



Lateral Lighting in Tunnel – Evacuation and more

European tunnel accidents from 1949 to 2002

Source: World Road Association (PIARC)

Date	Tunnel Length	Location/ Country	Vehicle Where Fire Occurred	Most Possible Cause of Fire	Duration of Fire	Consequences		
						People	Damaged Vehicles	Structures and Installations
13 May 1949	Holland 2,550 m	New York USA	Lorry with 11 tons of carbon disulfide	Load falling off lorry - explosion	4 hr	66 injured smoke inhalation	10 lorries 13 cars	Serious damage over 200 m
31 August 1968	Moorfleet 243	Hamburg Germany	Trailer with 14 tons of PE granulate	Brakes jamming	1 hr 30 min	none	1 trailer	Serious damage over 34 m
28 January 1974	Mont Blanc 11,600 m	France-Italy	Lorry with 21 tons of steel billet	Motor	15 min	1 injured	1 lorry	N/A
14 August 1975	Guaderrama 2,345	Madrid Spain	Truck with tanks filled with pine resin	N/A	2 hrs 45 min	none	1 truck	Serious damage (closed for 21 days)
11 August 1976	Crossing BP - A6 430 m	Paris France	Lorry with drums of 16 tons polyester film	High speed	1 hr	12 light injuries (smoke)	1 lorry	Serious damage over 150 m
11 August 1978	Velsen 770 m	Velsen Nederland	4 lorries 2 cars	Front-rear collision	1hr 20 min	5 dead 5 injured	4 lorries 2 cars	Serious damage over 30 m
11 July 1979	Nihonzaka 2,045 m	Shitzuoka Japan	4 lorries 2 cars	Front-rear collision	159 hr	7 dead 1 injured	127 lorries 46 cars	Serious damage over 1,100 m
17 April 1980	Kajiwara 740 m	Japan	1 lorry with 3,600 l of paint in 200 cans	Collision with side wall and overturning	1 hr 20 min	1 dead	1 lorry, 4t 1 lorry, 10t	Serious damage over 280 m
15 July 1980	Sakai 459 m	Japan	6 heavy lorries, 3 lorries, 2 cars	Multiple collision	3 hr	5 dead 5 injured	10 vehicles	Serious damage
17 April 1982	Caldecott 1,028 m	Oakland USA	1 car, 1 coach 1 lorry with 33,000 l of petrol	Front-rear collision	2 hr 40 min	7 dead 2 injured	3 lorries 1 coach 4 cars	Serious damage over 580 m
February 1983	Pecorila Galleria 662 m	Gênes Savone Italy	Lorry with fish	Front-rear collision	N/A	9 dead 22 injured	10 cars	Little damage

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						People	Damaged Vehicles	Structures and Installations
5 May 1983	Frejus 12,870 m	France-Italy	Lorry with plastic material	Motor	~2 hrs	None	1 lorry	Damage to roof slab and equipment
2 April 1984	St. Gotthard	A2 Switzerland	Lorry with plastic material	Motor	24 min	None	1 lorry	Serious damage over 30 m
1 July 1984	Felbertauern 5,281 m	Austria	Bus	Blocking brakes	1 hr 30 min	None	1 bus	Damage to pavement and ceiling
9 September 1986	L'Arme 1,105 m	Nice France	Lorry with trailer	Braking after high speed	N/A	3 dead 5 injured	1 lorry 4 cars	Some equipment destroyed
18 February 1987	Gumefens 343 m	Berne Switzerland	1 lorry	Front-rear collision	2 hr	2 dead	2 lorries 1 van	Slight damage
19 August 1990	Røldal 4,656 m	Røldal Norway	VW transporter with trailer	Motor	50 min	1 injured	1 transporter 1 trailer	Little damage
11 January 1990	Mont Blanc 11,600 m	France-Italy	Lorry with 20 tons of cotton	Motor	30 min	2 injured	1 lorry	Some equipment destroyed
1993	Serra Ripoli 442 m	Bologne-Florence Italy	1 car and lorry with rolls of paper	Collision	2 hr 30 min	4 dead 4 injured	5 lorries 11 cars	Little damage
13 June 1993	Hovden 1,290m	Høyanger Norway	Motorcycle 2 cars	Front-rear collision	1 hr	5 injured	1 motorcycle 2 cars	111 m insulation material destroyed
27 February 1994	Huguenot 3,914 m	South Africa	Bus with 45 passengers	Electrical fault	1 hr	1 dead 28 injured	1 coach	Serious damage
10 April 1995	Pfander 6,719 m	Austria	Lorry with trailer	Collision	1 hr	3 dead 4 injured	1 lorry 1 van 1 car	Serious damage
18 March 1996	Isola delle Femmine 148 m	Palermo Italy	1 tanker with liquid gas + 1 little bus	Front-rear collision	2 hrs	5 dead 20 injured	1 tanker 1 bus 18 cars	Serious damage. Tunnel closed for 2.5 days

European tunnel accidents from 1949 to 2002

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						People	Damaged Vehicles	Structures and Installations
31 October 1997	St. Gotthard 16,918 m	A2 Switzerland	Transporter with 8 private cars loaded	Motor	3 hrs	2 injured	1 lorry 8 cars	N/A
24 March 1999	Mont Blanc 11,600 m	France-Italy	Lorry with flour and margarine	Self-ignition	53 hrs	39 dead	23 lorries 10 cars 1 motorcycle 2 fire engines	Serious damage. Tunnel reopened March 2002
29 May 1999	Tauern 6,401 m	A10 Salzburg- Spittal Austria	Lorry with paint	Front-rear collision 4 cars and 2 lorries	14 hrs	12 dead 49 injured	14 lorries 26 cars	Serious damage
14 July 2000	Seljestad 1,272 m	E 134 Drammen - Haugesund Norway	The trailer-lorry that caused the multiple collisions had a diesel fire in the engine room before the collision.	Front-rear collision. A trailer-lorry pushed a car into 4 cars that had stopped behind another lorry.	45 min	6 injured	1 lorry 6 cars 1 MC	Serious damage. NOK 1 mill. Tunnel closed for 1.5 days
28 May 2001	Prapontin 4,409 m	A32 Torino - Bardonecchi Italy	Lorry charged with vegetables	Self ignition of tyres	15 min	11 injured by smoke	1 lorry	Closed until 6/6 in direction Torino (east)
6 August 2001	Gleinalm 8,320 m	A9 near Graz Austria	Car	Front collision van - car	50 min	5 dead 4 injured	1 car 1 van	Serious damage. Reopened 07 aug 01
24 October 2001	St. Gotthard 16,918 m	A2 Switzerland	Lorry	Front collision 2 lorries	6 hours	11 dead	2 lorries 13 cars	Serious damage. Closed 2 months
27 January 2002	Roppener 5,100 m	A12 Austria	Bus	Motor	1 hr	2 injured	N/A	N/A
3 November 2002	Homer 1,200 m	New Zealand	Bus	N/A	N/A	4 injured	1 bus	N/A

European Regulation

2004_54_CE

EN 1838 (CEN2013)

EN 16276

CIE 193

CIE 88

European Regulation

- Emergency for vehicles is provided by an adequate number of luminaires used for general lighting energized from a non interruptible power supply source
- Evacuation for pedestrian that need to abandon the vehicle in emergency situation is provided by a dedicated group of luminaires (markers)
- Evacuation lighting is required for tunnel $> 500\text{m}$ or with AADT (annual ave. daily traffic) > 500 vehicles

