Information Brochure

New Concepts for Directionally Variable Emergency Lighting

Dynamic adaptive escape routing

May 2022

New Concepts for Directionally Variable Emergency Lighting

Publisher:
ZVEI e. V.
Lighting Division
Lyoner Str. 9
60528 Frankfurt/Main
Germany

Responsible:
Sohéil Moghtader
Phone: +49 69 6302-201
E-mail: soheil.moghtader@zvei.org

www.zvei.org

May 2022

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1 Introduction

Today we live and work in a world with many different constantly changing risks. Building operators are obliged to take appropriate safety measures to ensure the protection of the people who use the building. Whenever human life is at risk, evacuation needs to take place quickly in a safe and orderly manner. Safety lighting with its high-mounted escape sign luminaires and emergency luminaires serves this purpose. In fact, these are required by law.

Fire was once the greatest threat to buildings. Today, however, other risks such as terrorism (e.g. bomb threats), riots, serious crimes and extreme weather must also be taken into consideration. Each of these hazards requires different evacuation strategies. This challenge is exacerbated by an increasingly dense urban environment. Large, multifunctional buildings with complex floor plans, as well as simply structured, multi-storey buildings, are often frequented by visitors who are usually unfamiliar with the location. Therefore, they are not or only insufficiently familiar with the escape routes and emergency measures of the building.

Operators, but also event organizers who only use the premises or buildings for a limited period of time, must ensure that dangers are detected. The objective is to automatically alert the users so that they can exit the building quickly and safely. The variable-direction design of emergency lighting provides support here not only in the event of a power failure. By means of variable-direction marking of escape and rescue routes depending on what is happening, the clear marking of escape routes required by building regulations can be sensibly solved. People who are rescuing themselves can thus be guided in a targeted manner.

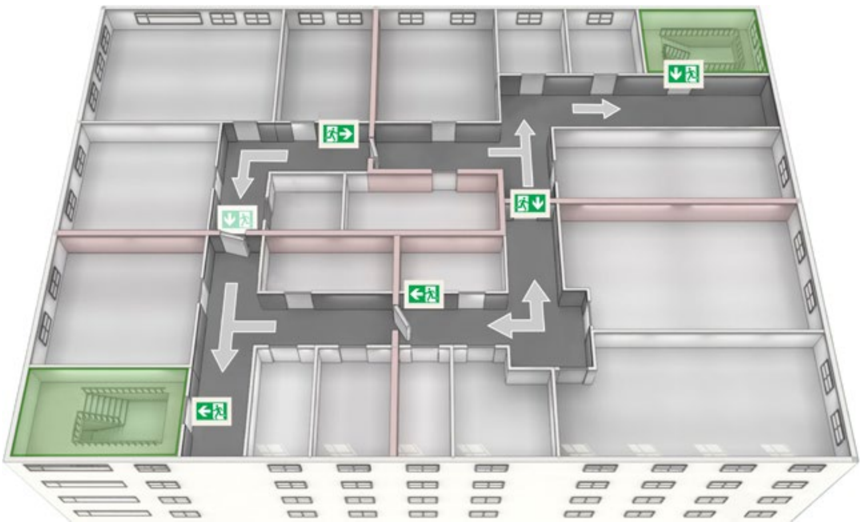
Such variable-direction markings are part of dynamic adaptive safety lighting systems. They are used to avoid potential disasters involving personal injury, financial loss and reputational damage in the event of danger.

2 Terms

To explain the terms, Figure 1 shows a simplified escape route marking. In it, there are two necessary stairwells with equal rights, which serve the escape by allowing the shortest route out of the building.

The illustrations serve to illustrate the concept of dynamic adaptive escape routing. Therefore, in all 3D floor plans, pictograms are only shown in simplified form at the most important points for the explanation and not at all points according to DIN EN 1838.

