

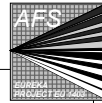
Adaptive Front Lighting Systems (AFS)

Presentation to the 48th Session of GRE
(9-12 April 2002) Agenda items 1.2. and 4.2.

Contents

- | | |
|---------------------|----------------------------|
| 1 Background | 5 Photometry |
| 2 Definitions | 6 Safety |
| 3 Functions / Modes | 7 Documentation & Approval |
| 4 The Appearance | |

Eureka Project EU 1403 The Program and the Milestones



- 1994 Phase I**
Drivers /Traffic Needs - Improvement Potential
Possible Functions & Modes Definition - **Feasibility**
Initial Tests - Market Response
- 1997 Phase II**
Field Studies
Scientific Support
Demonstration Lamps and Vehicles / Road Tests
- 1999 Phase III**
Balocco and 44th GRE (Apr. 2000) **Presentation**
Requirements **Draft Specification**
Support to GTB's work for draft Regulation

w203002

Eureka Project EU 1403 Situations and Possible Modes



Adaptation modes				
	passing beam	main beam	DRL	Front fog
Country / normal / narrow road road shape surroundings speed / traffic density / traffic direction	x	x		
Motorway / wide road fast driving /motorized traffic only flat road without intersections special signs	x			
Town / lit road restricted speed high traffic density sidewalks / pedestrian	x			
Wet road glossy road surface precipitation	x			
Turns / bends of any road	x	x		
Daytime			x	
Fog				x

w203003

AFS Acceptance and Market Proposed Passing Beams, Customers Ranking



Yes, I need an improved Passing beam lighting for..	Study 1996 France, Italy, Sweden	Study 1995 Germany
Wet roads	rank 1	rank 1
Country roads	rank 2	rank 2
Bends	rank 3	} rank 3
Motorways	rank 4	
Town Situation	rank 5	(rank 4)

Comparison with other features/ values (1996)

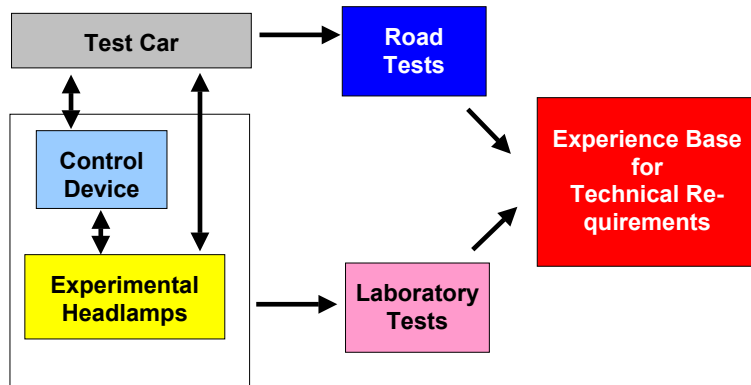
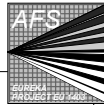
Adverse weather /wet road mode = as airbag (some 650 EUR option at that time)

Other AFS modes = as front fog lamps

w203004

Eureka Project EU 1403

Phase II Test Activities



w203005

Eureka Project EU 1403

Balocco Test Cars and Lamps



Balocco
Demo & Test Cars
and the Crews

XCE..



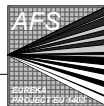
XCTVEWR..



w203007

Eureka Project EU 1403

AFS Presentation at Balocco (1999)



Project Presentation in the
Premises of Fiat Lancia in
Balocco (Italy)

Demo System
Explanation at Daytime
prior to the Tests



w203006

Eureka Project EU 1403

44th GRE: AFS Presentation

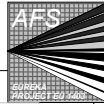


67. On 4 April, late in the evening after the session, a **demonstration was given inside the premises of the Palais des Nations of a number of configurations of AFS installed on ten passenger cars (M1) of various types and makes.** The GRE experts were provided the opportunity to drive these test vehicles. ...
68. Following the demonstration, all **GRE experts acknowledged the experience with the new technology of front lighting, designed to improve the illumination and to adapt it to various driving situations, whilst reducing glare.** ...

w203008

Eureka Project EU 1403

GTB - AFS Nov 2000 to Nov 2001



90th GTB
Paris 11/2000

Special Session Mandate

Special 1

First Check and Definition of Tasks

91st GTB
Rome 05/2001

Report, Additional Questions

Special 2

Main Discussion / Solutions
Light Source Module, R48 Amendment Structure, Photometry, Control,
Language / Editorials

Special 3

Settlement of Open Points

92nd GTB
Kyoto 11/2001

GTB Release

w203009

AFS - Draft Regulation

System Definition



Adaptive front lighting system (AFS) means ..

- ▶ *..a lighting device, providing **two or more differing modes for automatic adaptation** of the beam characteristics to varying conditions of use*
- ▶ *of the **passing beam** and, if it applies, the **main beam** and/or the **day-time running light**;*
- ▶ *such systems consist of the **system control**, one or more **supply and operating device(s)**, if any, and the **installation units of the right and of the left side of the vehicle**.*

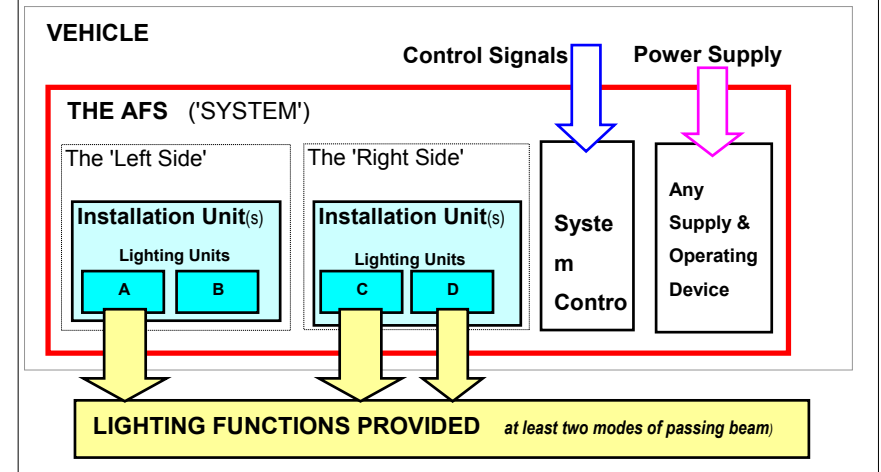
Para. 2.7.25 (AFS definition) of R.48 = scope of new Regulation on AFS

w203011

2 The Definitions

AFS - Draft Regulation

System Definition



w203012

AFS - Draft Regulation System Definition

Within the passing beam particular photometric provisions are defined..

..for the following classes

- (1) CLASS C (basic) passing beam
- (2) CLASS V (town) passing beam
- (3) CLASS E (motorway) passing beam
- (4) CLASS W (wet road) passing beam

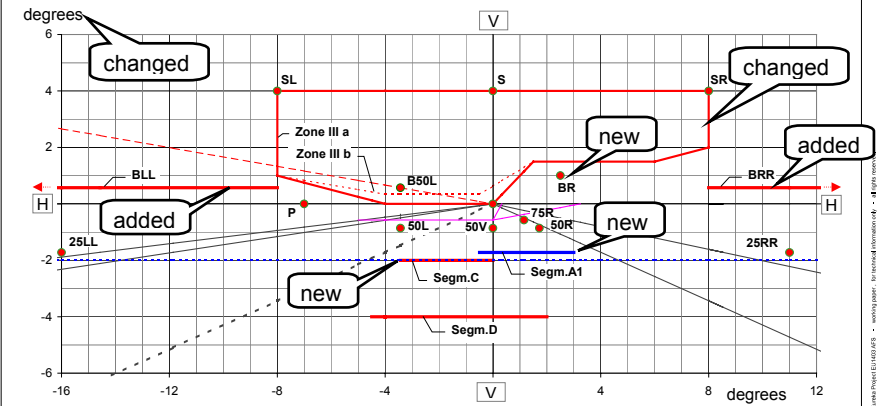
and the 'BENDING MODES' of them.

