INFORMAL DOCUMENT No.: **28**
(48th GRE, 9-12 April 2002
Agenda Items 1.2. and 4.2.)

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

Eureka Project EU 1403
Situations and Possible Modes

Adaptation modes

	passing beam	main beam	DRL	Front fog
Country / normal / narrow road road shape sourroundings 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

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

AFS Acceptance and Market
Proposed Passing Beams, Customers Ranking

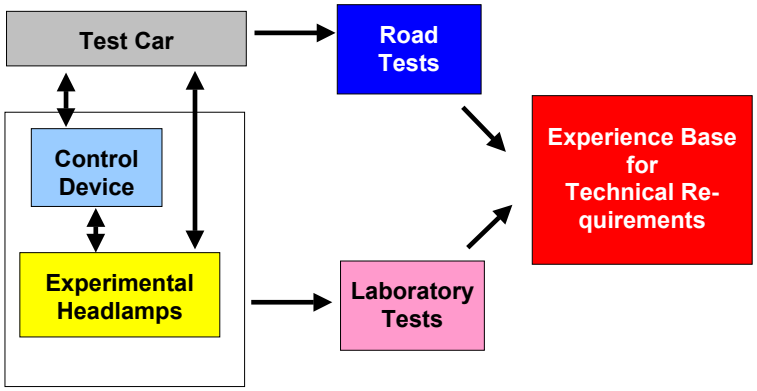
Yes, I need an improved Passing beam lighting for..	Study 1996 France, Italy, Sweden	Study 1995 Germany
Wet roads	rank 1	rank 1
Country roads	rank 2	rank 2
Bends	rank 3	rank 3
Motorways	rank 4	
Town Situation	rank 5	(rank 4)

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

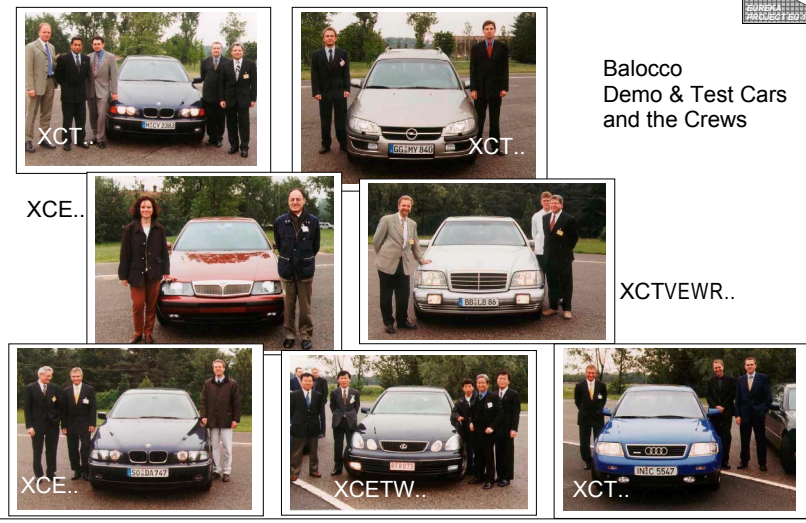
VWGoA EX1016
U.S. Patent No. 10,894,503

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

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

© Eureka Project EU 1403 AFS - working paper - for technical information only - - All rights reserved.

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.*

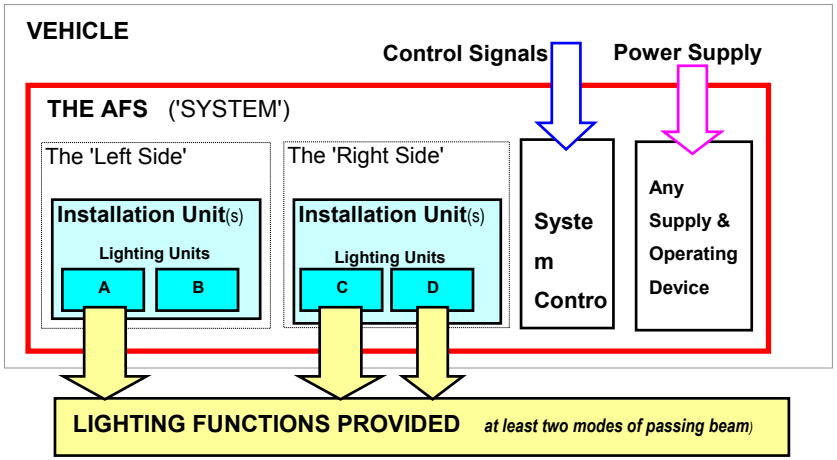
Para. 2.7.25 (AFS definition) of R.48 = scope of new Regulation on AFS