Figure 1: Simplified illustration of the escape route marking in the floor plan of a building



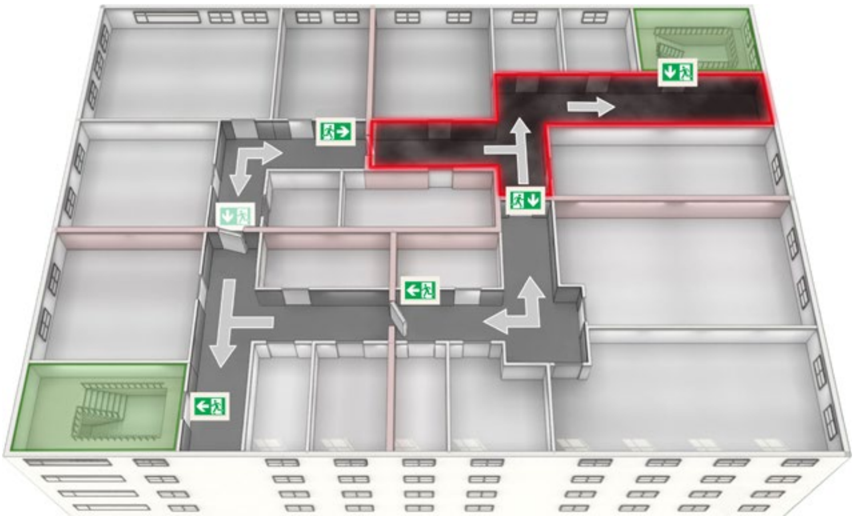
Rear representation of the pictogram of an escape sign luminaire.

2.1 Static escape route marking

Static escape route marking refers to escape routes with a fixed direction indicator, is not variable in terms of the direction and does not react to danger. With a static escape route marking, escape routes are marked with a fixed direction indicator and could direct people into a danger area. It is not directionally variable and does not react to danger.

Example of an escape route marking

Figure 2: Example of a static escape route marking



Escape route that can no longer be used safely, e.g. due to smoke formation.

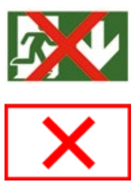
2.2 Dynamic escape routing

Depending on where the source of danger is located inside the building, the dynamic escape routing adjusts once to the dangerous situation. This is done, for example, by changing the direction indicator or by displaying a blocking symbol if the escape route is blocked.

Example 1: The dangerous situation requires a change of the direction the arrow is pointing in

Initial state → Changed state

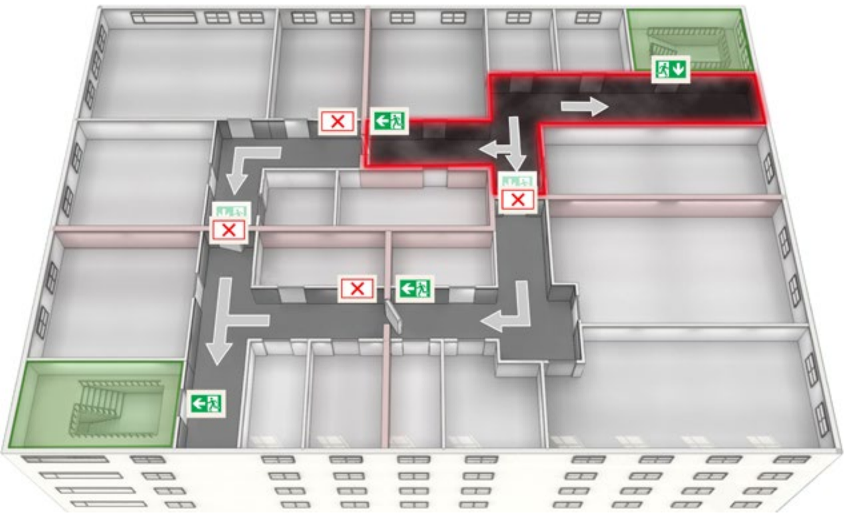
Example 2: The hazardous situation requires areas to be closed off with closure symbols.



Initial state → Changed state

Note: The signs shown here for the blocked escape route are not yet standardised.

Figure 3: Dynamic escape routing is variable in direction.
It can react once variably to a danger, visually blocks the danger area and guides safely into the open via the remaining escape route.