Italian tunnel accidents from 2013 to 2017

Source: INAIL

Year	2013	2014	2015	2016	2017
Accidents	596	577	598	708	696
Deaths or injuries	949	921	953	1143	1161
Labor related accidents	38	31	34	43	47
Deaths or injuries labor related	58	46	62	66	72

Accidents in
European Tunnels
from 1949 to ~~2017~~

3207

Deaths or injuries in
European Tunnels
from 1949 to ~~2017~~

5507

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Visibility in smoke – Evacuation lighting

An experimente conducted by Norwegian and Swedish Road Authorities

Source NORDFOU (Report number 2019-002)

> The Finnish Transport Infrastructure Agency



> The Swedish Transport Administration



> The Norwegian Public Roads Administration



> The Danish Road Directorate



> The Icelandic Road and Coastal Administration



> The Faroese Landsverk



Visibility in smoke – Evacuation lighting

Source NORDFOU – Tunnel setting



Image of test tunnel

Visibility in smoke – Evacuation lighting

Source NORDFOU – Luminaire setting

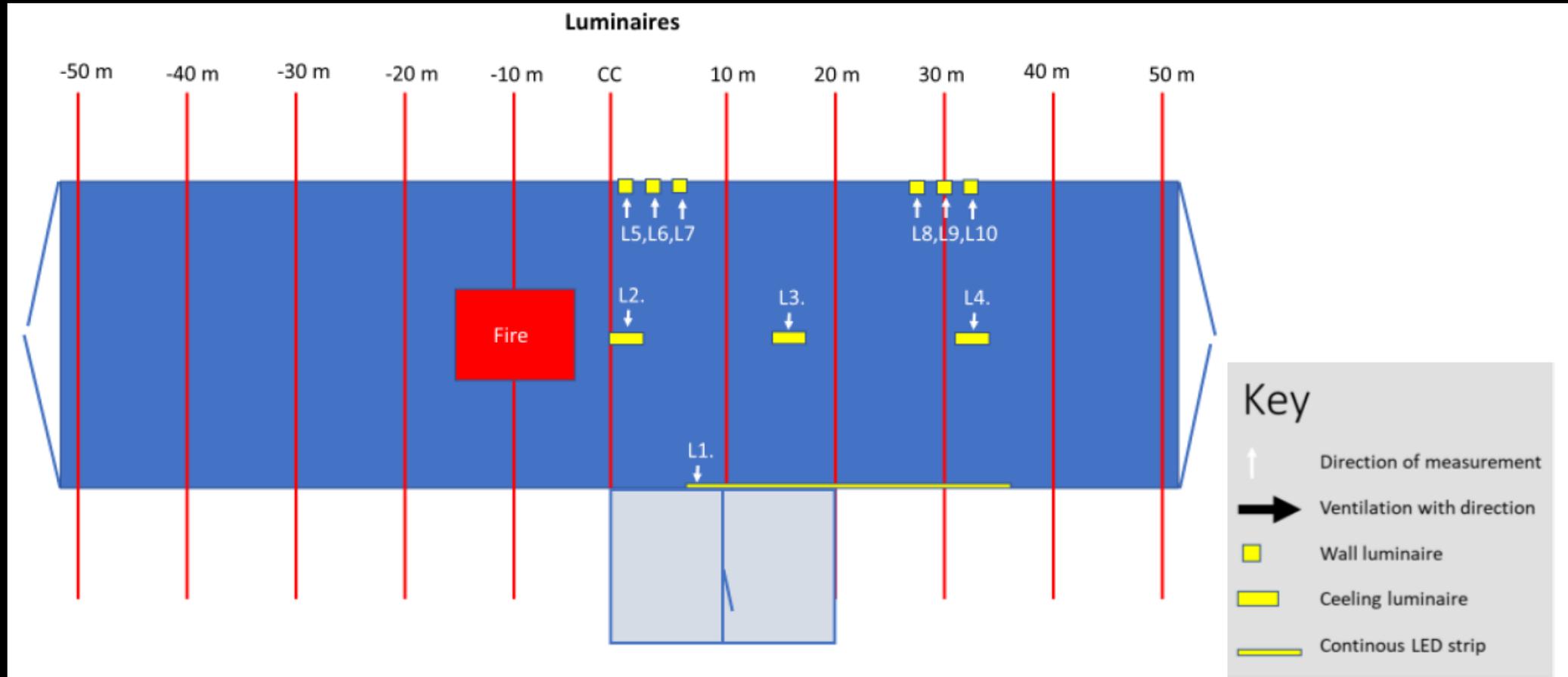


Figure 3 Luminaires in experiment

Visibility in smoke – Evacuation lighting

Source NORDFOU – Sensors setting

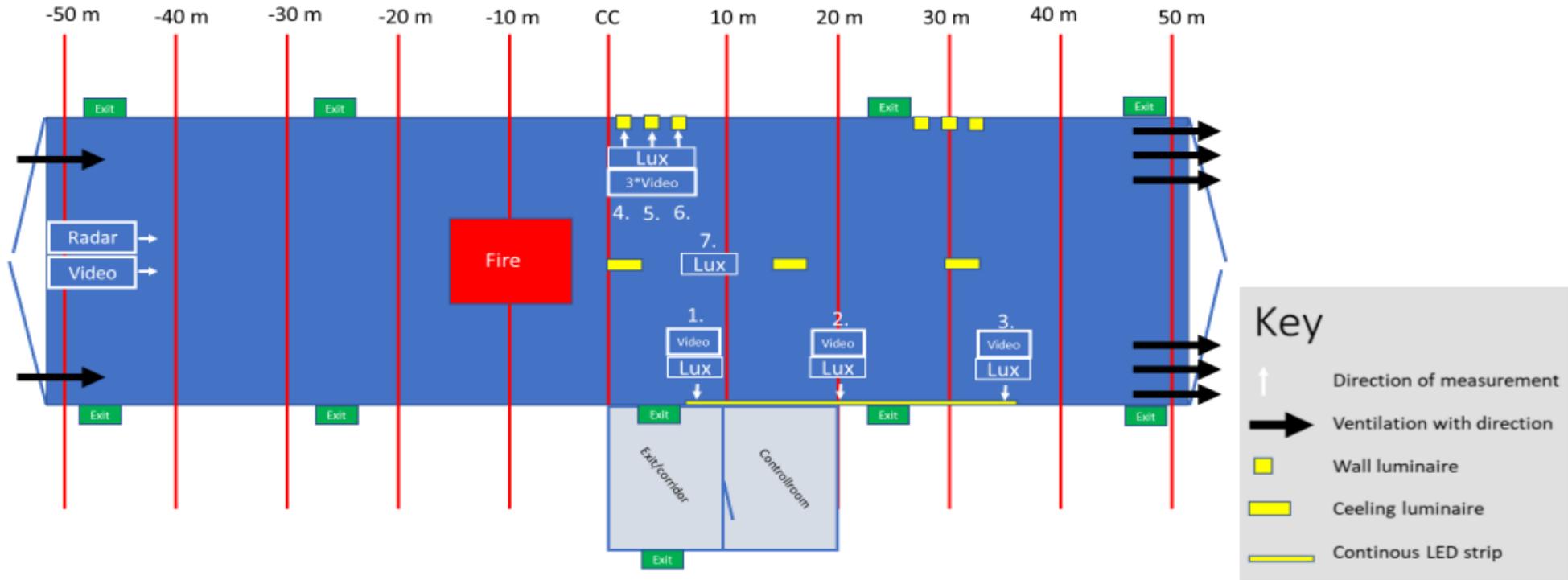
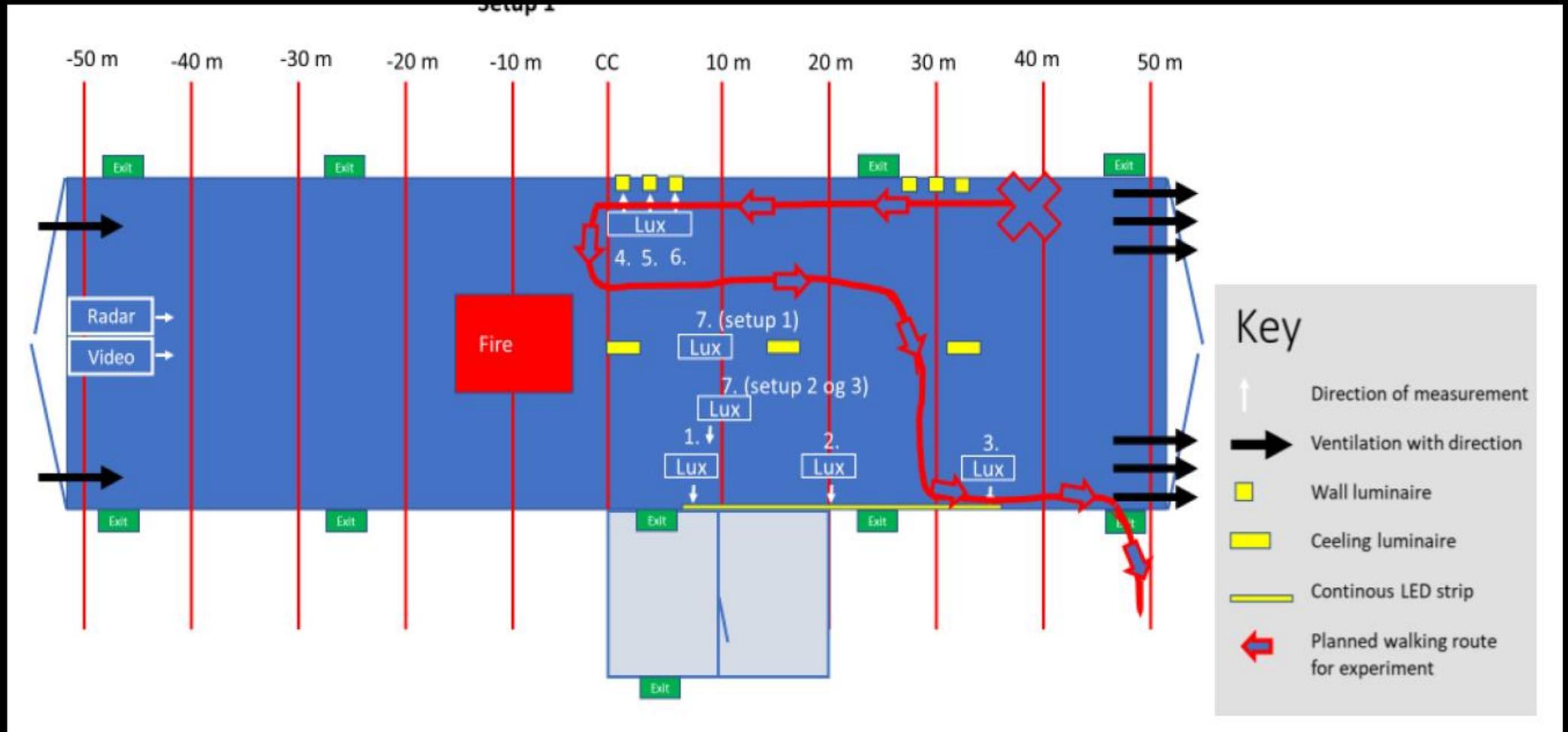


Figure 2 General experiment setup

Visibility in smoke – Evacuation lighting

Source NORDFOU – Walking route





Visibility in smoke – Evacuation lighting

Source NORDFOU (Report number 2019-002)

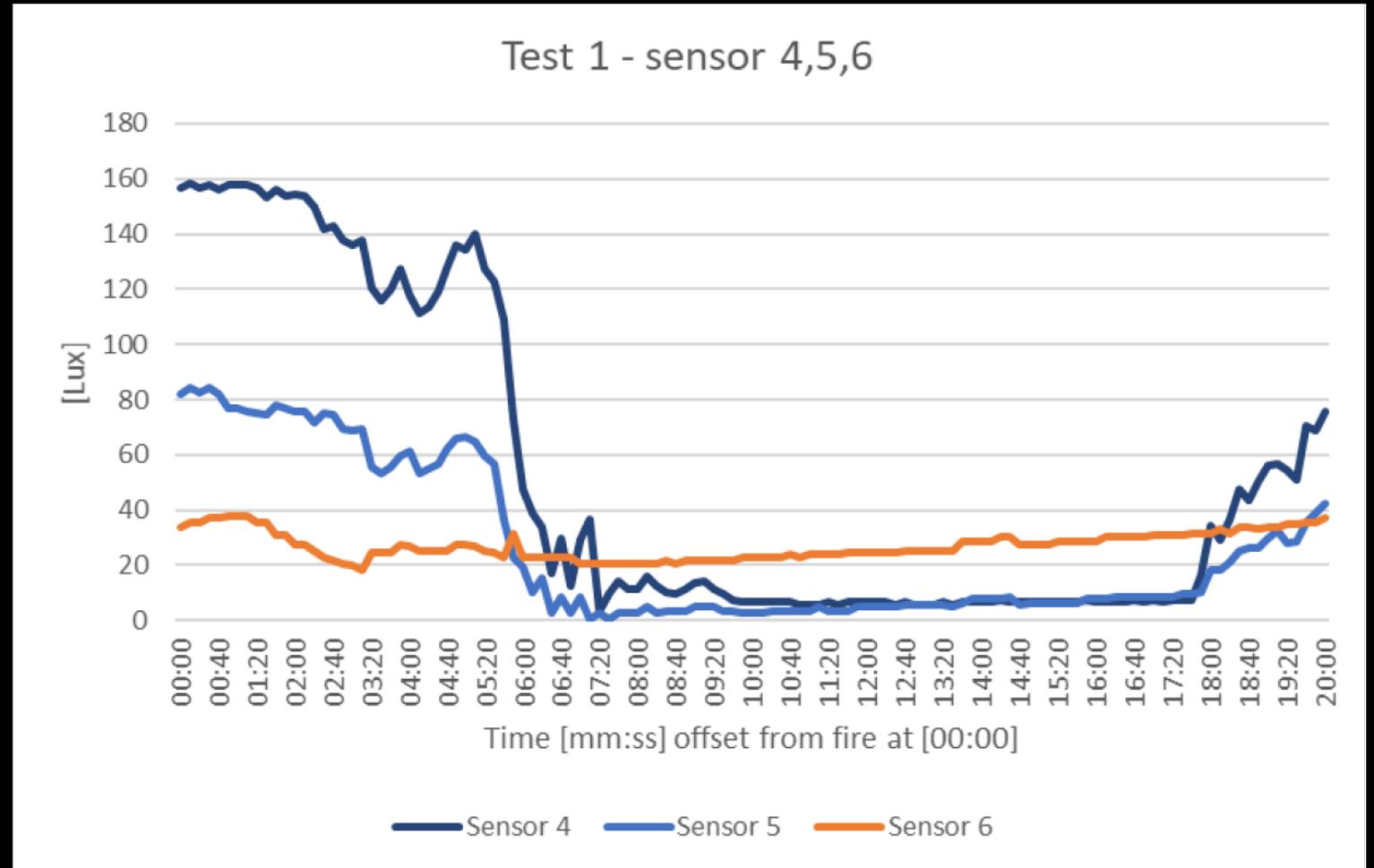
TEST SETTINGS

- Fire applied at time 00:00
- Ventilation off to simulate long tunnel worst scenario
- 12 minutes test
- Fire is off after 12 minutes
- Ventilation is on after after 12 minutes

