for the direction of escape. Trade associations have proposed an addition to the recommendations.

“Arrow down” has traditionally been used successfully to mark escape route doors and to identify emergency exits, but also to indicate the escape direction of straight ahead and down. There is no binding definition of the direction of the arrow at present. The international, non-binding (in Germany) ISO 16069:2003 Safety Way Guidance Systems or the German briefing paper DIN SPEC 4844-4 are now proposing to mark the escape routes instead with “arrow up”.

However, use of the “arrow up” can lead to confusion in some cases. For example: if the corridors in a six-storey office building are also part of the marked escape route, the doors to the stairwell at the end of these corridors must be marked with an escape sign. In five of the storeys this means that the ISO 16069 safety signs

with the additional “arrow up” sign would have to be used, despite the fact that the escape route leads down to the ground floor. This could be fatal in an emergency: people trying to escape could go up rather than down in their attempt to reach safety.

ZVEI recommendation

The ZVEI therefore proposes a supplement to the ISO 16069/DIN 4844-4 Spec system: The significance of “arrow down” should be supplemented by two further points: Firstly the additional meaning of “go straight ahead” and secondly the definition “go straight ahead and through a door if the sign is attached above a door”.

 The ZVEI position paper “Marking of escape direction” published in 2016 deals with this topic comprehensively.

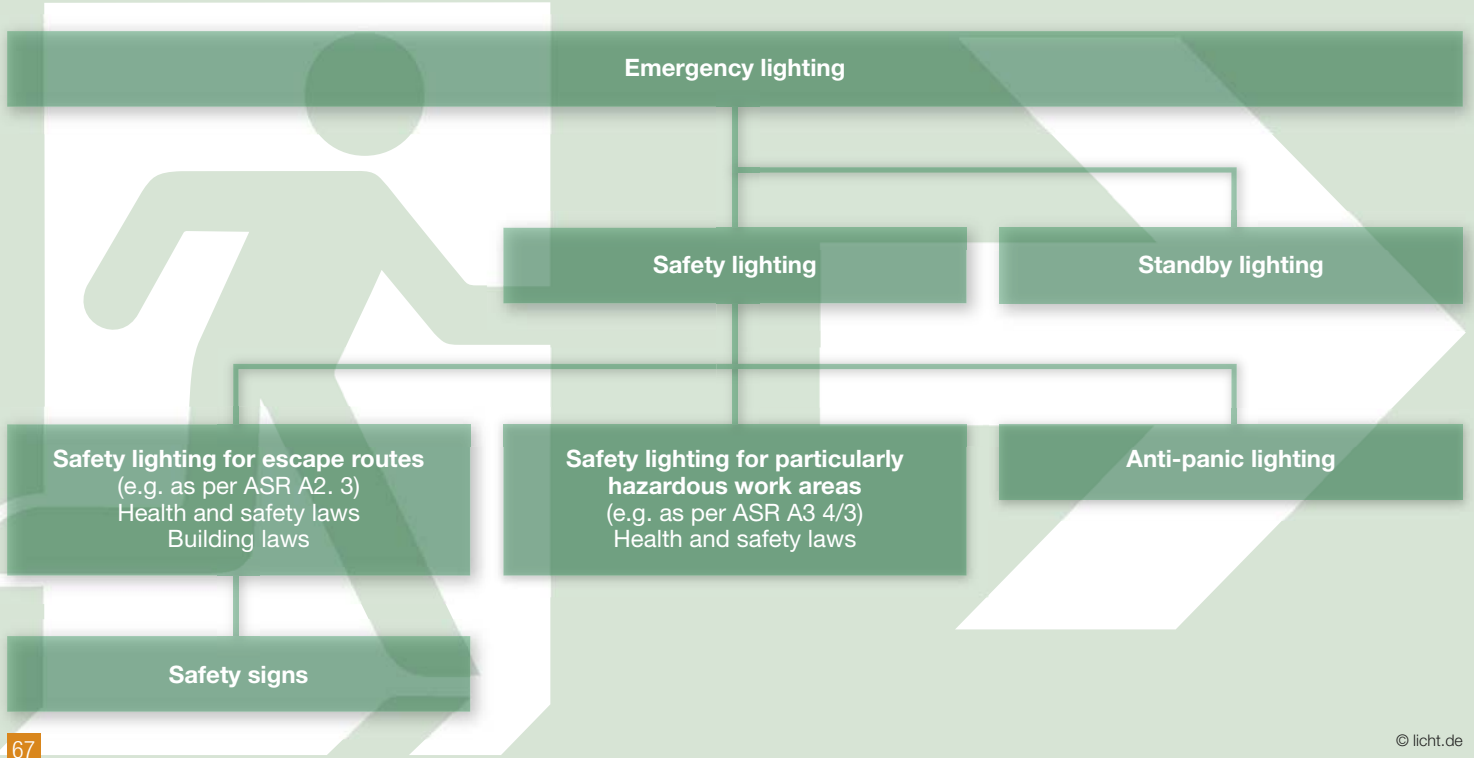
Regarding the combination of escape signs and direction indications, see also page 22.