Within each class differing 'MODES' (including the one or more bending modes) can be provided.

w203013

Passing Beam Requirements Annex 3, Figure 1

New/changed elements, compared with R.112/R.98



w203015

3 The Functions and Modes

3.1 General / The Class C (Basic) Passing Beam

Passing Beam Requirements Annex 3, Table 1

tabled requirements expressed in lux @ 25m				Position /degrees		class C (basic) passing beam		class V (town) passing beam		class E (motorway) passing beam		class W (wet road) passing beam	
No	Element	horizontal	vertical	all/ from	to	min	max	min	max	min	max	min	max
1	B50L	4/	L 3.43	U 0.57		0.4	0.4			0.7			0.7
2	HV	4/	V	H		0.7	0.7						
3	BR	4/	R 2.5	U 1	0.2	2	0.1	1		0.2	2	0.2	3
4	Segment BRR	4/	R 8	R 20	U 0.57	4	1	1		4	4		6
5	Segment BLL 4/ and above it		L 8	L 20	U 0.57	0.7		1		1			1
6			L 7	H	0.1							0.1	
7	Zone III (as specified by Table 3 of					0.7		0.7		1			1
8	S		V	U 4	0.1		0.1			0.1		0.1	
9	SL		L 8	U 4	0.05					0.05		0.05	
10	SR		R 8	U 4	0.05					0.05		0.05	
11	50 R		R 1.72	D 0.86			6						
12	75 R		R 1.15	D 0.57	12					18		24	
13	50 V		V	D 0.86	6		3			12		12	
14	50L		L 3.43	D 0.86	4.2	25	2	25		8		8	35
15	25LL		L 16	D 1.72	1.4		1			1.4		4	
16	25RR		R 11	D 1.72	1.4		1			1.4		4	
17	Segment C and below it		L 3.5	V	D 2								20 2/
18	Segment D (10m-Line) and below it		L 4.5	R 2.0	D 2								8 2/
19	Emax 3/					20	50	10	50	20	90	35	80 2/

Part A

Part B

end)

max 18 lx, if the system is provided to provide also a class W (wet road) passing beam

2/ requirements according to the provisions indicated in Table 4 below apply in addition the contribution of each side of the system, when measured according to the provisions of 4/ Annex 10 to this Regulation shall not be less than 0,05 lx

1/ B (bending modes): Table 1 Part A applies, however with the lines No.1, 2, 7, 14 and 19 being replaced by those listed hereunder

1	B50L	4/	L 3.43	U 0.57		0.6		0.6					0.9
2	HV	4/				1		1					
7	Zone III (as specified by Table 3 of this annex)									1			1
14	50L		L 3.43	D 0.86	2		1			4		4	
19	Emax	5/				12	50	6	50	12	90	24	80 2/

5/ Position requirements as indicated in paragraph 6.2.6.2 of this Regulation

Passing Beam Requirements Annex 3, Table 2

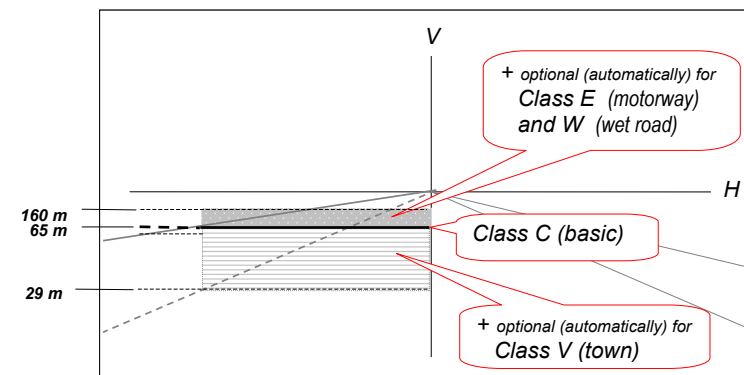
Emax and cut-off provisions

2	angular position / extend in degrees	Class C (basic) passing beam		Class V (town) passing beam		Class E (motorway) passing beam		Class W (wet road) passing beam	
		horiz.	vertical	horiz.	vertical	horiz.	vertical	horiz.	vertical
2-1	Emax shall not be positioned outside of the rectangle extending (above "Segment A1")	from $H = 0,5L$ to $3R$	from $V = 0,3D$ to $1,72D$	from $V = 0,3D$ to $1,72D$	from $H = 0,5L$ to $3R$	from $V = 0,1D$ to $1,72D$	from $H = 0,5L$ to $3R$	from $V = 0,3D$ to $1,72D$	from $V = 0,3D$ to $1,72D$
2-2	the "cut-off" and part(s) of shall: - comply with the requirements of paragraph 1. of Annex 9 to this Regulation and be positioned with its "kink" at $H = 0$ and - be positioned with its "straight horizontal part"								
			at $V = 0,57D$		not above $0,57D$ and not below $1,3D$		not above $0,23D$ and not below $0,57D$		not above $0,23D$ and not below $0,57D$

w203017

Passing Beam Requirements Annex 3 Table 2.2.

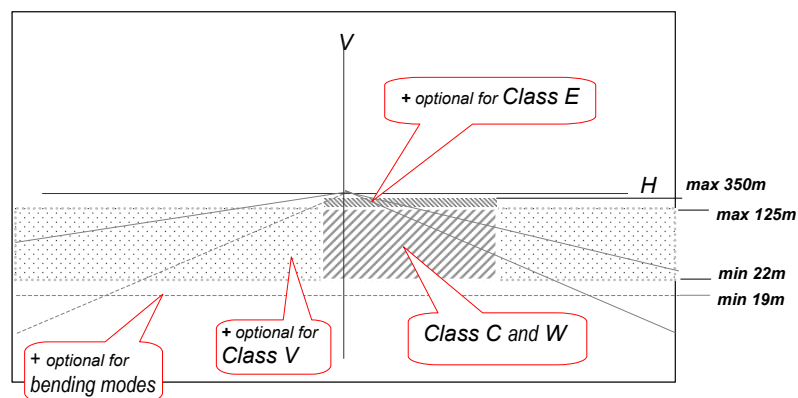
Optional left side cut-off position



w203019

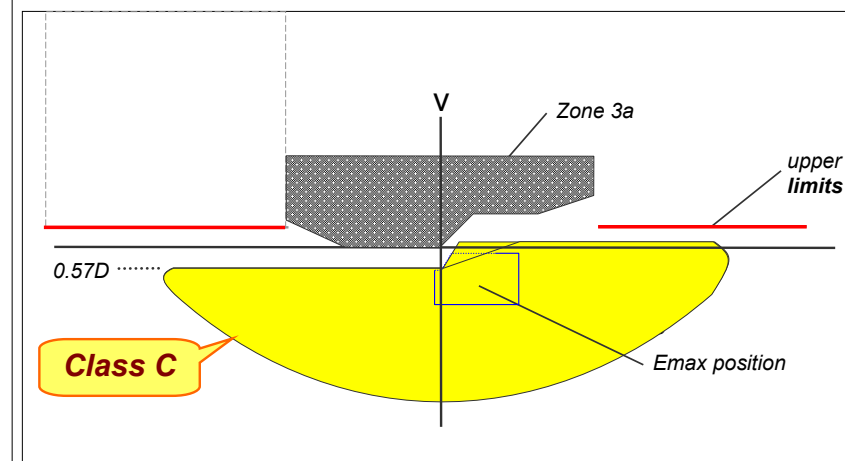
Passing Beam Requirements Annex 3 Table 2.1.