Visibility in smoke – Evacuation lighting

Source NORDFOU – Markers effectiveness

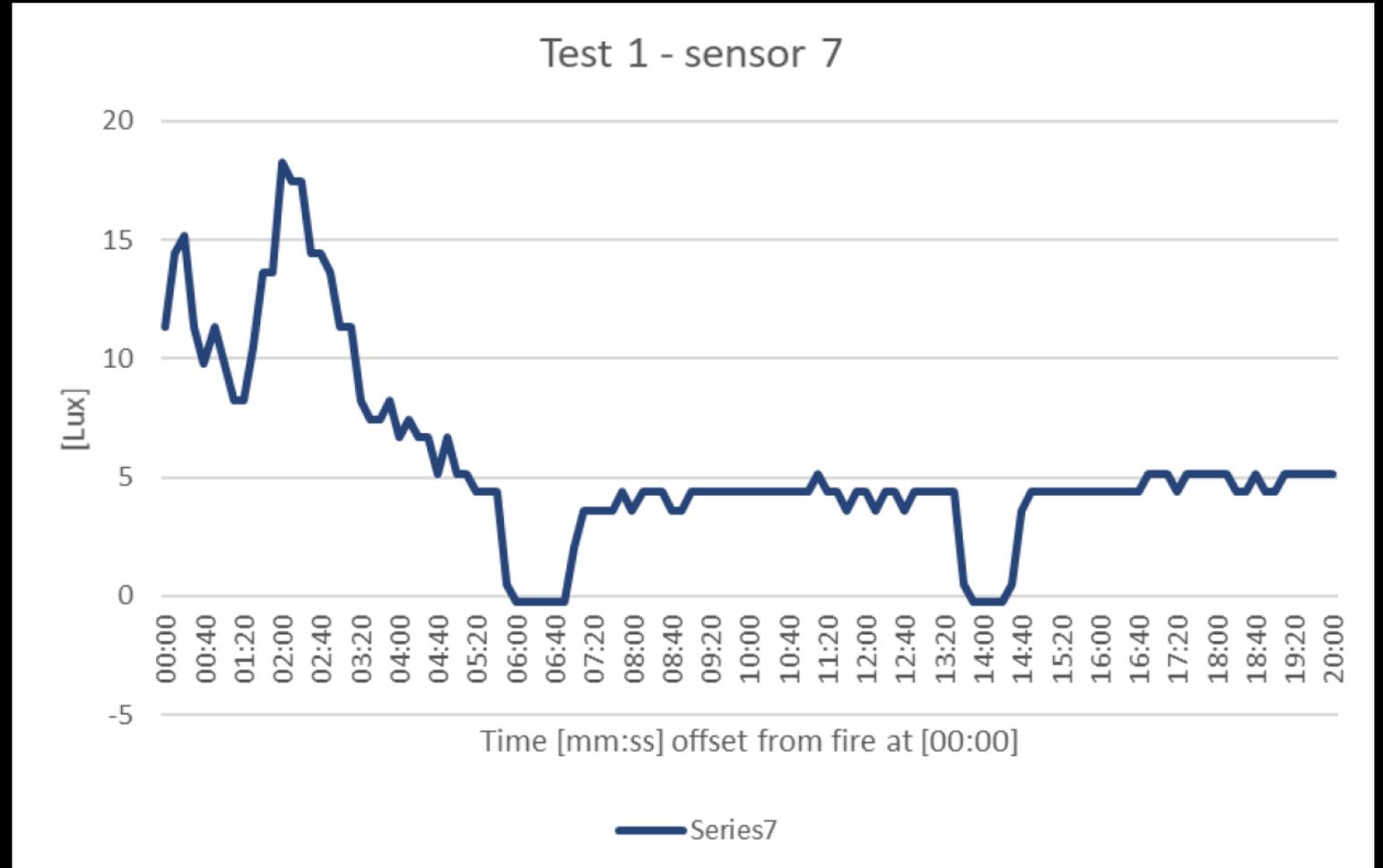
- 87,5% light reduction after 6 minutes at the two sensor closer to fire
- The requirement of 1 lux on the floor or a max 25mt spacing between markers has no practical guidance.



Visibility in smoke – Evacuation lighting

Source NORDFOU – Ceiling luminaires effectiveness

- 75% light reduction after 4 minutes with no recovery after end of fire and start of ventilation
- Normal ceiling light disappears a long time before the smoke becomes a problem at ground level



Visibility in smoke – Evacuation lighting

Source NORDFOU



Cars for test before ↑ after ↓



Visibility in smoke – Evacuation lighting

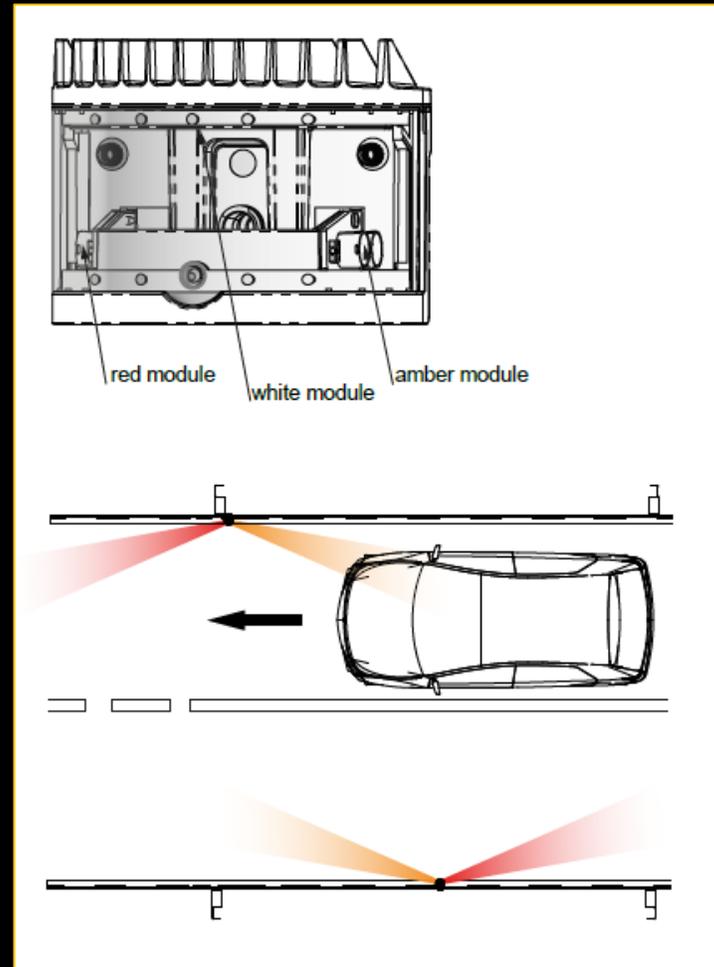
Source NORDFOU – Test Outcome

- In worst cases scenario the smoke conditions create a total blackout with visibility of 1mt.
- The general lighting from the ceiling is completely useless for pedestrian orientation.
- Test show that a maximum spacing of 10 mt between the markers is highly recommended, even with ongoing ventilation.
- A guidance to the pedestrians is still missing even with markers in place