[65] This example illustrates how easily confusion can arise if the arrow up sign is used although the escape route is actually downwards.

[66] In buildings with several storeys, the “arrow down” sign makes an unambiguous statement.



Overview of emergency and safety lighting



67

© licht.de

Standards and ordinances

Safety lighting ensures that a building can be evacuated swiftly in an emergency. The requirements that lighting installations need to meet are set out in standards and ordinances underlying building regulations and health and safety rules.

Technical regulations governing “Emergency lighting”

	Electrical	Non-electrical / Lighting
International	IEC	ISO / CIE
Europe	CENELEC	CEN
Germany	DIN / VDE	DIN

IEC = International Electrotechnical Commission

CENELEC = Comité Européen de normalisation Electrotechnique
(European Committee for Electrotechnical Standardization)

DIN = Deutsches Institut für Normung (German Institute for Standardization)

VDE = Verband der Elektrotechnik, Elektronik und Informationstechnik
(Association for Electrical, Electronic & Information Technologies)

ISO = International Organization for Standardization

CIE = Commission Internationale de L'Eclairage (International Commission on Illumination)

CEN = Comité Européen de Normalisation (European Committee for Standardisation)

Literature

Prof. Dr.-Ing. Bruno Weis, Dipl.-Ing. Hans Finke

Not- und Sicherheitsbeleuchtung, de-Fachwissen,
Hüthig & Pflaum Verlag, ISBN 978-3-8101-0310-9

Lighting requirements

ISO 30061; CIE S 020 (2007-11)	Emergency lighting
DIN EN 1838 (2013-10)	Lighting applications – Emergency lighting
DIN EN 13032-3 (2007-12)	Light and lighting – Measurement and presentation of photometric data of lamps and luminaires – Part 3: Presentation of data for emergency lighting of work places
DIN 5035-6 (2006-11)	Artificial lighting – Part 6: Measurement and evaluation
DIN 4844-1 (2012-06)	Graphical symbols – Safety colours and safety signs – Part 1: Observation distances and colorimetric and photometric requirements
DIN ISO 3864-1 (2012-06)	Graphical symbols – Safety colours and safety signs – Part 1: Design principles for safety signs and safety markings
DIN EN ISO 7010 (2012-10)	Graphical symbols – Safety colours and safety signs – Registered safety signs