Optional beam Emax position



w203018

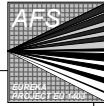
Class C (basic) Passing Beam The Beam Pattern, Schematically on Screen



w203020

Class C (basic) Passing Beam

The Automatic Activation



When the passing beam is switched on:

The class C (basic) passing beam:

- ▶ **must be emitted**
 - when none of the signals (E-, V-, W-) is present
 - in case of adjustment of the system or parts of (means required)
- ▶ **may be emitted**
 - at any time,
 - in case of failure of any other passing beam mode
- ▶ **is allowed be modified** within the range of requirements and according to the system description, due to the presence of the T-signal and /or any additional specified signal (e.g. indicating that a certain speed threshold is exceeded)

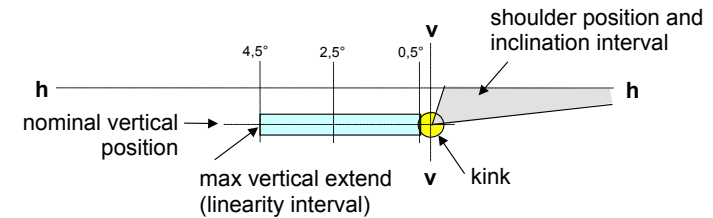
w203021

Passing Beam Provisions

Cut-Off Definitions (2)



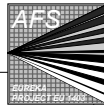
"Cut-Off" Adjustment



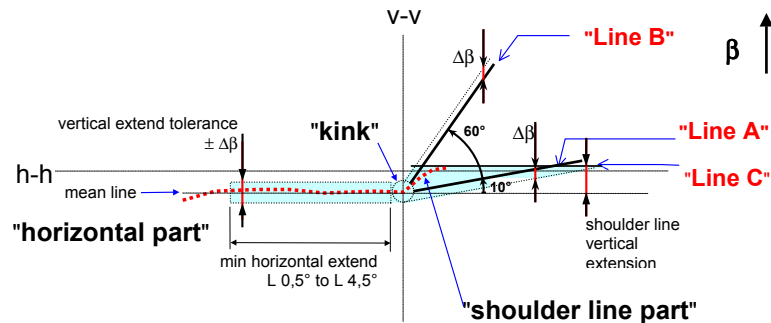
w203023

Passing Beam Provisions

Cut-Off Definitions (1)



Shape of the "cut-off" line

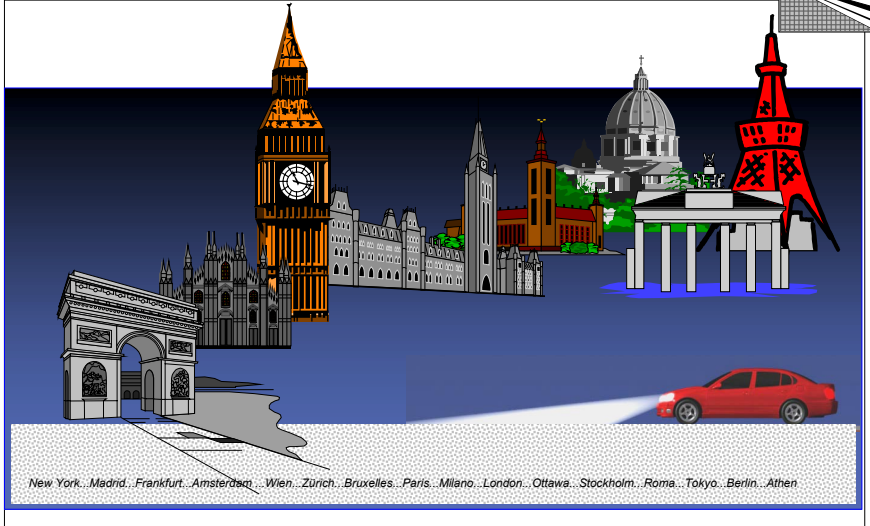


w203022

3.2 The Class V (Town) Passing Beam

Class V (town) Passing Beam

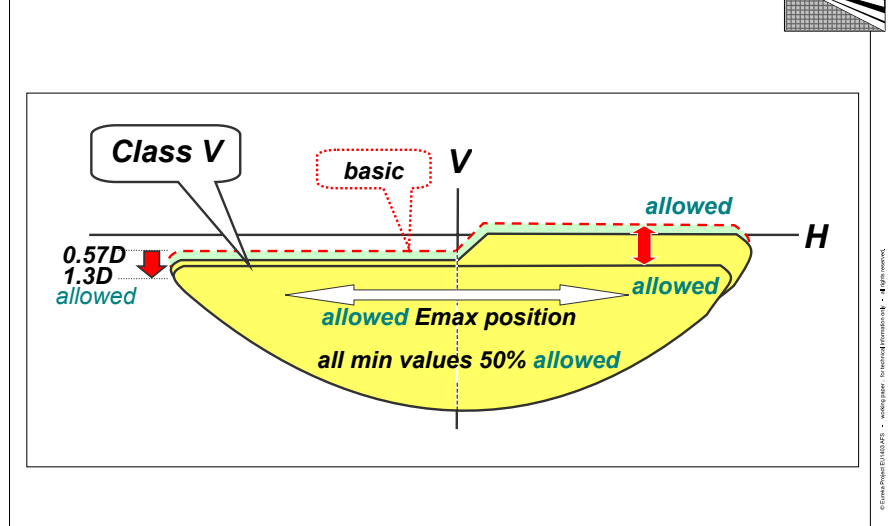
The Situation (1)



w203025

Class V (town) Passing Beam

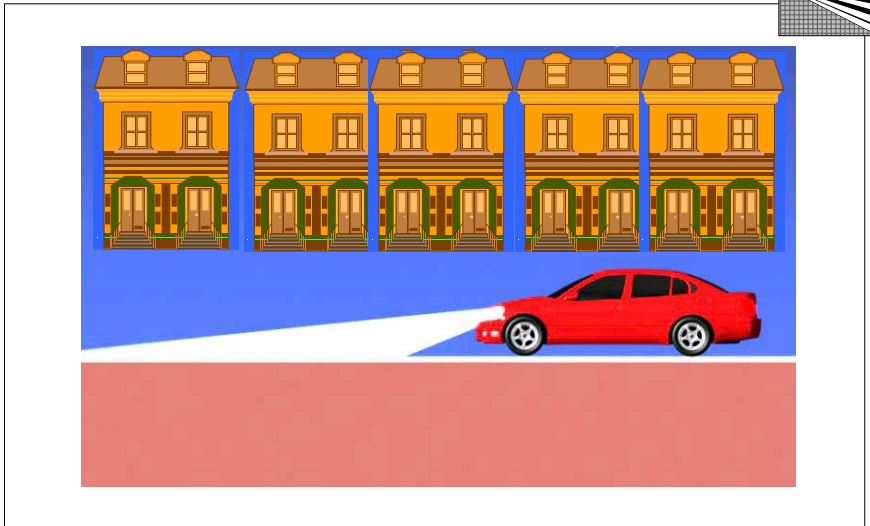
The Beam Pattern, Schematically on Screen



w203027

Class V (town) Passing Beam

The Situation (2)



w203026

Class V (town) Passing Beam

The Automatic Activation

When the passing beam is switched on:

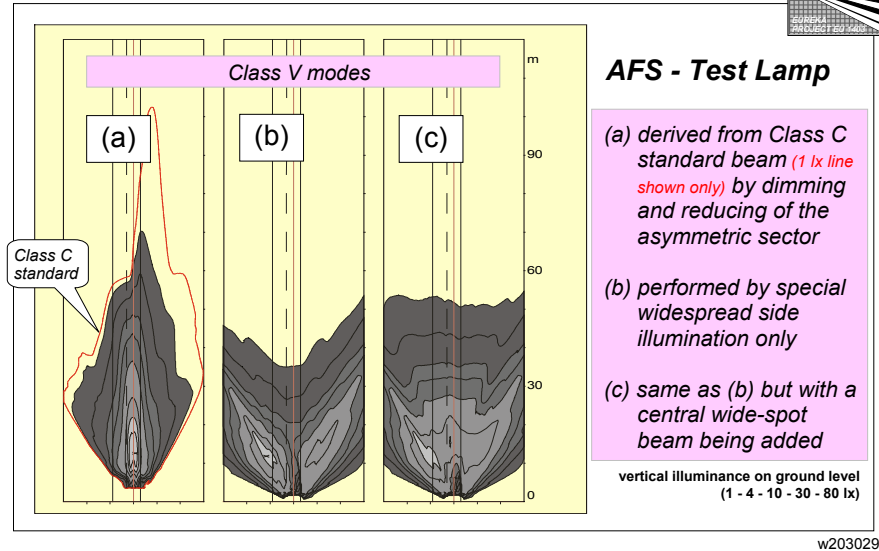
The class V (town) passing beam may be emitted if the vehicle generates the "V- signal".

