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Evacuation Lighting in Road Tunnels

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee EL/1/2, Road lighting.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Evacuation Lighting in Road Tunnels

Éclairage des itinéraires d'évacuation dans les tunnels routiers

Evakuierungsbeleuchtung in Straßentunneln

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Foreword

This document (EN 16276:2013) has been prepared by Technical Committee CEN/TC 169 “Light and lighting”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by July 2013, and conflicting national standards shall be withdrawn at the latest by July 2013.

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Introduction

The Directive 2004/54/EC of the European Parliament of 29 April 2004 aims at ensuring a minimum level of safety for road users in tunnels in the Trans-European Network by the prevention of critical events that may endanger human life. With regard to lighting, there are two main cases: normal lighting and safety lighting.

Normal lighting is provided to ensure appropriate visibility during the day and night for drivers in the entrance zone as well as in the interior zone.

Safety lighting is divided into two parts: standby lighting and evacuation lighting.

Standby lighting is provided to ensure a minimum visibility for tunnel users to evacuate the tunnel in their vehicles in the event of a breakdown of the power supply.

Evacuation lighting is provided to guide tunnel users during evacuation of the tunnel on foot in emergency circumstances such as fire. Evacuation lighting includes evacuation route marker lights, emergency exit lighting, emergency exit marker lights and evacuation route lighting.

1 Scope

This European Standard specifies evacuation lighting in road tunnels longer than 500 m and with an AADT (Annual Average Daily Traffic) higher than 500 vehicles to facilitate the safe evacuation of vehicle occupants in evacuation situations such as fire. It addresses the fundamental issues of evacuation lighting for evacuation routes, emergency exits and cross connections, as well as giving some practical advice regarding aspects of installation and maintenance in road tunnels. It is intended to be used in conjunction with CEN/CR 14380:2003 or relevant national standards for road tunnel lighting.

The recommendations may be applied to tunnels up to 500 m in length, especially where conditions such as high traffic volume, or severe curvature or gradient apply.

It specifies lighting levels and general provisions for evacuation lighting installations that, based on experience, are considered to be necessary for the safety of people driving through road tunnels in case of an incident and particularly in case of fire. However, as there are different types of road tunnels, both in construction and traffic conditions, various types of incident may occur. This standard should be considered as a list of minimum prescriptions for evacuation lighting in tunnels, to be completed by means of specific risk analysis for the particular tunnel.

The design of marking and safety signs is not part of this standard.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1838:1999, *Lighting applications — Emergency lighting*

EN 12665:2011, *Light and lighting — Basic terms and criteria for specifying lighting requirements*

EN 50172:2004, *Emergency escape lighting systems*

CEN/CR 14380:2003, *Lighting applications — Tunnel Lighting*

3 Terms and definitions

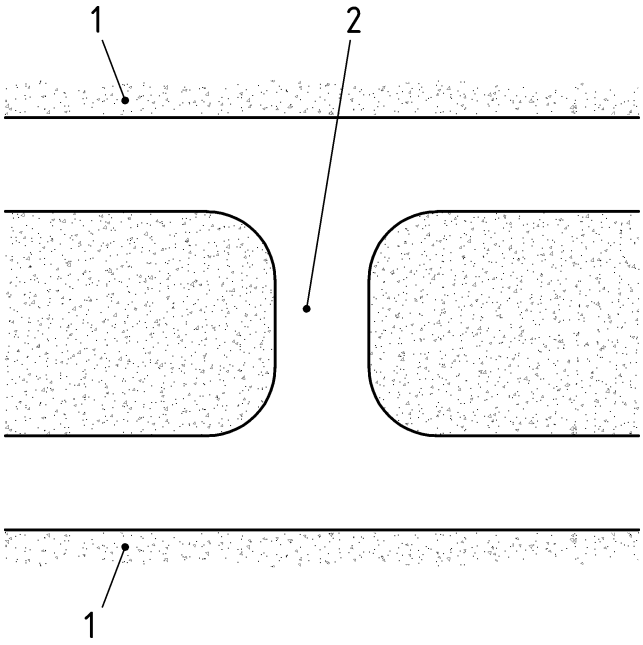
For the purposes of this document, the terms and definitions given in EN 12665:2011, EN 1838:1999 and the following apply.