Electrical requirements

DIN EN 50172 (2005-01)	Emergency escape lighting systems (VDE 0108 Part 100)
DIN V VDE V 0108-100 (2010-08)	Emergency escape lighting systems (Prestandard VDE 0108-100) Note: Application of this prestandard is recommended by UK 221.3 of the DKE.
DIN VDE 0100-710 (2012-10)	Erection of low-voltage installations – Requirements for special installations or locations – Part 710:
DIN VDE 0100-560 (2013-10)	Low-voltage electrical installations – Part 5-56: Selection and construction of electrical equipment – Safety services.
DIN EN 60598-1 (2015-10)	Luminaires – General requirements and tests (VDE 0711 Part 1))
DIN EN 60598-2-22 (2015-06)	Luminaires – Part 2-22: Particular requirements – Luminaires for emergency lighting (VDE 0711 Part 2-22) (IEC 60598-2-22)
DIN EN 50171 (2001-11)	Central power supply systems
DIN EN 50272-2 (2001-12)	Safety requirements for secondary batteries and battery installations
DIN EN 62034 (2013-02)	Automatic test systems for battery powered emergency escape lighting (IEC 62034:2006)

Occupational health and safety

ArbStättV (2004-08)	Workplace ordinance
ASR A1.3 (2013-02)	Technical workplace regulation on health and safety signs
ASR A2.3 (2007-08, geänd. 2014)	Technical workplace regulation on escape routes, emergency exits, escape and rescue plan
ASR A3.4/3 (2009-05, geänd. 2014)	Technical workplace regulation on safety lighting, optical safety guiding systems

Building regulations

MBO (2012-09)	Standard building regulations
MVStättV (2014-07)	Model ordinance governing places of assembly
MGarVO (2008-05)	Model ordinance governing parking facilities
MIndBauRL (2014-02)	Model guideline for industrial buildings
MBeVO (2014-05)	Model ordinance governing accommodation establishments
MSchulbauR (2009-04)	Model guideline for school buildings
MHHR (2008-04)	Model guideline for high-rise buildings
MLAR (2005-11)	Model guideline for conduction systems
MVkVO (2014-07)	Model ordinance governing sales premises
M-EitBauVO (2009-01)	Model ordinance on the construction of operations rooms for electrical installations

licht.de publications

Per issue!

€ 10,-



licht.wissen 01

Lighting with artificial light

The basic issue: licht.wissen 01 provides basic information on modern lighting technology in a comprehensible and impartial way. This is the first of a total of 20 "licht.wissen" brochures.



[licht.wissen 02] Good Lighting for a Better Learning Environment: Booklet 2 explains over 56 pages how optimum lighting can support the motivation and performance of learners. It presents efficient solutions and explains different lighting terms.



[licht.wissen 04] Optimal office lighting promotes a sense of well-being and saves energy and maintenance costs. Booklet 4 contains 56 pages devoted to different applications, and explains which standards need to be observed.



[licht.wissen 05] 60 pages on workplace lighting in trade and industry: Booklet 05 shows how optimal lighting installations help make for an ergonomic work space and at the same time save energy and costs.



[licht.wissen 07] Lighting used in healthcare must meet high standards. Booklet 07 cites the relevant regulations and highlights on 64 pages how light can contribute to recovery and increase visual comfort in the workplace.

licht.wissen in English – all booklets are available as PDFs, free download at www.licht.de/en

- 01 Lighting with Artificial Light (2016)
- 02 Good Lighting for a Better Learning Environment (2012)
- 03 Roads, Paths and Squares (2014)
- 04 Office Lighting: Motivating and Efficient (2012)
- 05 Industry and Trade (2009)
- 06 Shop Lighting – Attractive and Efficient (2011)
- 07 Light as a Factor in Health (2012)
- 08 Sport and Leisure (2010)

- 09 Refurbishment in Trade, Commerce and Administration (2014)
- 10 Emergency Lighting, Safety Lighting (2016)
- 11 Good Lighting for Hotels and Restaurants (2005)
- 12 Lighting Quality with Electronics (2003)
- 13 Outdoor workplaces (2007)
- 14 Ideas for Good Lighting for the Home (2009)
- 15 Good Outdoor Lighting for the Home (2009)

- 16 City Marketing with Light (2010)
- 17 LED: The Light of the Future (2010)
- 18 Good Lighting for Museums, Galleries and Exhibitions (2016)
- 19 Impact of Light on Human Beings (2014)
- 20 Sustainable lighting (2014)

All about light!