A dynamic marker

Act as a traditional marker to identify evacuation route

Has multiple optical distribution remotely controlled that can adjust and help orientation in emergency



Has two separate light flash to warn both drivers and pedestrians of imminent and ongoing danger

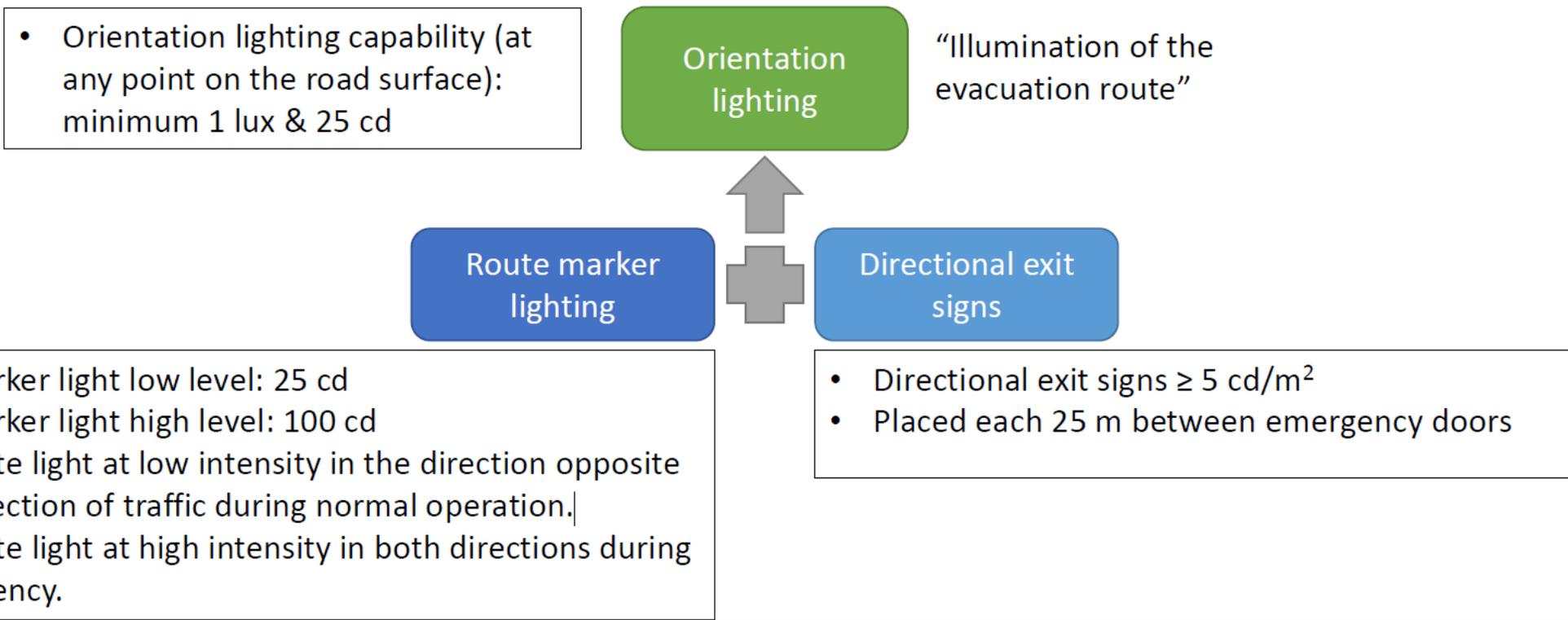
Can integrate general roadway lighting in case of emergency

Marker requirements

- Three lighting scenarios required
 - normal mode (counter traffic light distribution)
 - tidal mode (pro traffic light distribution)
 - emergency mode (symmetrical light distribution)
- One control box every 6 luminaires
- Use of DALI protocol

3. Road Tunnel – Emergency Lighting

- Two different systems and one lighting concept



6.9 Route marker lighting in the road tubes

Route marker lighting shall be provided in the road tubes providing visual guidance during normal operation and marking the escape route when an emergency situation is detected. Route marker lighting shall be provided in both sides of each road tunnel tube.

TEM-DES-05260

517733

Rev. 0
23-05-2022

158 of 292

PDF ID: 513479

Fehmarnbelt Fixed Link

Contract: Tunnel Electrical and Mechanical (TEM)

Volume 6: Design Requirements

The route marker lighting may also provide a part of the overall orientation lighting (i.e. provide the illumination of the evacuation route in the area close to the edge of the carriageway).

TEM-DES-05265

Route marker lights shall emit white light at low intensity in the direction opposite to the direction of traffic during normal operation (i.e. towards oncoming traffic). Route marker lights shall emit white light at low intensity in the opposite direction during tidal flow operation.

TEM-DES-05270

Route marker lights shall emit white light at high intensity in both directions during an emergency.

TEM-DES-05275

Route marker lights shall emit a light intensity in compliance with EN 16276:2013 and DIN 67524-1:2019. The light intensity shall be automatically increased to the high intensity when fire is detected; as detailed in EN 16276:2013. Lighting control shall be done by dividing the system into longitudinal sections suitable for operational control and switching purposes. It shall be possible to control the route marker lights from the ICA system.

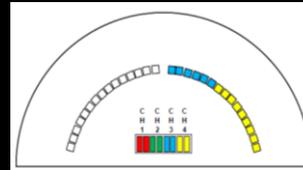
TEM-DES-05280

The lighting shall be placed at the midpoints between the directional exit signs and be located near the top of the concrete barrier.

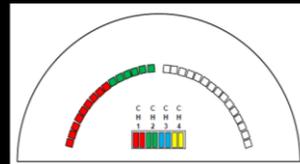
TEM-DES-05285



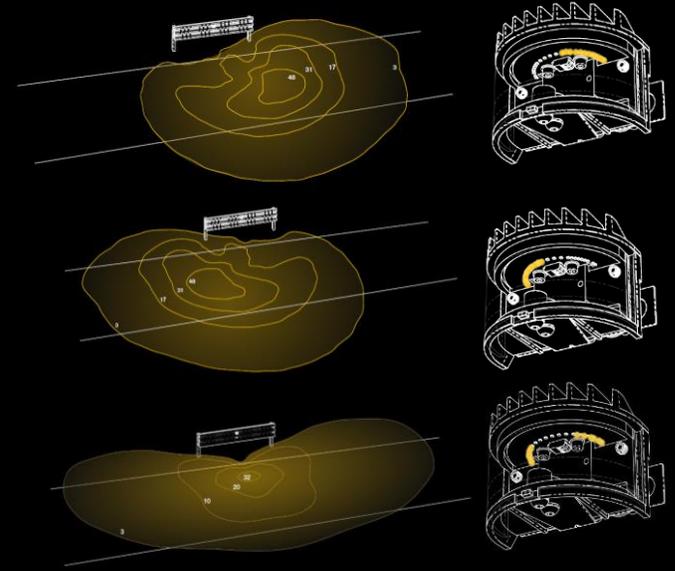
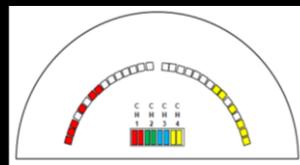
Normal /Tidal Mode