© Eureka Project EU 1403 AFS - working paper - for technical information only - - All rights reserved.

w203011

2 The Definitions

AFS - Draft Regulation
System Definition



© Eureka Project EU 1403 AFS - working paper - for technical information only - - All rights reserved.

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.

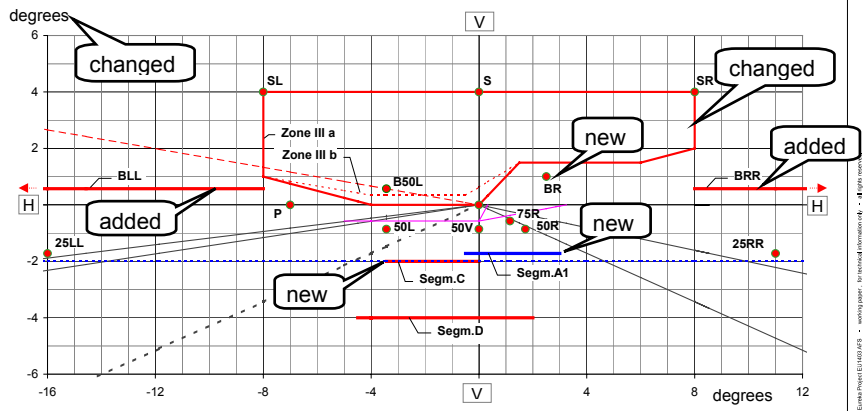
Within each class differing 'MODES' (including the one or more bending modes) can be provided.

© Eureka Project EU 143 AFS - working paper - for technical information only - - all rights reserved.

w203013

Passing Beam Requirements
Annex 3, Figure 1

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



© Eureka Project EU 143 AFS - working paper - for technical information only - - all rights reserved.

w203015

3 The Functions and Modes

3.1 General / The Class C (Basic) Passing Beam

Passing Beam Requirements
Annex 3, Table 1

	No	Element	Position /degrees horizontal at/ from	horizontal to	vertical at/ from	class C (basic) passing beam (1) min	class C max	class V (town) passing beam (2) min	class V max	class E (motorway) passing beam (3) min	class E max	class W (wet road) passing beam (4) min	class W max
		tabled requirements expressed in **lux @ 25m**											
Part A	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		4		6
	5	**Segment BLL 4/, and above it**	L 8	L 20	U 0,57		0,7		1		1		1
	6	**P**	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 4		14 1/		14 1/		14 1/		8 2/
	19	**Emax** 3/				20	50	10	50	20	90	35	80 2/
Part B		**rt 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		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/

(bend)

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

*Position requirements according to the provisions of **Table 2** below*

*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*

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

© Eureka Project EU 143 AFS - working paper - for technical information only - - all rights reserved.

w203016

Passing Beam Requirements
Annex 3, Table 2

Emax and cut-off provisions

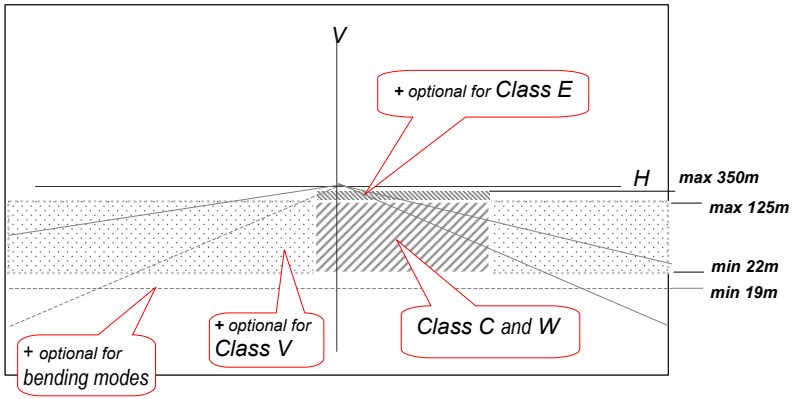
	angular position / extend in degrees	Class C (basic) passing beam		Class V (town) passing beam		Class E (motorway) passing beam		Class W (wet road) passing beam	
	beam part designation and requirement	horiz.	vertical	horiz.	vertical	horiz.	vertical	horiz.	vertical
2-1	**Emax** shall not be positioned 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
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 = 0,57 D		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

© Eureka Project EU1403 AFS - working paper - for technical information only - - all rights reserved.

w203017

Passing Beam Requirements
Annex 3 Table 2.1.