Escape route that can no longer be used safely, e.g. due to smoke formation.

2.3 Adaptive escape routing

An adaptive escape route guidance system marks escape routes in variable directions. It reacts not only once but permanently and variably to a course of danger, e.g. by changing the escape direction display and blocking escape routes with blocking symbols.

Example 1: Hazard course requires multiple changes of the direction of the arrow

Initial state → Changed state 1 → Initial state

Note: The signs shown here for the blocked escape route are not yet standardised.

Example 2: Hazard course requires multiple changes of the direction of the arrow.

Initial state → Changed state 1 → Initial state

Figure 4a: The escape route marking reacts to the onset of danger by visually blocking the affected area

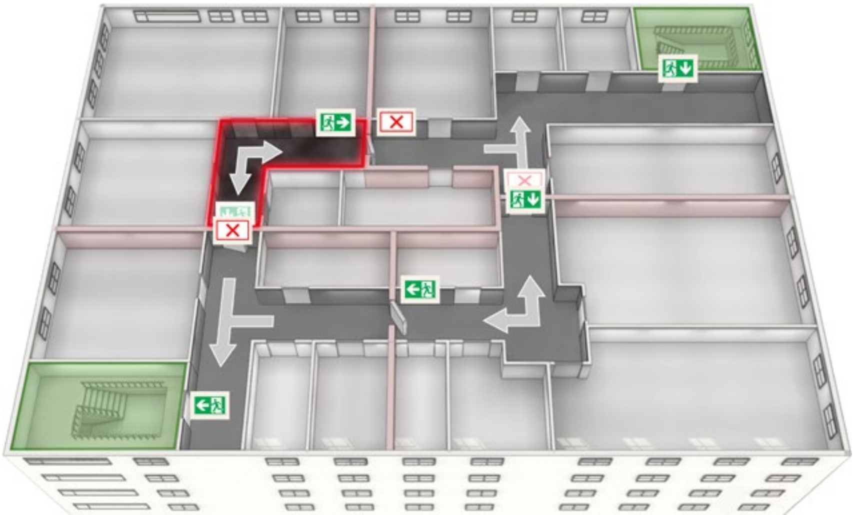
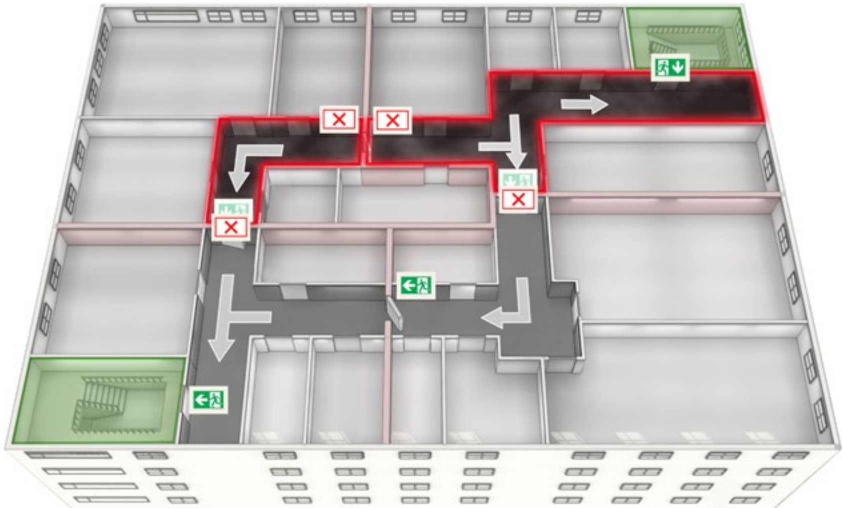


Figure 4b: An adaptive escape route guidance system is permanently variable and can thus react to a course of danger by changing the escape route marking several times



Escape route that can no longer be used safely, e.g. due to smoke.

Besides high-mounted luminaires, low-mounted luminaires close to the floor can be useful in case of smoke, however they cannot replace high-mounted emergency lighting.