*This is allowed to be generated only:
if the vehicle's speed does not exceed 60 km/h;
notwithstanding the smart application of any light sensors,
camera devices, localization sensors, telemetry systems, or
others;*

*it is not allowed to be generated at >60km/h
the car's lighting - even if not needed - has the priority
for redundancy reasons*

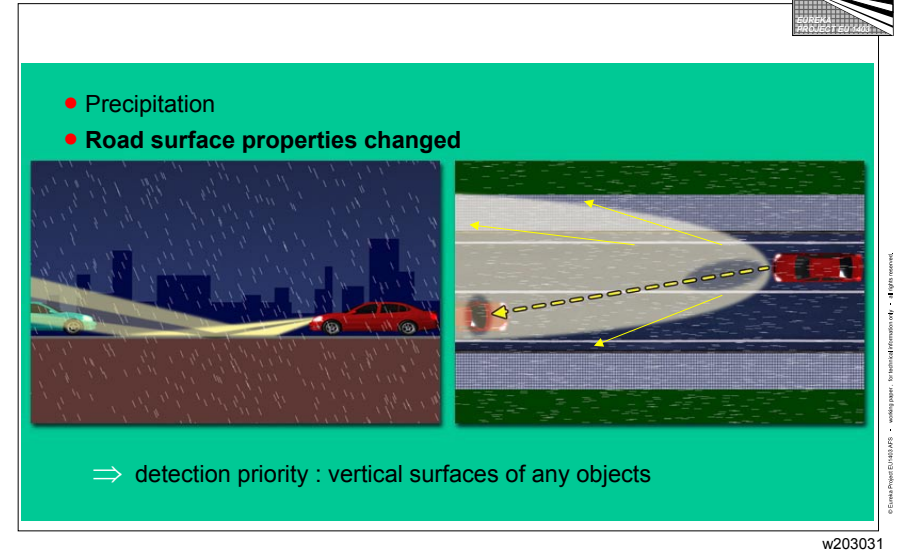
w203028

AFS Passing Beams (Examples) Bird's Eye View Comparison

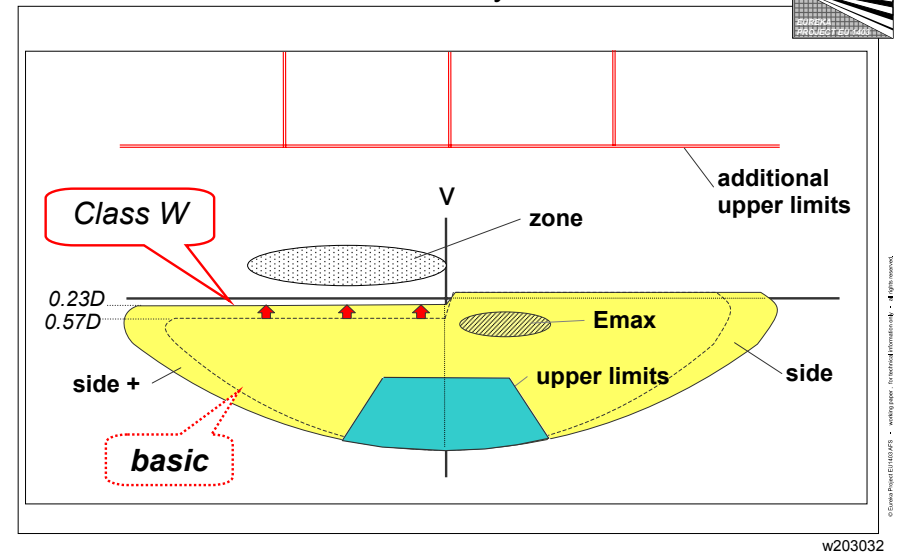


3.3 The Class W (Wet Road) Passing Beam

Class W (wet road) Passing Beam The Situation



Class W (wet road) Passing Beam The Beam Pattern, Schematically on Screen



Class W (wet road) Passing Beam The Automatic Activation



When the passing beam is switched on:

The class W (wet-road) passing beam may be emitted, if the vehicle generates the "W-signal".

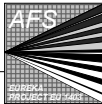
This is allowed to be generated only:

- a) in general
 - if wet road and/or rain or snowfall is detected and
 - the front fog lamp (if any) is not switched on
- b) especially
 - windshield wiper has operated for ≥ 2 min, and/or
 - road wetness is automatically detected by any special means

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w203033

Class W (wet road) Passing Beam Functionality – Requirements on the 25m Screen



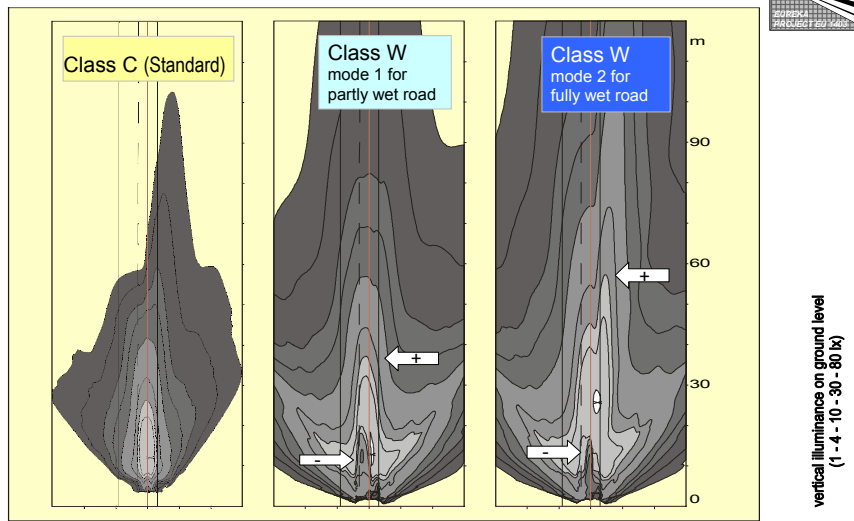
Passing beam requirements comparison

<u>lx @25m</u>	Class W	grade 2 fully wet road	grade 1 partly wet road	Class C any type of road
E_{max} (fixed position area, including 50R and 75R)	≤ 100	≤ 80	≤ 50	
foreground segment D (10m)	≤ 4	≤ 8 lx	≤ 18	
segment C (20m)	≤ 10	≤ 20 lx	(no req.)	
road curb minimum illumination 25RR/LL	≥ 4	≥ 4	$\geq 1,4$	
direct illuminance values B50L, BR, BRR	$\leq 0,7..5$	$\leq 0,7..5$	$\leq 0,4..2$	