Optional beam Emax position

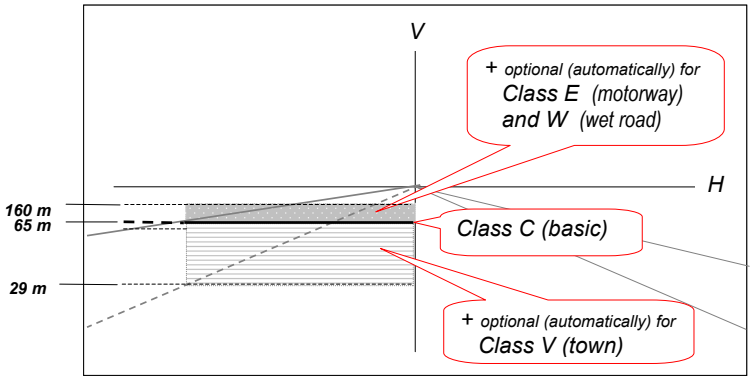


© Eureka Project EU1403 AFS - working paper - for technical information only - - all rights reserved.

w203018

Passing Beam Requirements
Annex 3 Table 2.2.

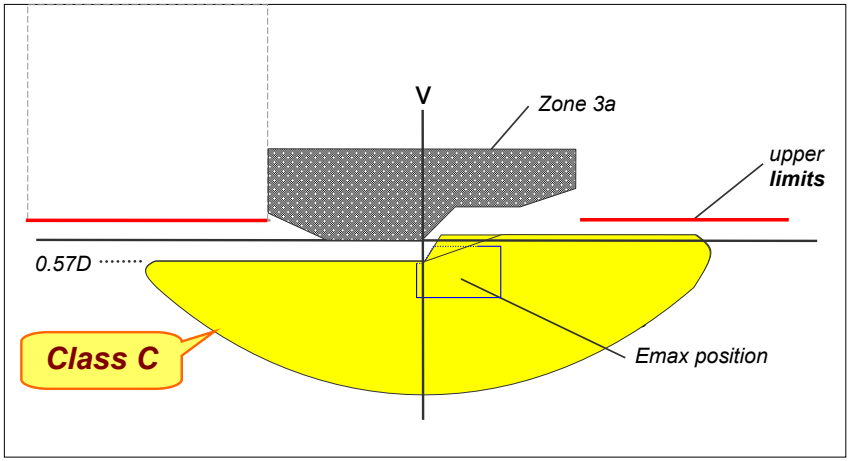
Optional left side cut-off position



© Eureka Project EU1403 AFS - working paper - for technical information only - - all rights reserved.

w203019

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:

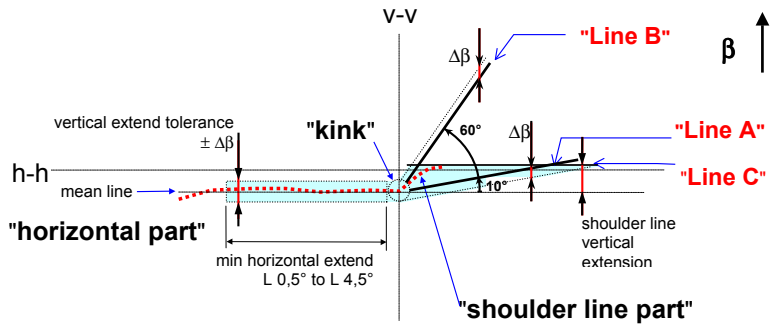
The class C (basic) passing beam:

- ***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 (1)