Even if the escape route gets longer, the dynamic adaptive escape route guidance shortens the time for self-rescue because it immediately adapts the escape route marking to the hazardous event from the very outset. This allows people to orientate themselves more quickly and avoid choosing the wrong escape direction. This would inevitably require a time-consuming reversal and thus increase the danger.

3 Areas of application of the dynamic adaptive escape routing system

Possible applications are described below.

3.1 In case of fire

Every year, people die in fires, even in public or commercial buildings, often from carbon monoxide poisoning. By using "dynamic escape route control," 100% of these people could save themselves without even being injured (vfdb fire loss statistics 2020).

3.2 Renovation work (temporary change of use)

During painting work in the stairwell, this is temporarily not available as an escape route in this example.

Figure 5:

The escape route through the stairwell is marked.

Figure 6:

The stairwell cannot be used due to renovation work. The exit sign no longer guides into the stairwell, but to the left towards an alternative escape route. An escape sign has been activated above the left-hand door to show the way ahead.

Figure 7:

Alternatively, a blocked symbol can be displayed above the door to the stairwell. The alternative path is still activated above the left door.

An escape staircase can be seen on the right in each of the photos. In practice, an escape route is often temporarily unusable, due to renovation work, for instance. But the escape route signage is usually not adapted to the new situation. By using directionally variable internally illuminated safety signs, the escape route marking can be adapted to the current situation very easily.

3.3 Compensation measures

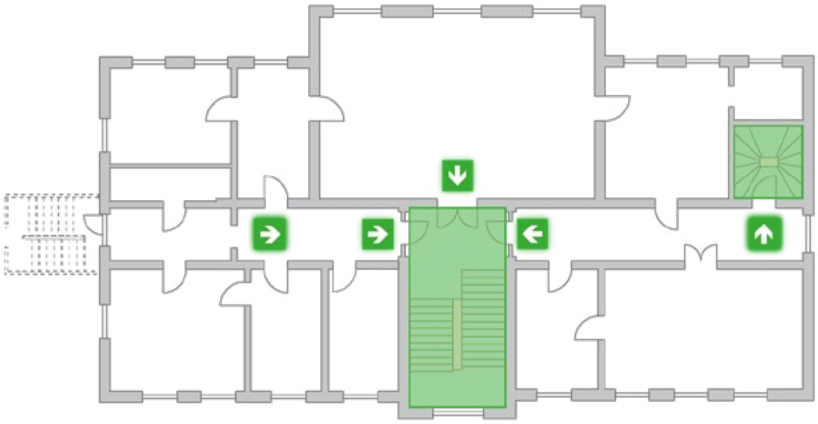
If special structural conditions apply, compensation measures are often needed in practice, as the following examples show:

- Complications in structural fire protection in new buildings as well as in existing buildings (e.g. wooden staircases, non-existent fire doors)
- Rehabilitation of historic buildings (listed buildings)
- Open connection between two floors (e.g. a free-standing staircase with a gallery)
- Exceeding escape route lengths (the maximum permissible horizontal escape route length under building regulations is exceeded)
- Escape route (vertical) does not directly lead into outside (e.g. the escape staircase room opens into the hotel lobby in a hotel)
- Two evacuation levels (e.g. the slope of a building requires an escape route to the outside, both via the ground floor and via the basement).

In addition, the planning of an escape route guidance system allows for greater flexibility even during the planning of buildings. For example, slight deviations from the building regulations can be directly compensated for in the design as well as in the execution phase.