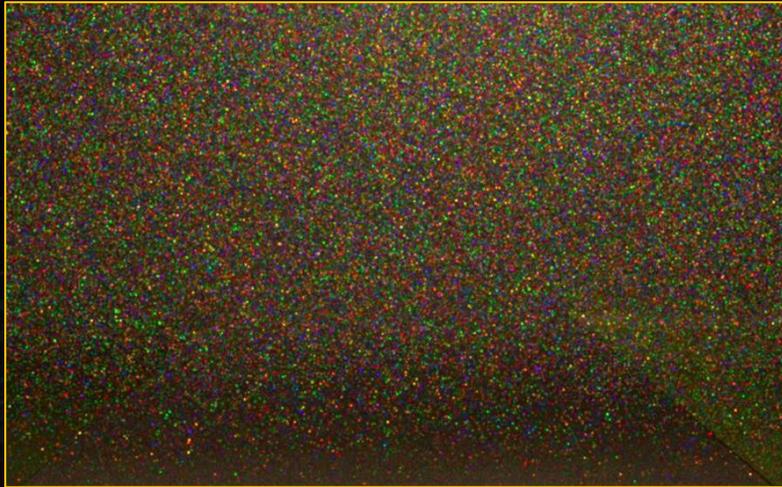
Normal /Tidal Mode



Emergency Mode



Light effectiveness in smoke and fog



Conventional

A wall of fog drastically reduces a driver's visibility and reduces the luminance on the road



Lateral lighting

Lowering the light source to 1m from the ground makes the fog wall 10 times lower and delimits the perimeter of the road

Configurazioni Sideis

Rev1.2 150722

Sideis versione: BIANCO PBR+FCR / AMBRA PBF + SX+DX

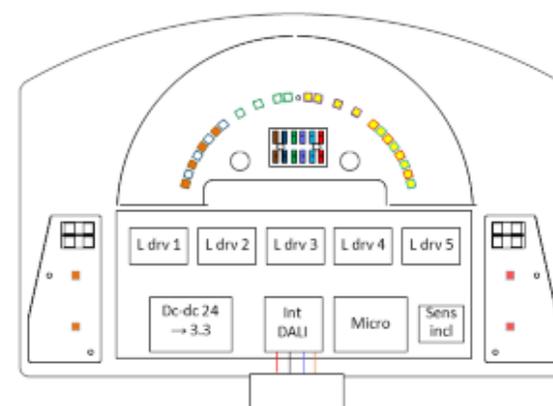
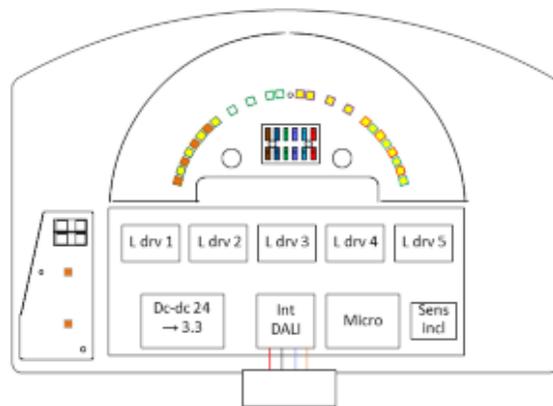
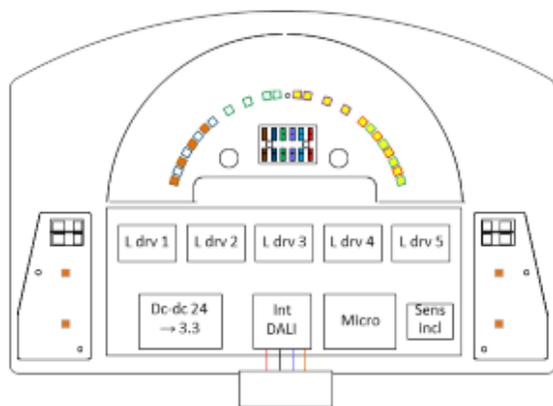
Sideis versione: BIANCO PBR+FCR+PBL / AMBRA SX

Sideis versione: BIANCO PBR+FCR / AMBRA PBF + SX / ROSSO DX

Canale/LED	Ruolo gruppo led scheda LED	Driver led	controllo
CH1	Non montato	---	---
CH2	Led bianco gruppo FCR	L drv 3	Off / On / dimm 0-100%
CH3	Non montato	---	---
CH4	Led bianco gruppo PBR5	L drv 2	Off / On / dimm 0-100%
CH5	Led ambra gruppo PBL	L drv 4	Off / On con lampeggio
CH6	Led bianco gruppo PBRL	L drv 1	Off / On / dimm 0-100%
CH7	Led ambra segnalazione sx-dx	L drv 5	Off / On con lampeggio

Canale/LED	Ruolo gruppo led scheda LED	Driver led	controllo
CH1	Non montato	---	---
CH2	Led bianco gruppo FCR	L drv 3	Off / On / dimm 0-100%
CH3	Led bianco gruppo PBL	---	Off / On / dimm 0-100%
CH4	Led bianco gruppo PBR	L drv 2	Off / On / dimm 0-100%
CH5	Led ambra gruppo PBL	L drv 4	---
CH6	Led bianco gruppo PBR	L drv 1	Off / On / dimm 0-100%
CH7	Led ambra segnalazione sx-dx	L drv 5	Off / On con lampeggio

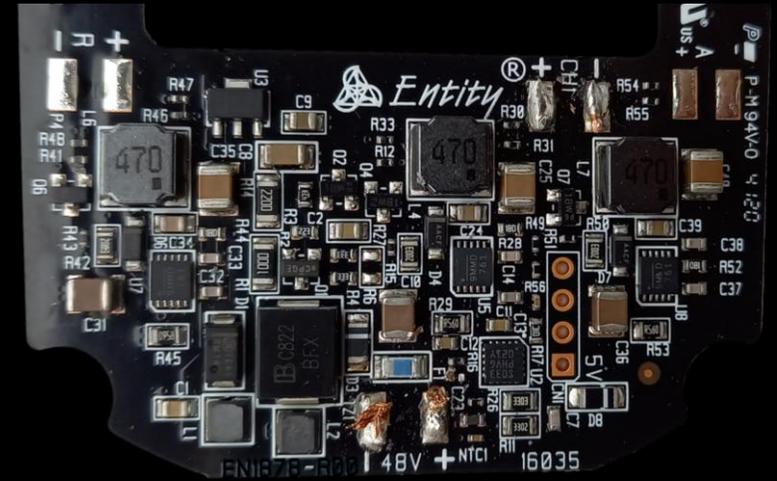
Canale/LED	Ruolo gruppo led scheda LED	Driver led	controllo
CH1	Non montato	---	---
CH2	Led bianco gruppo FCR	L drv 3	Off / On / dimm 0-100%
CH3	Non montato	---	---
CH4	Led bianco gruppo PBR	L drv 2	Off / On / dimm 0-100%
CH5	Led ambra gruppo PBL+DX	L drv 4	Off / On con lampeggio
CH6	Led bianco gruppo PBR	L drv 1	Off / On / dimm 0-100%
CH7	Led rosso contromano	L drv 5	Off / On con lampeggio