3.1 Tunnel construction aspects

3.1.1
main tunnel
part of a tunnel which contains the carriageway

3.1.2
carriageway
part of the road used by vehicular traffic, normally divided into lanes

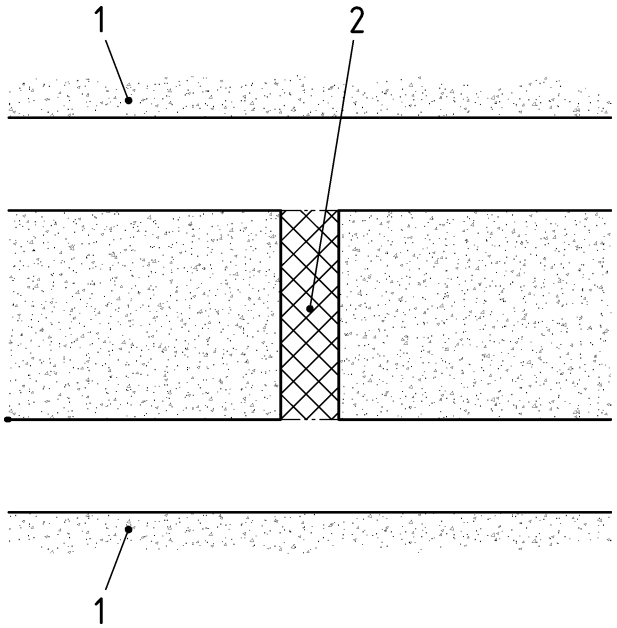
3.1.3
vehicular cross connections (between tunnel tubes)
vehicular carriageway connecting adjacent tubes



Key
1 main tunnel
2 vehicular cross connection

Figure 1 — Vehicular cross connection

3.1.4
pedestrian cross connections (between tunnel tubes)
pedestrian route connecting adjacent tubes



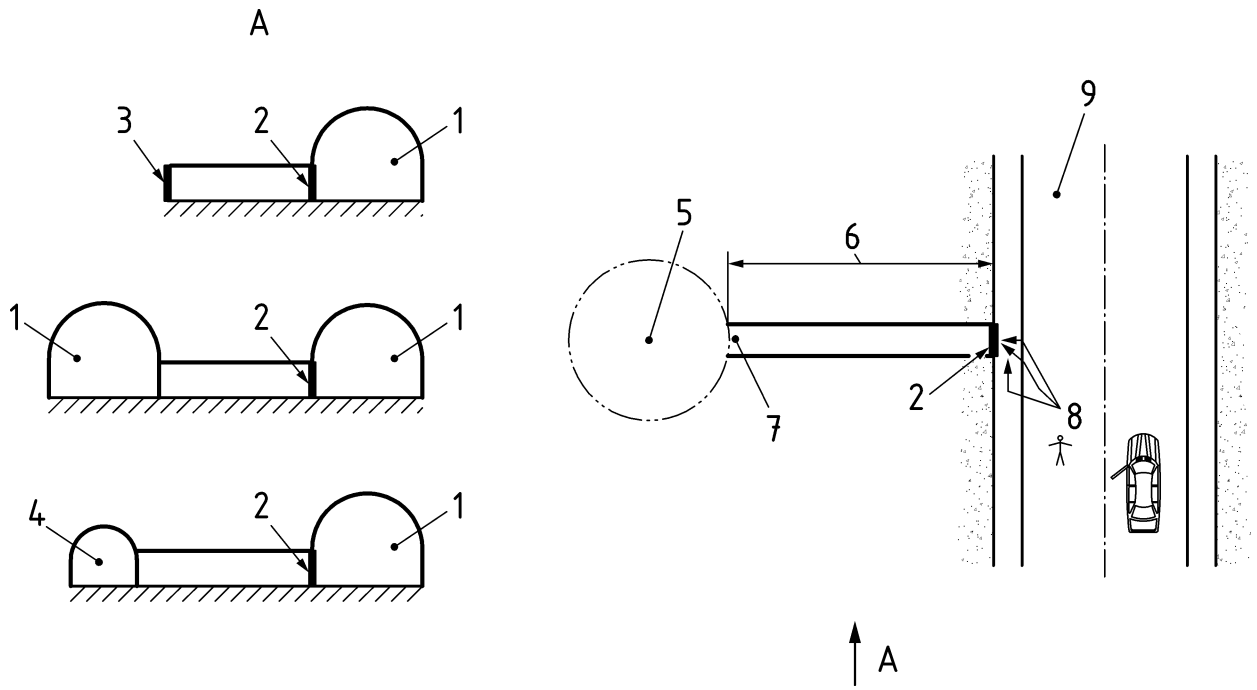
Key
1 main tunnel
2 pedestrian cross connection