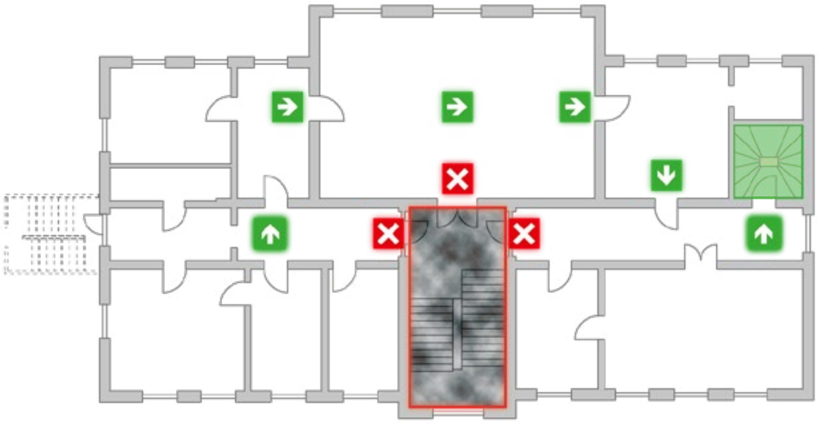
As an example, Figure 8 shows an upper floor of a multi-storey listed office building. Due to a wooden staircase and wood panelling in the central stairwell (fire loads), this was initially ruled out as an escape route. An additional stair tower was to be built on the left front side of the building in order to realise a second escape route for all floors (dashed illustration).

Figure 8: The escape route here is via the main stairwell



The use of a dynamic escape routing system made it possible to eliminate the need for the left front exterior staircase. In the event of a fire in the main stairwell, it is visually blocked and the users of the left half of the building are led around the affected area and safely outside the building via the escape stairwell of the right half of the building (Figure 9). In all other cases, the main stairwell is used as an escape route.

Figure 9: Smoky stairwell, escape route routing around the incident



 Escape route that can no longer be used safely, e.g. due to smoke formation.

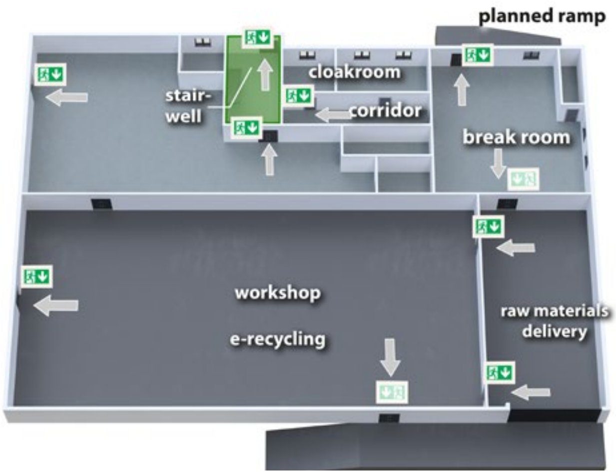
Note: The signs shown here for the blocked escape route are not yet standardised.

By using the dynamic escape routing as a compensatory measure, the overall renovation costs were reduced considerably and the front of the monument could be preserved in its original state. At the same time, the protection objective was achieved without having to accept any compromises.

3.4 Change of use

In this example, a former bicycle workshop was converted into a workshop for the disabled with e-recycling. In the course of this, safety lighting was required, as was an area-wide fire alarm system (FD&A) due to increased fire loads.

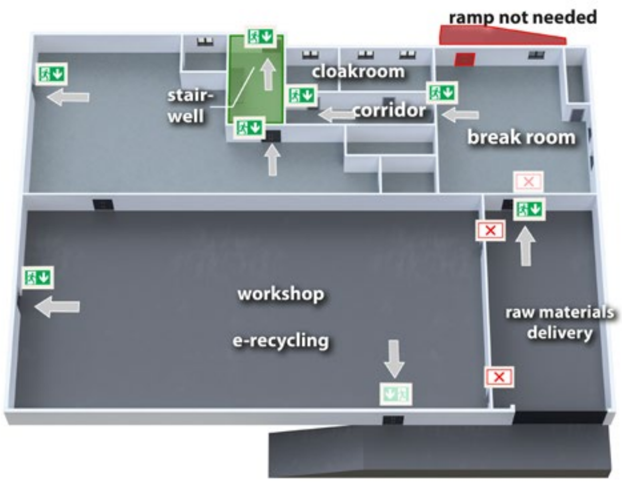
Figure 10: Original planning without dynamic adaptive escape routing



The escape route from the social room was difficult to plan because the adjoining corridor had increased fire loads and could not be strengthened accordingly. The second escape route through the workshop was also unsafe due to the increased fire load in the e-recycling area.