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w203035

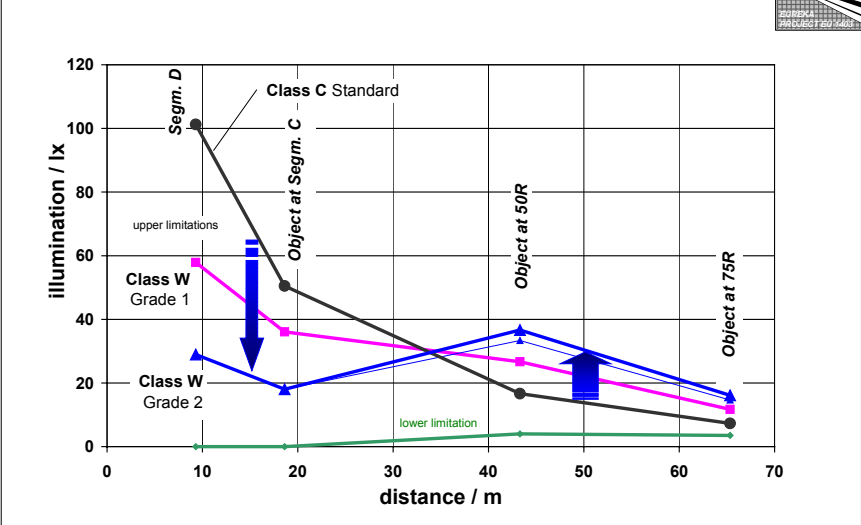
AFS Passing Beams (Examples) Bird's Eye View Comparison



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w203034

Class W (wet road) Passing Beam Functionality - Illumination of Objects on the Road

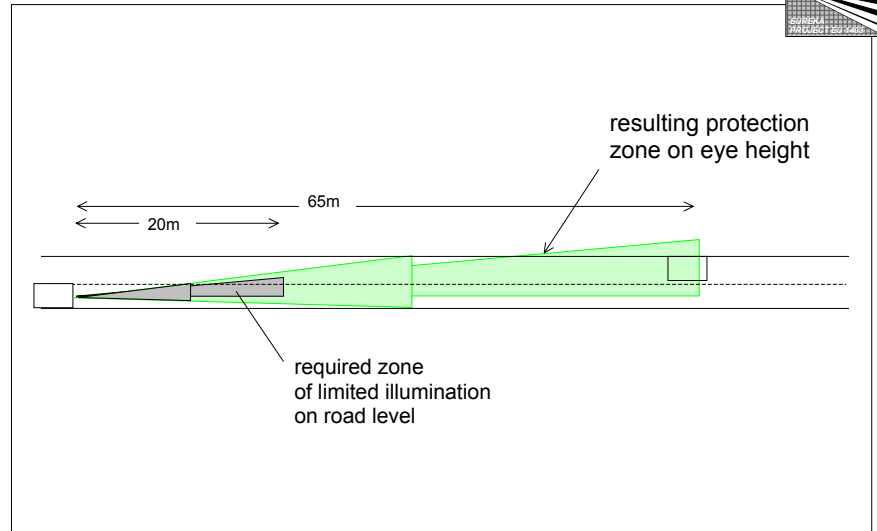


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w203036

Class W (wet road) Passing Beam

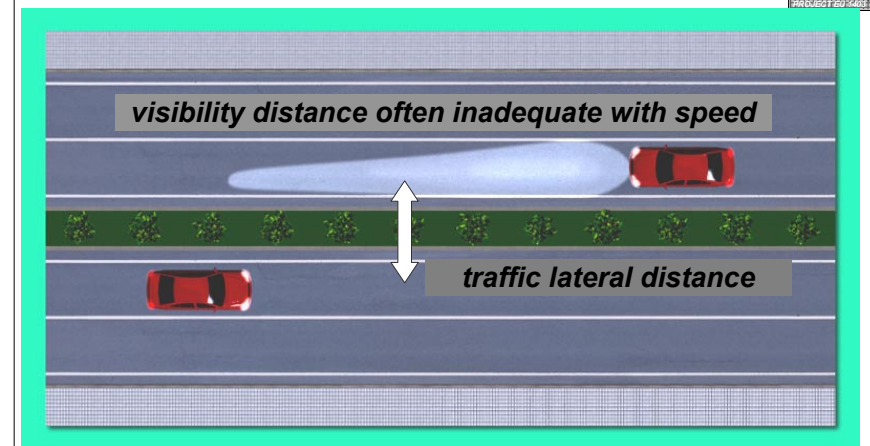
Functionality – Reflex Glare Reduction Zone



w203037

Class E (motorway) Passing Beam

The Situation



w203039

3.4 The Class E (Motorway) Passing Beam

Class E (motorway) Passing Beam

The Situation - Background

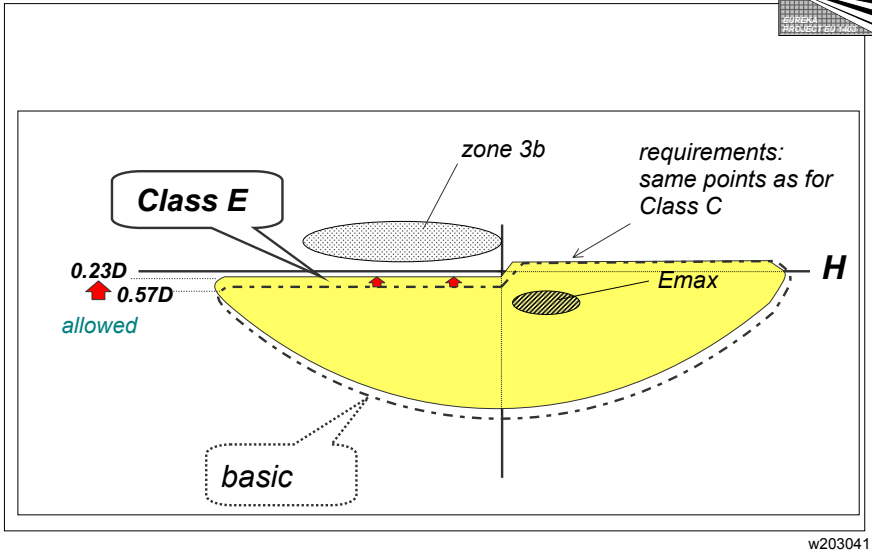
1968 Agreement
Definition of a Motorway:

- (j) "Motorway" means a road specially designed and built for motor traffic, which does not serve properties bordering on it, and which:
 - (i) Is provided, except at special points or temporarily, with separate carriageways for the two directions of traffic, separated from each other either by a dividing strip not intended for traffic or, exceptionally, by other means;
 - (ii) Does not cross at level with any road, railway or tramway track, or footpath; and
 - (iii) Is specially signposted as a motorway.

w203040

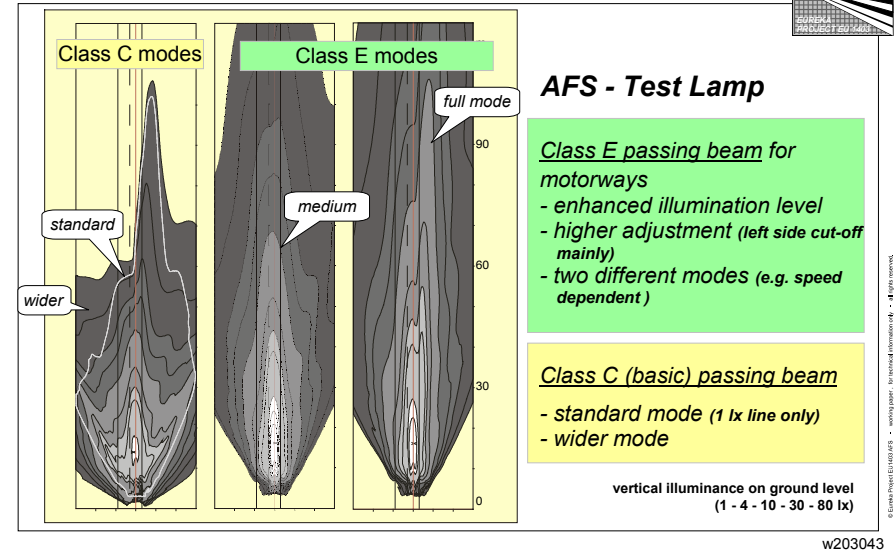
Class E (motorway) Passing Beam

The Beam Pattern, Schematically on Screen



AFS Passing Beams (Examples)

Bird's Eye View Comparison



Class E (motorway) Passing Beam

The Automatic Activation

When the passing beam is switched on:

The class E (motorway) passing beam may be emitted, if the vehicle generates the "E-signal".