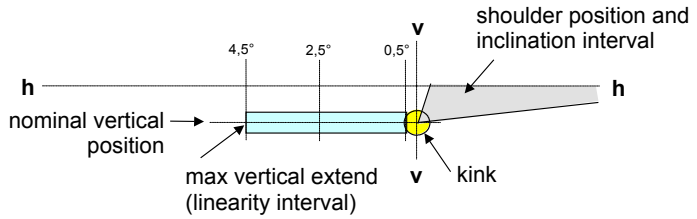
Shape of the "cut-off" line



w203022

Passing Beam Provisions
Cut-Off Definitions (2)

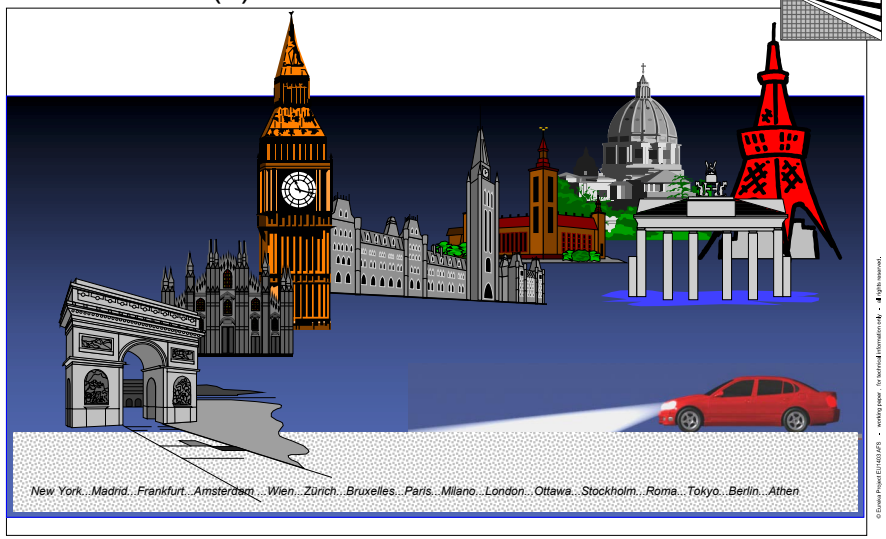
"Cut-Off" Adjustment



w203023

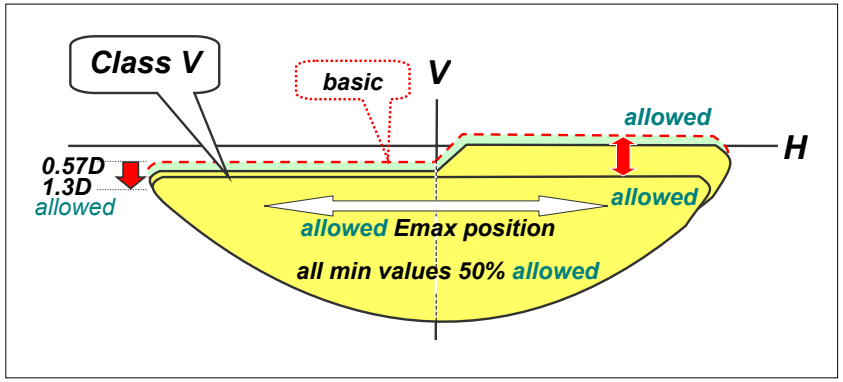
3.2 The Class V (Town) Passing Beam

Class V (town) Passing Beam
The Situation (1)



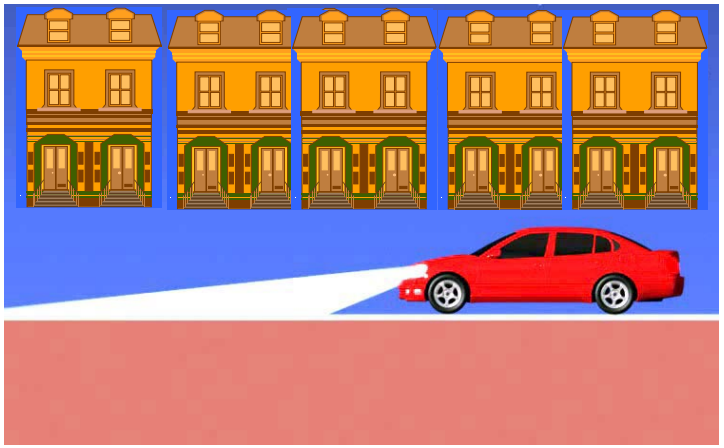
w203025

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:

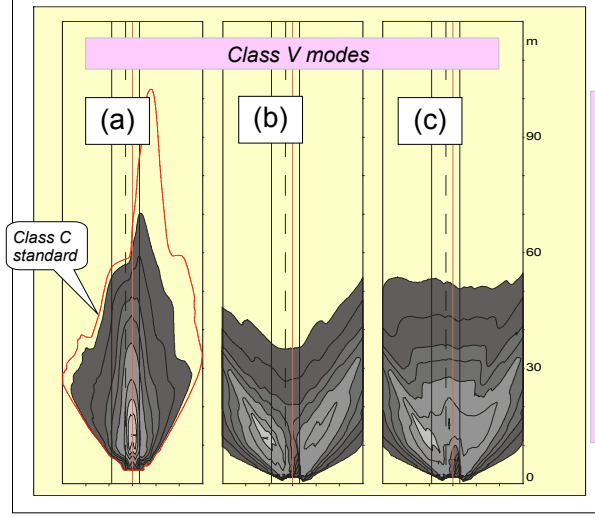
The class V (town) passing beam may be emitted if the vehicle generates the "V- signal".

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



AFS - Test Lamp

(a) derived from Class C standard beam (1 lx line shown only) by dimming and reducing of the asymmetric sector

(b) performed by special widespread side illumination only

(c) same as (b) but with a central wide-spot beam being added

vertical illuminance on ground level (1 - 4 - 10 - 30 - 80 lx)

w203029

Class W (wet road) Passing Beam
The Situation

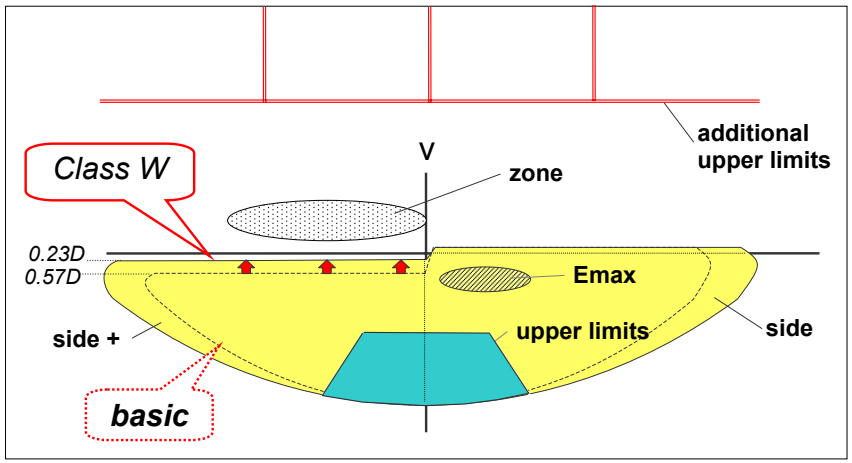
- Precipitation
- **Road surface properties changed**

⇒ detection priority : vertical surfaces of any objects

w203031

3.3 The Class W (Wet Road) Passing Beam

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



w203032

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***

w203033

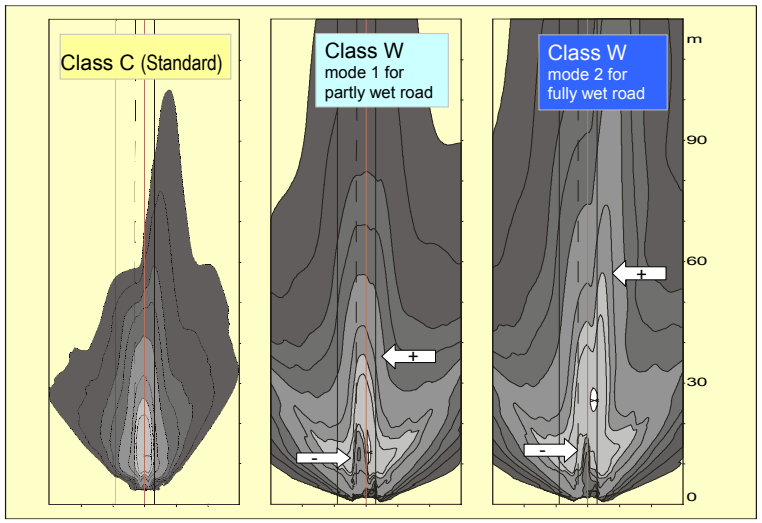
Class W (wet road) Passing Beam
Functionality – Requirements on the 25m Screen