Therefore, a direct exit to the outside was to be built to escape the social room. In addition to an escape door in the outer front, this would have required a ramp for barrier-free access. (see Figure 10: planned ramp with an emergency exit).

Figure 11: Thanks to the dynamic escape route control, the originally planned ramp with an emergency exit could be omitted



To compensate for these structural measures, two directionally variable, dynamic escape sign luminaires were used in the social room instead. In the event of a fire in the workshop or in the corridor to the changing room, this is announced by the fire alarm system. The dynamic escape sign luminaires visually block the affected area with a red cross. Only the usable escape route is shown.

Representation of the back of the pictogram in the image.

Only three alarms from the fire alarm system had to be evaluated, namely "workshop/e-recycling," "arrival of the fire" and "fire in the corridor." The use of dynamic escape routing was associated with additional costs on the security lighting side, but led to significant savings in the planned total conversion costs overall, as the emergency exit door and ramp were no longer necessary (Figure 11).

3.5 Danger alarm

In the event of an unforeseen incident such as a bomb scare, terrorism or a piece of luggage without an owner in public areas, the endangered areas can be visually cordoned off at short notice. In addition, these are relieved by diverting the flow of people by means of directionally variable signs.

Figure 12: Use of a sniffer dog in the building

3.6 End of event

At the end of an event (e.g. in a cinema), visitors should not leave the assembly room through the entrance, which normally also serves as an escape route, as the next visitors are already waiting here. For this purpose, this entrance/emergency exit is temporarily visually blocked by the operating staff.

or

Note: The signs shown here for the blocked escape route are not yet standardised.

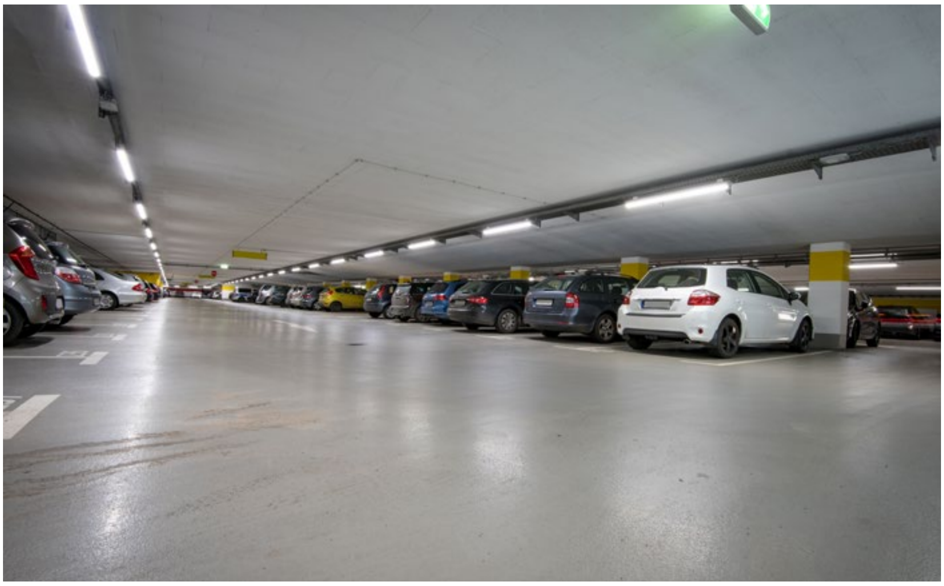
The event room can then be exited, through emergency exits on the side wall, for example, that lead outside.

Oncoming groups of people potentially pose a danger even when there is not an emergency situation, which is minimised by the dynamic adaptive wayfinding. Consequently, this means added value and becomes part of the regular use of the building.

3.7 Leakage of hazardous substances

In the event of unforeseen incidents, e.g. a chlorine gas alarm in the swimming pool, a CO alarm in the underground car park, a laboratory accident, etc., the endangered areas can be visually cordoned off at short notice. The evacuation of the building can be carried out via safe escape and rescue routes, depending on the situation.