Figure 2 — Pedestrian cross connection

3.1.5
evacuation route within the main tunnel
pedestrian route from a stationary vehicle to an emergency exit

3.1.6
emergency exit
exit intended to be used by pedestrians to escape from the main tunnel to a safe area (directly or via an evacuation route)

3.1.7
evacuation route outside the main tunnel
pedestrian route after an emergency exit



Key
1 main tunnel
2 emergency exit
3 outdoor
4 safety gallery
5 safe area
6 evacuation route outside the main tunnel
7 final exit
8 evacuation route within the main tunnel
9 carriageway

Figure 3 — Tunnel construction examples

3.2 Road tunnel evacuation lighting terms

3.2.1
standby lighting
part of the normal lighting that maintains the tunnel lighting at a specific level in the event of a breakdown of the power supply

Note 1 to entry: Standby lighting is called emergency lighting in CEN/CR 14380:2003.

3.2.2
evacuation lighting
lighting whose function is to guide tunnel users to evacuate the tunnel on foot in case of emergency circumstances such as fire

3.2.3
evacuation route marker light
light used to guide pedestrians and delineate an evacuation route to an emergency exit

3.2.4
emergency exit lighting
lighting to make emergency exits visible and identifiable

3.2.5
emergency exit marker light
light used to delineate the frame of an emergency exit

3.2.6
evacuation route lighting
lighting provided to ensure that the means of evacuation can be identified and safely used when the location is occupied

3.2.7
duration of the evacuation mode
time for which the required evacuation lighting performance is maintained

4 Lighting of specific areas under emergency circumstances

4.1 General

In emergency circumstances, lighting covers two main functions:

— to provide guidance and visibility for drivers able to exit the tunnel in their vehicles (standby lighting);

— to provide guidance and visibility for people leaving their vehicles and evacuating the tunnel as pedestrians.

All the lighting systems described in this section shall be supplied from an uninterruptible power supply, in order to guarantee continuity of lighting.

In emergency circumstances, the duration of the evacuation mode shall be in accordance with national requirements. If a national standard does not exist, a duration of at least 30 min is to be realised, or otherwise in accordance with the results of a specific evacuation study.

Inspection and testing of tunnel evacuation lighting systems shall be made in accordance with EN 50172, unless existing national regulation states otherwise.

4.2 Driving task lighting

4.2.1 Carriageway

For guidance on the appropriate carriageway lighting requirements to apply in the event of a breakdown of the normal power supply (standby lighting), reference should be made to CEN/CR 14380:2003, Clause 7 or to national recommendations or standards.

4.2.2 Vehicular cross connections

In emergency circumstances, the values of average maintained horizontal illuminance and uniformity of illuminance on a vehicular cross connection shall be at least equal to the values on the carriageway in the interior zone of the main tunnel.

4.3 Pedestrian guidance

4.3.1 General

When visibility is normal, the normal lighting or standby lighting of the main tunnel can be assumed to be adequate for this purpose.

It has been observed that vehicle occupants tend to stay in their vehicles and are reluctant to leave at an early stage of an emergency. Specific systems instructing them to leave their vehicles are strongly recommended.

4.3.2 Evacuation route within the main tunnel

In emergency circumstances, the main tunnel carriageway becomes a footway for fleeing pedestrians to the emergency exits.

In any emergency, as a complement to the normal lighting or standby lighting, and in particular in situations where visibility is impaired, evacuation route marker lights are requested to provide tunnel users with guidance to facilitate their evacuation of the tunnel on foot towards the emergency exits.

The evacuation route shall be clearly and unambiguously marked with evacuation route marker lights at a spacing not exceeding 25 m and not higher than 1,5 m above the carriageway level. This shall be done at least on one side of the tunnel where the emergency exits are situated. Where there are three or more traffic lanes, consideration can be given to provide evacuation route marker lights on both sides of the tunnel, provided that clear direction is given towards emergency exits.