Impartial information

licht.de provides information on the advantages of good lighting and offers plenty of material on every aspect of artificial lighting and its correct usage. The information is impartial and based on current DIN standards and VDE regulations.

licht.wissen

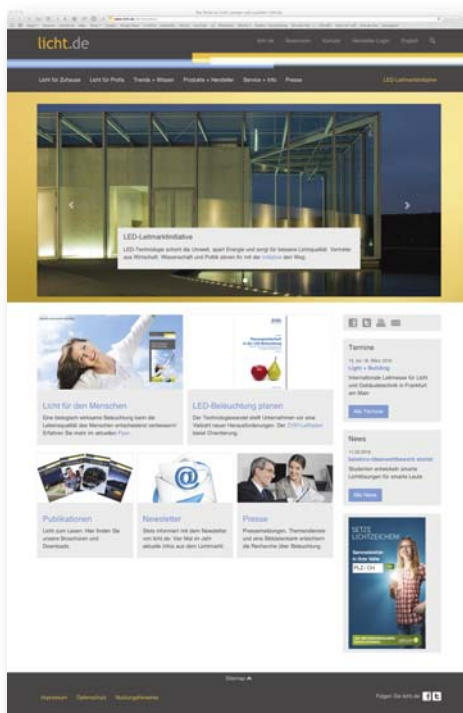
Booklets 1 to 20 of the licht.wissen series provide information on the use of lighting. The themed brochures use plenty of practical examples to explain the basics of lighting technology and present exemplary solutions. In this way they facilitate cooperation with lighting and electrical specialists. The lighting information contained in all of these booklets is of a general nature.

licht.forum

licht.forum focuses on topical lighting issues and trends. It is a compact specialist periodical published at irregular intervals.

www.licht.de

The industry initiative also presents its knowledge of lighting on the Internet. At www.licht.de, architects, designers, lighting engineers and end consumers have access to around 5,000 pages of practical tips, details of a host of lighting applications and up-to-the-minute information on light and lighting. An extensive database of product overviews provides a direct link to manufacturers.



www.twitter.com/licht_de
www.twitter.com/all_about_light



www.facebook.com/lichtde

Imprint

Publisher

licht.de
Fördergemeinschaft Gutes Licht
– eine Brancheninitiative des ZVEI e.V. –
Lyoner Straße 9, 60528 Frankfurt am Main
Tel. +49 (0)69 6302-353, Fax +49 (0)69 6302-400
licht.de@zvei.org, www.licht.de

Editing and design

r.f.w. kommunikation, Darmstadt

ISBN No. PDF edition (english) 978-3-945220-14-6
November 2016 (11/16/00/10VII)

This booklet takes account of DIN standards and VDE stipulations valid at the time of publication, reproduced with the permission of DIN, Deutsches Institut für Normung e.V. In each case, the DIN standard applicable is the latest version, available from Beuth Verlag GmbH, Burggrafenstraße 6, 10787 Berlin.

Reprints of licht.wissen 10 in full or in part only with the permission of the publishers.

Acknowledgements for photographs:

Numbering of photos on back page

		68
69	70	71
72	73	74

Images

Title: Moritz Finke; Table of contents and (68): Lothar Sprenger; Portrait page 3: Thomas Neu, Bensheim; (01, 71) Linus Lintner Fotografie; (03) Fotolia.com/Ralf Geithe; (04) Fotolia.com/Mario Beauregard; (20) Fotolia.com/Industrieblick; (21) Fotolia.com/DWP; (22) Fotolia.com/efks; (69) Fotostudio Thomas Lippmann
All other photographs, illustrations and charts were made available by licht.de members or produced for licht.de.

licht.wissen 10

Emergency Lighting, Safety Lighting



licht.de

Fördergemeinschaft Gutes Licht
Lyoner Straße 9
60528 Frankfurt am Main
Tel. +49 (0)69 63 02-353
Fax +49 (0)69 63 02-400
licht.de@zvei.org
www.licht.de