Figure 13: An underground car park with a CO sensor



3.8 Reduction of panic-like behaviour at large events

A fleeing crowd can be diverted to less frequented escape routes at an early stage, thus avoiding panic situations in the congested escape and rescue route.

Figure 14: Crowd at a concert in the building

4 Legal basis

Current status of regulations and normative requirements

Physical integrity is considered the highest legal asset. This leads to legal obligations – also for building owners and operators. Buildings must be planned, erected and operated in such a way that all persons in the building remain unharmed in case of danger.

Section 823 paragraph 1 of the German Civil Code (BGB) defines the duty to ensure safety. According to this, all dangers must be eliminated or at least controlled. This requires a hazard-oriented approach – even during the planning stage.

The protection concepts of the various state building codes are designed in such a way that self-rescue must be possible for all building users without the fire brigade having to intervene to support them in the event of a fire.

For workplaces, ASR A 2.3 lists the design of escape route guidance systems in the form of electrically operated optical safety guidance systems.

Technical innovations expand the scope of action. They usually result in new legal obligations, the non-fulfilment of which can lead to liability.

5 Summary

The shortest escape route is not always the safest one

Traditional emergency lighting, as described in many different standards and regulations, is designed for power failure to illuminate escape routes and to mark them by means of escape signs. The direction of the static escape signs indicates a precisely defined escape route from any point in the building. The building authorities assume that the shortest escape route is the decisive one and remains accessible in case of danger.

However, this is not always the case. In the event of a fire, for example, escape routes may be blocked by smoke or fire. Static emergency lighting cannot react to this danger and can even lead those fleeing into smoke and fire. There is a high risk to life of the building occupants.

Modern state-of-the-art emergency lighting can counter this danger and thus do much more than just “be there” in the event of a power failure.

In addition, dynamic adaptive escape routing can be used as a compensatory measure in new buildings, building renovations or in listed buildings if there are deviations from the building regulations. Expensive structural measures can be dispensed with in many cases to significantly reduce the overall construction costs. Above all, however, the safety for building users increases considerably, as the dynamic adaptive escape route marking shows a safe escape route adapted to the respective danger. Thus, the self-rescue required by building and occupational safety laws can be achieved. The building users can exit the building quickly and safely without having to rely on external rescue from outside due to the clear escape route marking that is adapted to the dangerous situation.

Outlook

Dynamic adaptive escape routing with directionally variable escape signs has been used for several years in many buildings. The application precursor DIN VDE V 0108-200 “Emergency escape lighting systems- Part 200: Electrically operated optical safety guidance systems” provides all those involved in construction with initial application security. Further standardisation activities underscore the importance of this topic and will regulate the design of these systems as a component of safety lighting in the future.

6 Appendix

Legal provisions, standards, official requirements and other sources

Workplace regulation ASR A 2.3, escape routes and emergency exits

Fire protection concept as part of the building permit

DIN VDE V 0108-200, Emergency escape lighting systems, Part 200: “Electrically operated optical safety guidance systems.”

DIN EN 1838, Applied lighting technology – Emergency lighting

The DIN Firefighting and Fire Protection Standards Committee (FNFW) is currently working on a standard on dynamic adaptive escape routing (expected to be published as DIN 14036).

Sebastian Festag, Ernst-Peter Döbbeling: vfdb-Brandschadenstatistik – Untersuchung der Wirksamkeit von (anlagentechnischen) Brandschutzmaßnahmen (vfdb Fire Loss Statistics – Investigating the Effectiveness of Fire Protection Measures)

ZVEI leaflet 33013, Adaptive escape routing – Further development of technical building evacuation: From dynamic to adaptive escape routing

7 Image directory

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Die Elektroindustrie

ZVEI e.V.
Lyoner Straße 9
60528 Frankfurt/Main
Germany

Phone: +49 69 6302-0
Fax: +49 69 6302-317
E-mail: zvei@zvei.org
www.zvei.org