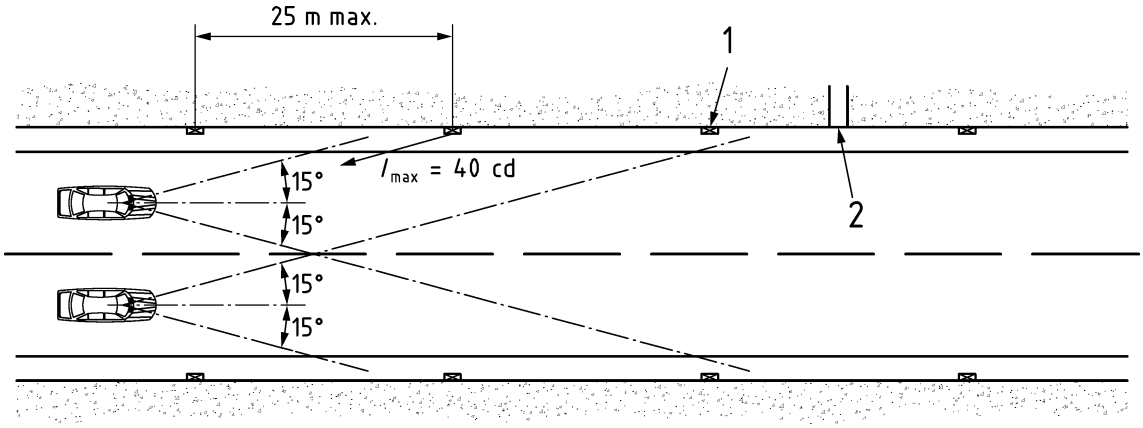
At all times, evacuation route marker lights along the evacuation route shall be operational, either to be illuminated in an emergency, or permanently illuminated. Where the markers are permanently illuminated, in order to limit disability glare to drivers, the intensity in the critical directions shall be limited.

For that purpose, luminous intensities of each marker shall not exceed 40 cd during normal conditions, in a cone of 2 × 15° with the axis formed by the driver's observation direction (see Figure 4). During evacuation circumstances, the marker's intensity can be increased.

To enhance the visibility in smoke, the minimum maintained luminous intensity of each marker, in all directions from which it could be seen by a fleeing pedestrian, shall be determined by their spacing. The minimum maintained luminous intensity shall be 0,1 cd for each meter of spacing between markers, with a minimum luminous intensity of 1 cd.

EXAMPLE For a distance of 15 m between two markers, the minimum maintained luminous intensity is 1,5 cd.

In case of tunnels wider than the spacing of markers, the minimum luminous intensity shall instead be determined by the tunnel width and not the marker spacing, using the same rule as before.



Key
1 markers
2 emergency exit

Figure 4 — Limitation of intensities emitted towards driver (Plan view showing cone of limited intensities and markers)

Visible flicker effect shall be avoided by following the requirements stated in CEN/CR 14380:2003, or in national recommendations or standards.

Alternative methods of marking the evacuation route in the main tunnel are acceptable if visibility under all conditions, including smoke, is equivalent to or better than the system described above.

4.3.3 Emergency exits

4.3.3.1 General

Exits clearly identified by dedicated emergency exit lighting will help encourage vehicle occupants to leave their vehicles when necessary.

There are two objectives: the first is to make the emergency exits adequately visible to familiarise users with their presence under normal conditions; the second is to highlight the emergency exits when needed for evacuation.

These two objectives can be reached by using a single system or different systems.

They can be reached by a) marking the emergency exit (required) and by b) lighting (recommended).

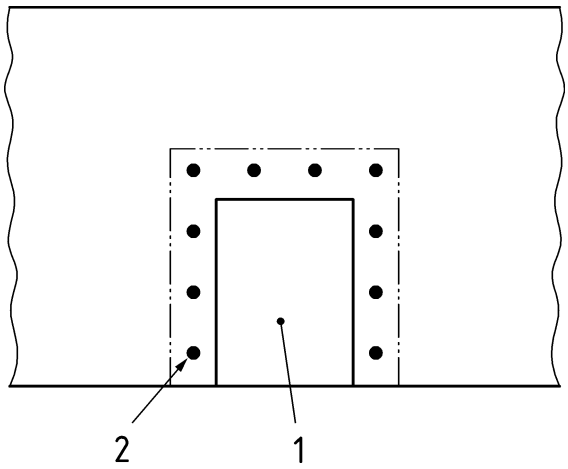
When surfaces are coloured to make emergency exits more visible and so to facilitate their recognition, this colour shall be green.