This is allowed to be generated only:

if the road characteristics correspond to motorway conditions;

it is not allowed to be generated if the vehicle speed is less than 60km/h

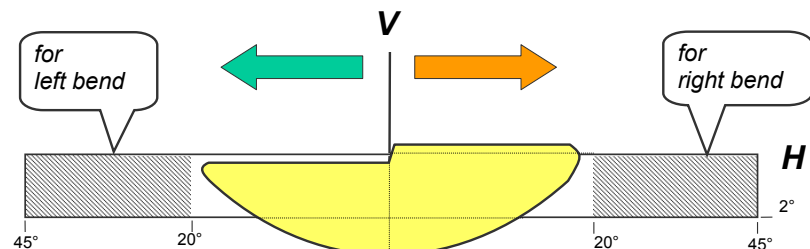
w203042

3.5 The Passing Beam Bending Modes

Passing Beam Bending Modes

Additional Photometric Provisions

Bending Modes (on Screen, schematically)



- ▶ max value within area L or R shall not be less than 3 lx when smallest turn radius
- ▶ Emax of the beam: horiz. position within 45° R / L and above 2° D

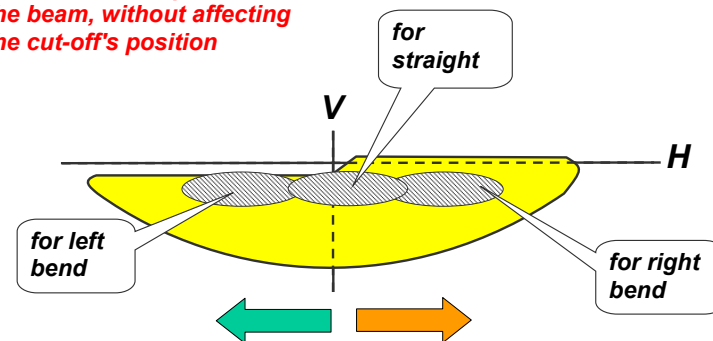
w203045

Passing Beam Bending Modes

Categories Definition

Bending Modes <Category 2> (on Screen, schematically)

moved or added parts of the beam, without affecting the cut-off's position

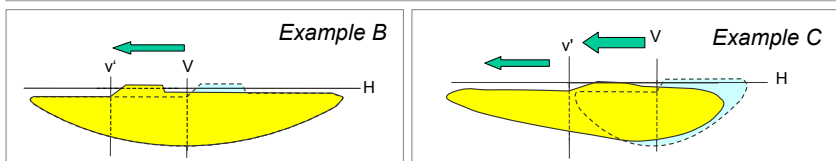
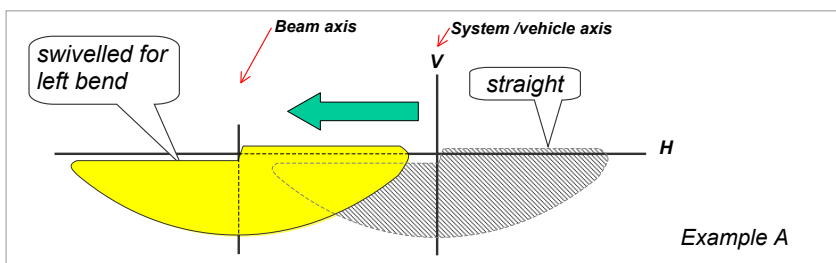


w203047

Passing Beam Bending Modes

Categories Definition

Bending Modes <Category 1> (on Screen, schematically)



w203046

Passing Beam Bending Modes

The Automatic Activation

When the passing beam is switched on:

The bending mode of a passing beam may be emitted if the vehicle generates the "T- signal".

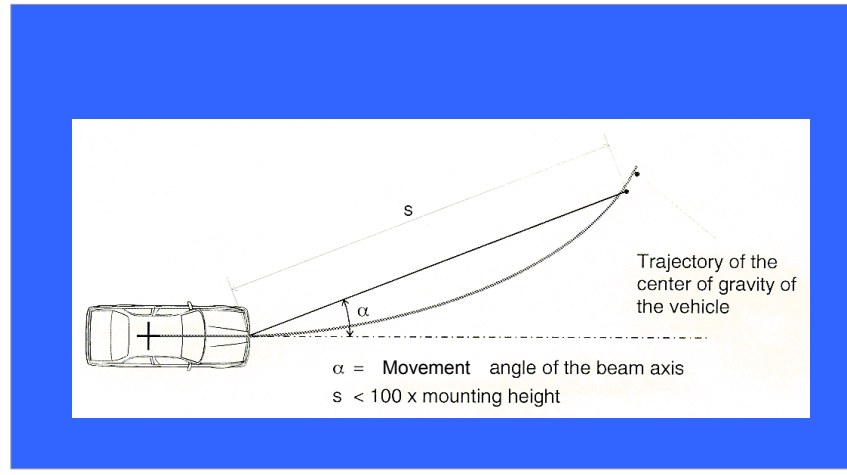
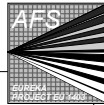
*This is allowed to be generated only:
in / for curves or during / for cornering at intersections.*

In Addition:

- the activation of additional unit(s) is only permitted if the turn radius is 500 m or less
- the activation of a category 1 bending mode is only permitted during forward motion of the vehicle except for turn to the side of traffic direction and S shall not exceed 100 x h (for the definitions see the following figure)