Patented Optic

- It combines principles of refraction and reflection. It is composed of:
 1. A light guide which by total internal reflection collects and flattens all the photons emitted by the LEDs
 2. A curved lens that refracts the collected light and distributes it on the road



48V intelligent DC/DC on-board

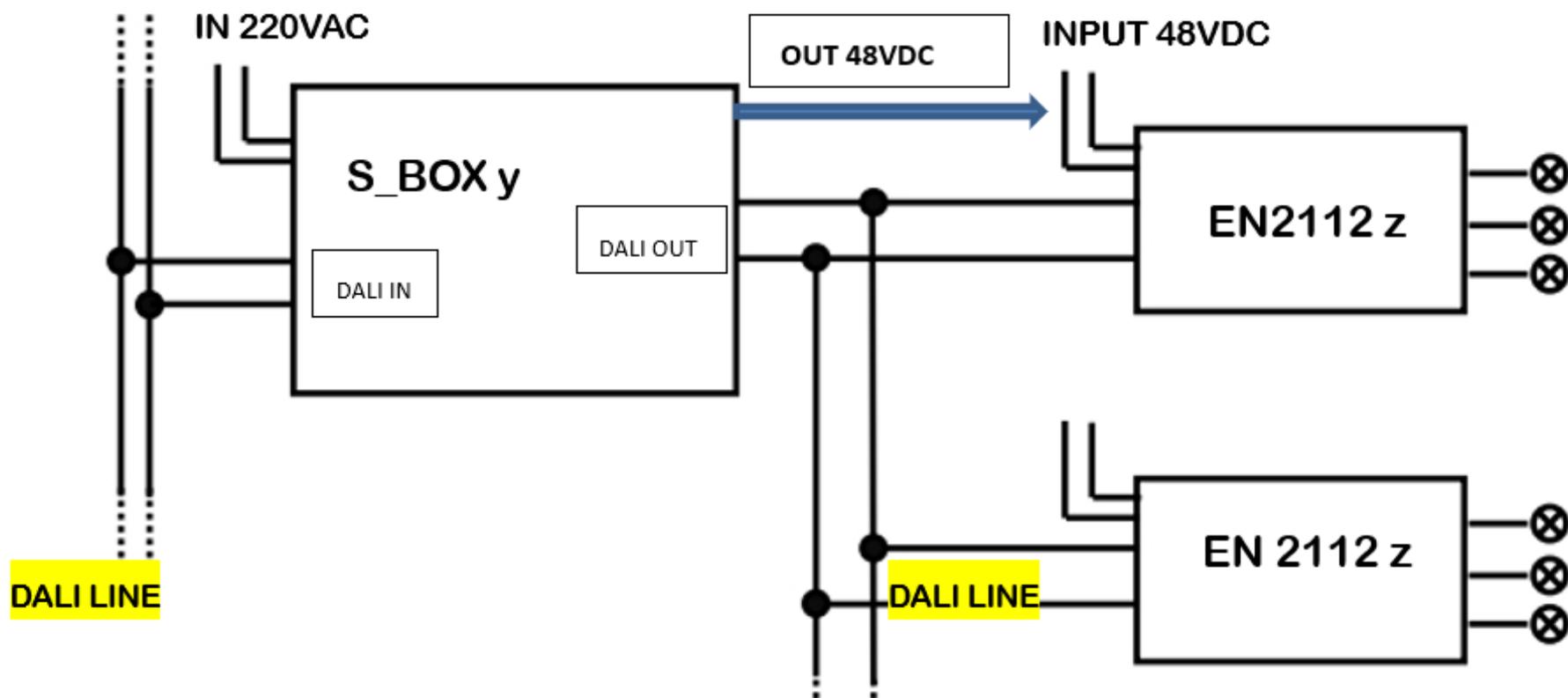
- Allows flexible lighting control options, from simple dimming to an advanced central management system