Design of emergency signs is covered by ISO 3864-1 and ISO 7010 in the absence of relevant national standards.

4.3.3.2 Marking of the emergency exit

Green emergency exit marker light shall be provided around or at both sides of the exit door. An example of an arrangement is shown in Figure 5.

During an emergency situation, it is recommended that the lights flash to attract the attention of fleeing pedestrians. A frequency of flashing within a range of 0,5 Hz to 2 Hz with luminous intensity not lower than 100 cd in all emitting directions, can be satisfactory.



Key
1 emergency exit
2 green emergency exit marker light

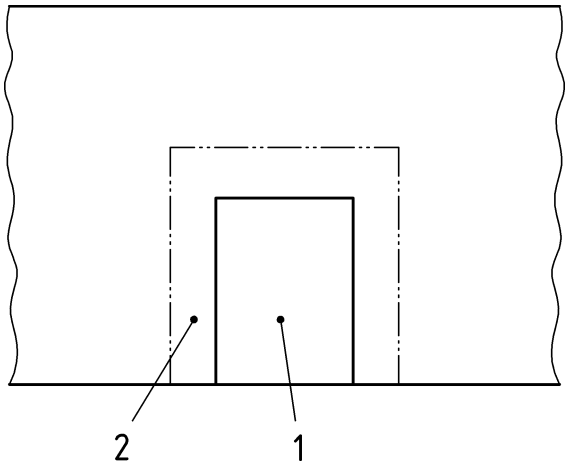
Figure 5— Example of an arrangement for the green emergency exit marker lights

4.3.3.3 Lighting

In order to make the emergency exits more visible and to familiarise all tunnel users with their positions and geometry, each emergency exit including the door and an area of tunnel wall extending around the door frame can be illuminated, externally or internally (an example is shown in Figure 6).

Emergency exit light sources (if any) should provide good colour rendering of green surface finishes.

In case of calculating the Threshold Increment (TI) for the main tunnel lighting, the luminaires used to illuminate the emergency exit shall be taken into account.



Key
1 emergency exit
2 lit area

Figure 6— Example of lighting of emergency exit (front view)

4.3.4 Evacuation route outside the main tunnel

In emergency circumstances, evacuation route lighting shall provide an average maintained horizontal illuminance level on the ground of not less than the tunnel interior zone daytime illuminance level, with an

overall uniformity (min/ave) of not less than 0,2. The average wall illuminance shall be equivalent up to a height of 1,5 m. Light sources shall have a colour rendering index R_a ≥ 40.

Annex A
(informative)

A–deviations

A- deviation: National deviation due to regulations, the alteration of which is for the time being outside the competence of the CEN member.

This European Standard does not fall under any Directive of the EU. In the relevant CEN countries, these A-deviations are valid instead of the provisions of the European Standard until they have been removed.

Deviation	
Country: Norway	National Regulation Road Tunnels Standard published by Norwegian Public Roads Administration in 03.2004 Concerns the emergency escape route lighting
Country: Norway 4.3.2. The evacuation route shall be clearly and unambiguously marked with evacuation route marker lights at a spacing not exceeding 25 m and not higher than 1,5 m above the carriageway level. This requirement is in conflict with 602.202 of “Road Tunnels” Norwegian standard.	602.202 of “Road Tunnels” The lights are mounted 1 m above the carriageway, on one side at intervals of approx. 62.5 m In order to allow compliance of numerous existing installations at reasonable costs, the installation of an additional marker light between two existing adjacent ones asks for extension of maximum spacing of these marker lights up to 33 m.
Country: Switzerland 4.3.1 The evacuation route shall be clearly and unambiguously marked with evacuation route marker lights at a spacing not exceeding 25 m and not higher than 1,5 m above the carriageway level.	This requirement is in conflict with 3.3.2 of Swiss National Regulation 13010, Ausgabe 2009 V1.99b “Signalisation der Sicherheitseinrichtungen in Tunneln” published by the Swiss Federal Roads Office. The evacuation route shall be marked with photoluminescent panels at a spacing not exceeding 25 m and not higher than 1.5 m above the carriageway level (3.3.2 of Swiss National Regulation 13010).

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