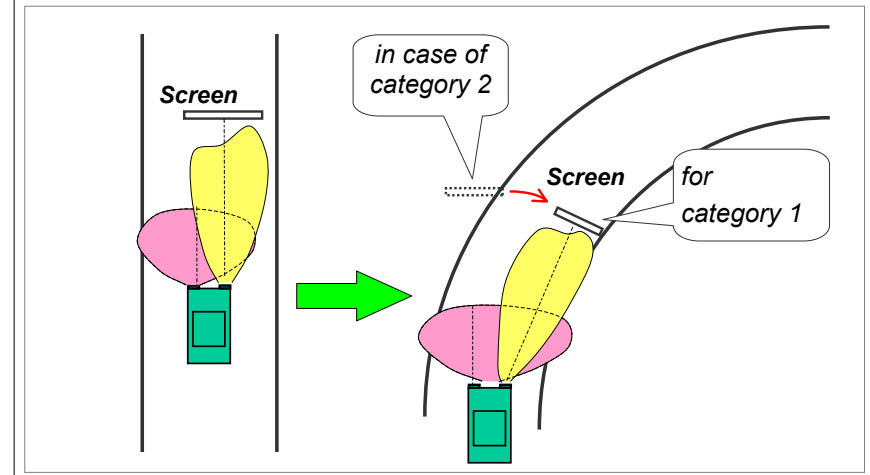
w203048

Passing Beam Bending Modes The Automatic Activation



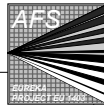
w203049

Passing Beam Bending Modes Category Dependent Photometry

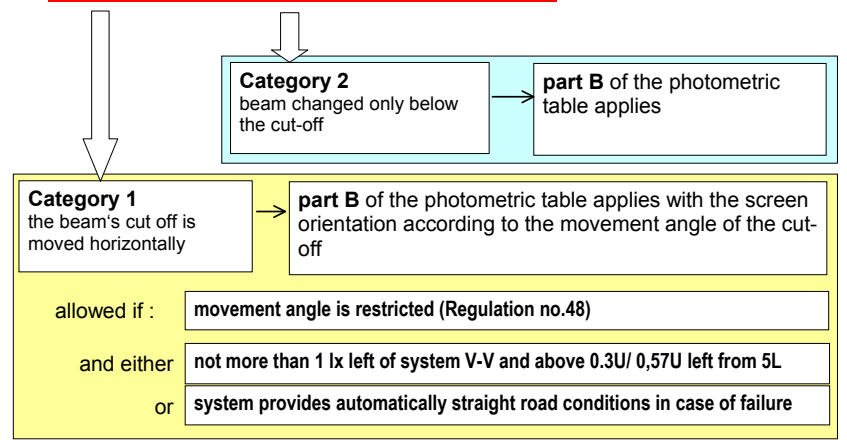


w203051

Passing Beam Bending Modes Categories, Survey



Bending modes of a passing beam

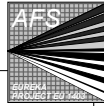


w203050

3.6 The Main Beam and DRL Provisions

Main Beam

New / Changed Items



New

- ▶ *number of lighting units per side not restricted*
- ▶ *swivelling of any lighting unit allowed* (test provisions corresponding to those for passing beam categories)
- ▶ *automatic beam modifications allowed* (to specified/ tested)

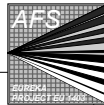
unchanged (compared with R.112 / R.98)

- *photometry provisions* (however system based instead for individual lamps)
- *reference figures system and relevant limitations*
- *time conditions* (as R.98)
- *activation of the main beam* (switching on /off)

w203053

Daytime Running Light (DRL)

New / Changed Items



New

- ▶ *more than one lighting unit per side allowed* (each of them must comply)
- ▶ *photometry maximum requirements combined with that of a basic passing beam*
- ▶ *automatic beam modifications allowed, including swivelling*

unchanged (compared with R.87)

- *photometry minimum requirements*
- *the activation of the DRL* (switching on/off)

w203054

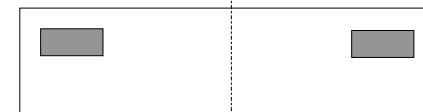
4 The Appearance

The Appearance

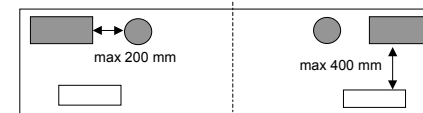
Installation Provisions (1)



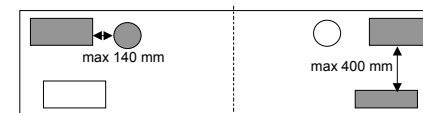
Vehicle's front view, illuminating surfaces, schematically



two symmetrically placed lighting units



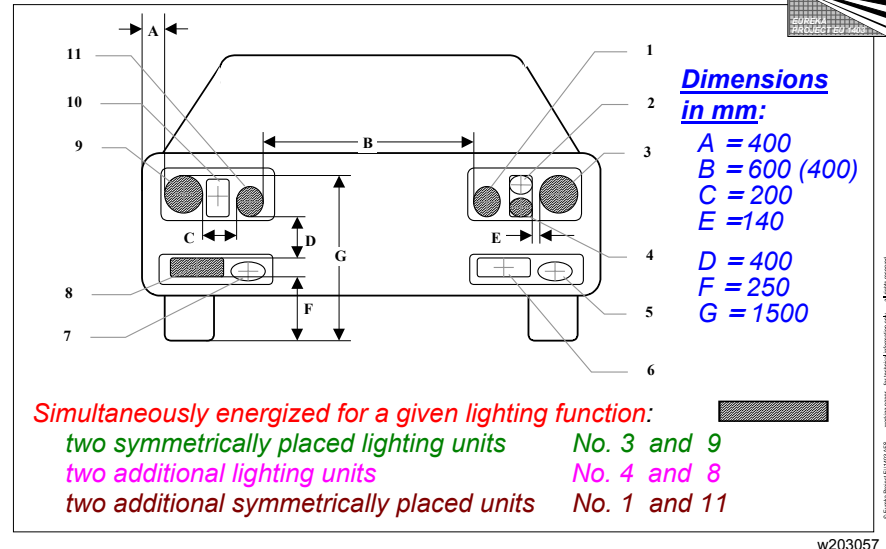
more than two symmetrically placed lighting units, if intended to be used symmetrically



more than two symmetrically placed lighting units, if intended to be lit in an asymmetrical configuration

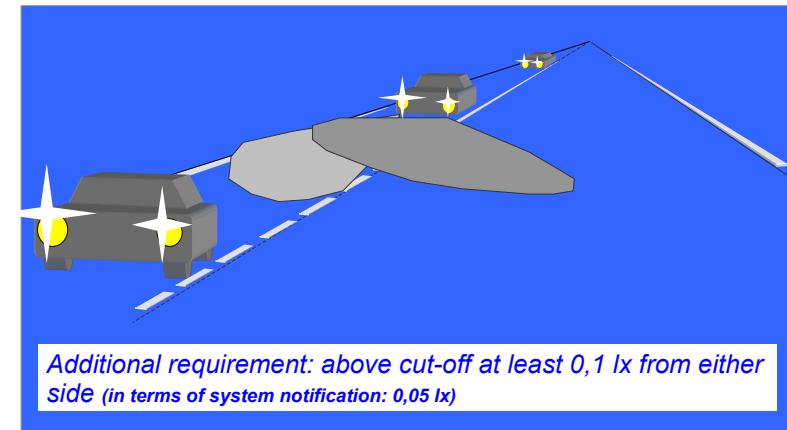
w203056

The Appearance Installation Provisions (2)

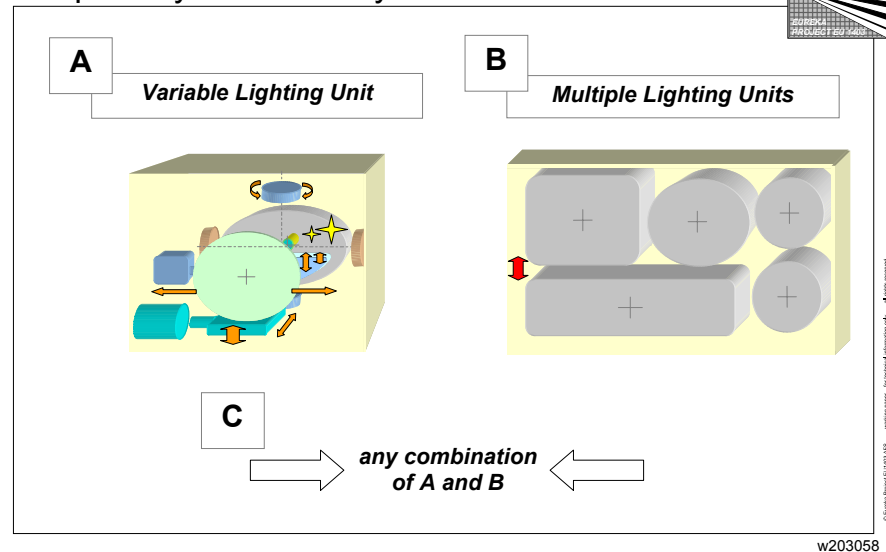


The Appearance The Right-Left Symmetry

Oncoming vehicle, drivers view (schematically)