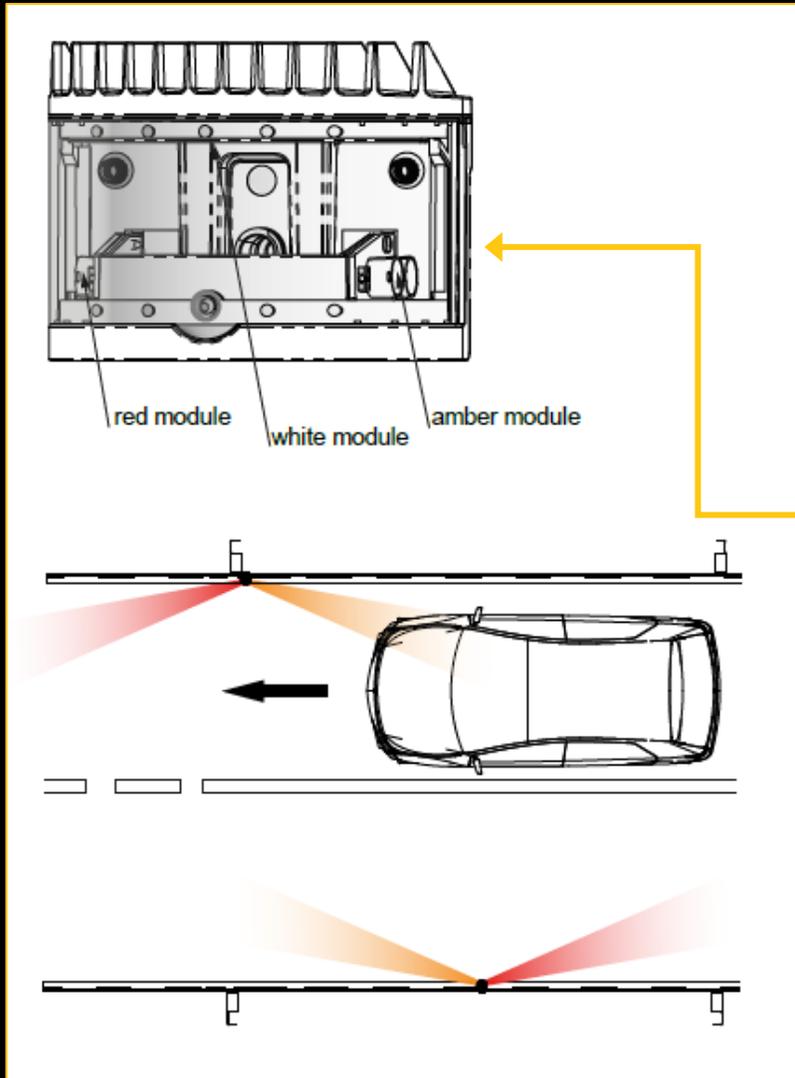


ENTITY

SIDEis SPECIFICATION EN2112 + DALI

OBJECT: Specification of EN2112 control via DALI





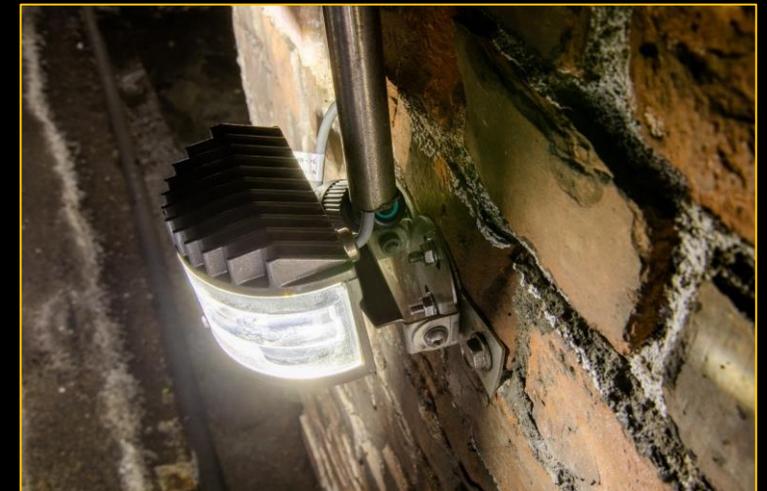
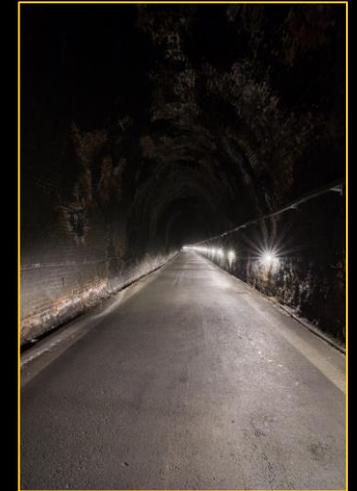
Integrated Signalling Modules

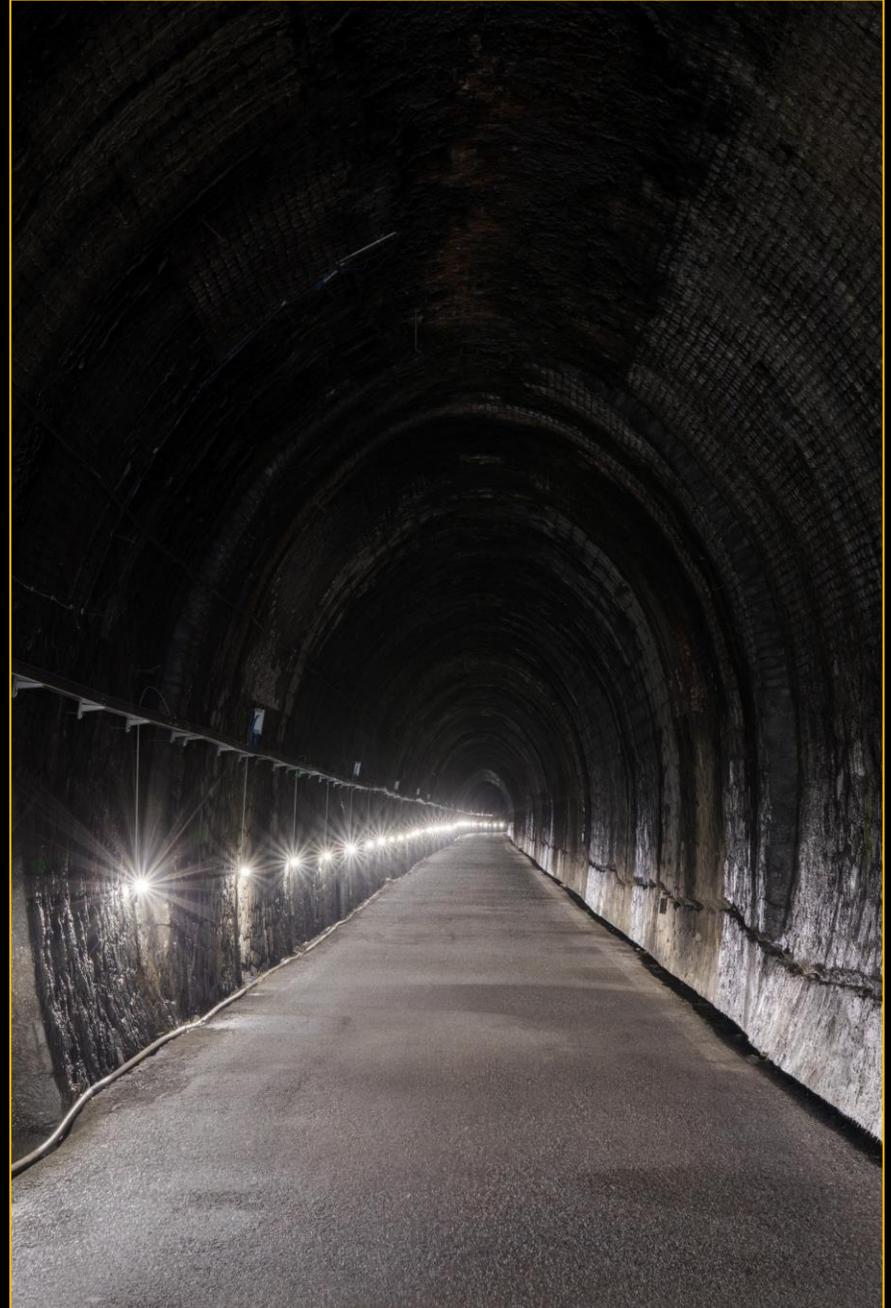
SIDEIS can be equipped with two signaling modules:

1. The left module : Mounted on the bottom of the body
2. The right module : next to the internal driver to emit a continuous or pulsed amber / red / green / blue light

The intelligent driver and signaling modules allows SIDEIS to receive remote control commands and acts as an intelligent light body, capable of creating signaling scenarios for road users.

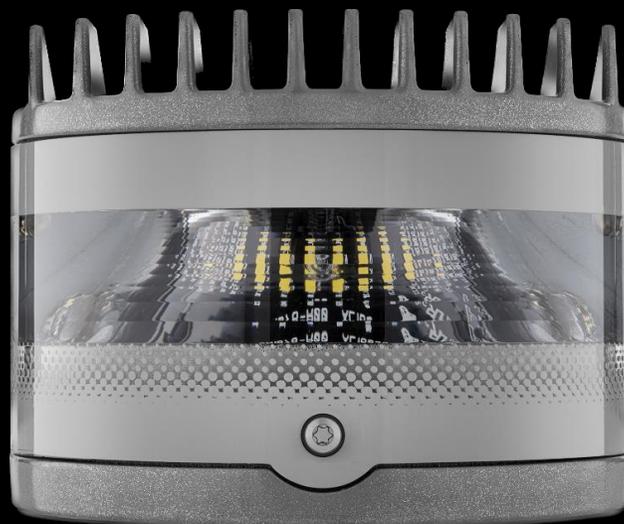
An ancient Railway tunnels in Sestri Levante, Italy- December 2020







Patent for Sideis tunnel luminaire



Ministero delle Imprese e del Made in Italy
DIREZIONE GENERALE PER LA TUTELA DELLA PROPRIETÀ INDUSTRIALE - UIBM

ATTESTATO DI BREVETTO PER INVENZIONE INDUSTRIALE

Il presente brevetto viene concesso per l'invenzione oggetto della domanda:

N. 102021000023114

TITOLARE/I: • SIDEIS S.R.L. 100.0%
Cicconetti Andrea

DOMICILIO: Aceapi S.r.l.
Via Garibaldi 3
40124 Bologna

INVENTORE/I: • TARGETTI Massimo
• GERLI Alberto
• TRAVAGLINI Daniele

TITOLO: Dispositivo e sistema di illuminazione per gallerie stradali

CLASSIFICA: F21S

DATA DEPOSITO: 07/09/2021

Roma, 25/10/2023

Il Dirigente della Divisione VII
Loredana Guglielmetti



SIDEiS