The Appearance Adaptability – Necessary Means



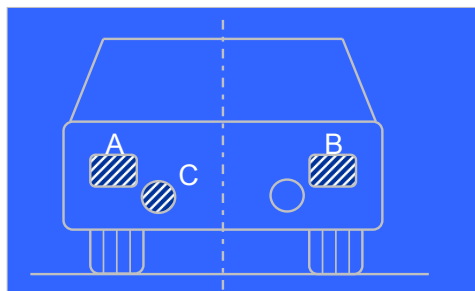
5 The Photometry

Photometry

Individual Contributions by the Lighting Units



Photometric requirements per vehicle



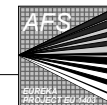
Lighting units may be differently "specialized" each to perform an individual lighting task producing in total one common illumination of the road

$$\frac{1}{2} [\text{Measured illumination values } A + B + C]$$

w203061

Photometry

Different Light Sources



Measurements and conversion of results

Light source	Operation of the lighting unit	Factor
replaceable, accord. R37	with étalon light source at standard luminous flux	1
Any other	with its own light source and supply / operating device (if any) at vehicle voltage (13,5 V for 12 V system, e.g.)	0,7

w203063

Photometry

Light Sources Provisions



Light source	A		B		
	Mechanical status being exchange-able	being part of a 'light source module'	Power control status		
			voltage from the vehicle's electrical system	specified separately	
			-directly-	-proportional-	-by a 'supply and operating device'-
R.37	Standard	☒	Basis	☒ *	☒ *
R.99		☒		--	☒ *
not being type approved**	not allowed	☒	☒ *	☒ *	☒ *

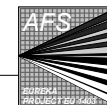
** requirements corresponding to R.99 and relevant information, identification, marking, etc.

* to be measured @13,5V (e.g., in the case of a 12 V system)

w203062

Photometry

Non-Approved Light Sources



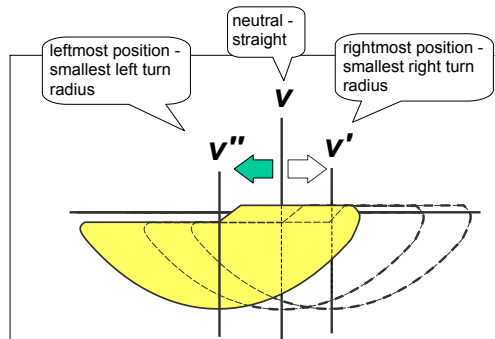
Supplementary Provisions

- ▶ **Non-replaceable / as part of a light source module, only**
- ▶ **Annex 8: additional requirements and test specifications**
 - ⇒ bulb and fixation performance
 - ⇒ dimensions and positioning compliance / data sheet
 - ⇒ starting, run-up and hot-restrike (from R.99)
 - ⇒ minimum red content (from R.99)
 - ⇒ UV-radiation Test etc. (from R.99)

w203064

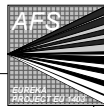
Photometry Bending Modes Testing

Test positions



- ▶ extreme positions
- ▶ visual check and decision about tests in intermediate positions
- ▶ in case of category 1 or main beam: horizontal re-aim by means of the goniometer before testing

w203065



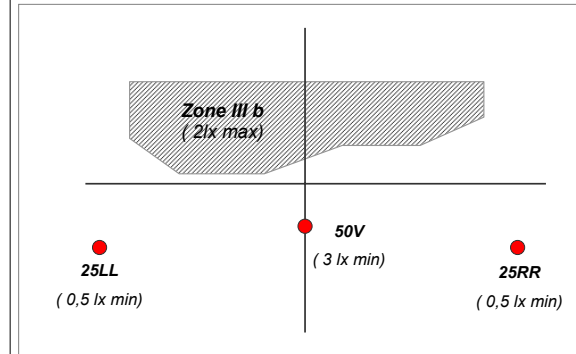
6 The Safety Provisions

Safety Provisions Fail Safe Requirements

In case of failure:

(1) General provisions

- ▶ tell tale operation
- ▶ illumination values ..



..to be obtained automatically

(a) by means within the AFS and/or

(b) by means of a substitute lighting function

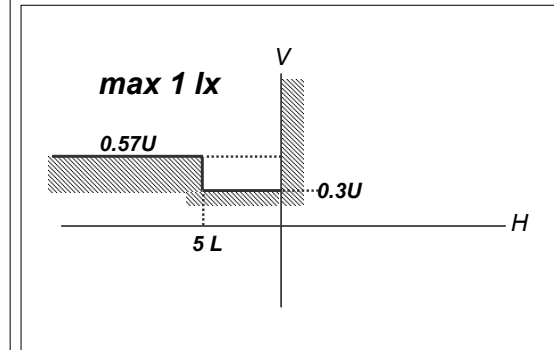
w203067



Safety Provisions Fail Safe Requirements

In case of failure:

(2) Additional provisions for category 1 bending modes



either
(a) being so designed that in no case 1 lx is exceeded above the line 0,3°/ 0,57° (see graph)

or/ and
(b) to obtain automatically a non-bending mode

w203068



Safety Provisions

Cleaning and Levelling (1)

Automatic levelling and cleaning requirements

The use of lighting units providing a cut-off which projects into the area of 8 L to 8 R and above 0,9 D

is confined to vehicles that provide headlamp cleaner and automatic headlamp levelling devices, if:

from all such lighting units on a side of the vehicle

(a) the combined objective luminous flux exceeds 2000 lm and

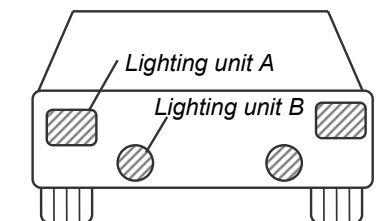
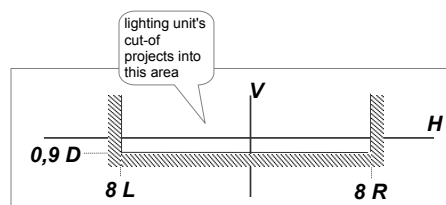
(b) the combined light output in terms of luminous flux within its isolux of 0,5 lx exceeds 650 lm

To be indicated in the type approval documents

w203069

Safety Provisions

Cleaning and Levelling (2)



Example

► Design values [lighting units A + B]

**if the sum exceeds
2000 lm light sources
objective luminous flux
and 650 lm units output**

**then devices for
cleaning and automatic
levelling for these
lighting units required**

w203070

7 Documentation & Approval

Application for Approval Documentation

Additional documentation

► Description of the system

- lighting functions provided
 - modes of these lighting functions
 - the lighting units providing each of them
- control signals relevant to each mode
- the passing beam classes being provided
- cut-off characteristics
- adjustment means and specific procedures, if any

► Safety concept

w203072

***..lamps providing separate functions
being grouped, combined or
reciprocally incorporated to an AFS***

- R.07 Front Position Lamp
- R.19 Front Fog Lamp***
- R.87 Daytime Running Lamp
- R.98 Driving Beam
- R.112 Driving Beam

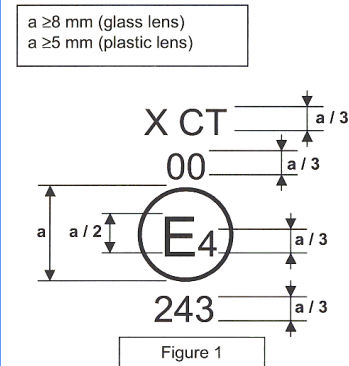
- ▶ ***To be indicated in the Application, including details of intended use as functional substitution, if any***
- ▶ ***AFS designed operation must not impair the lamp's compliance***
- ▶ ***Contribution to AFS (to be specified) only if not used in its separate 'original' function***

*** Front fog lamp subjected to adjustment prescriptions in that case

w203073

AFS
EUREKA
PROJECT 601403

<i>Passing beam (class, mode)</i>	<i>Marking</i>
AFS	X
Class C (basic)	C
Class V (town)	V
Class E (motorway)	E
Class W (wet road)	W
Bend modes	...«T



w203075

[illegible]

w203074