Passing beam requirements comparison

lx @25m	Class W	*grade 2* *fully wet road*	*grade 1* *partly wet road*	Class C any type of road
Emax (*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	≥ 1,4
direct illuminance values **B50L, BR, BRR**		≤ 0,7..5	≤ 0,7..5	≤ 0,4..2

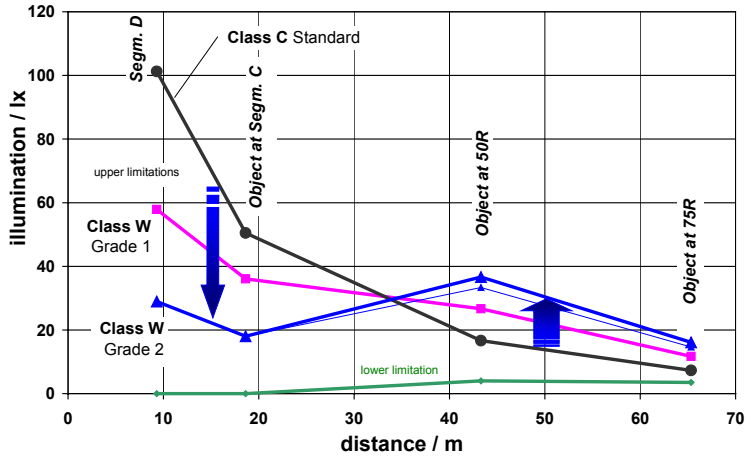
w203035

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



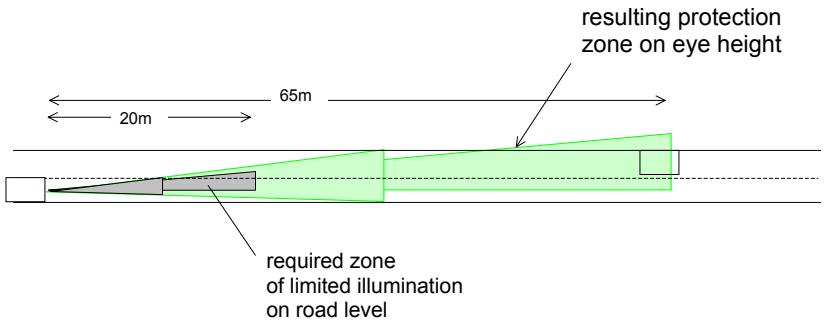
w203034

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



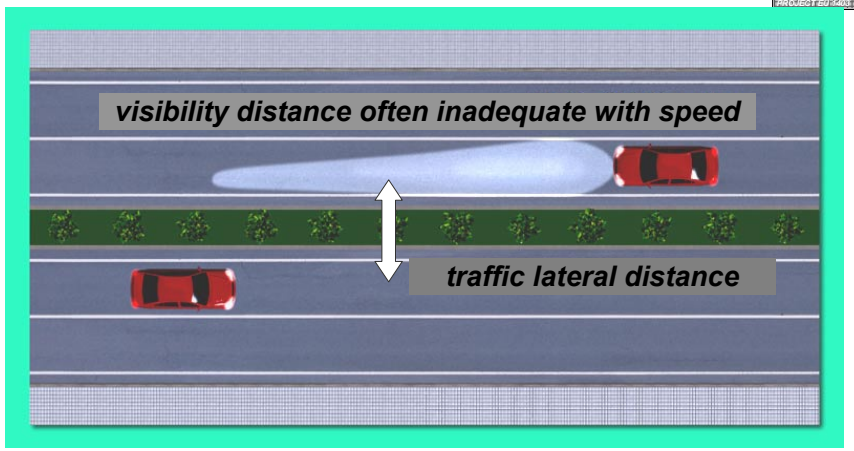
w203036

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 (Motor-way) 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:

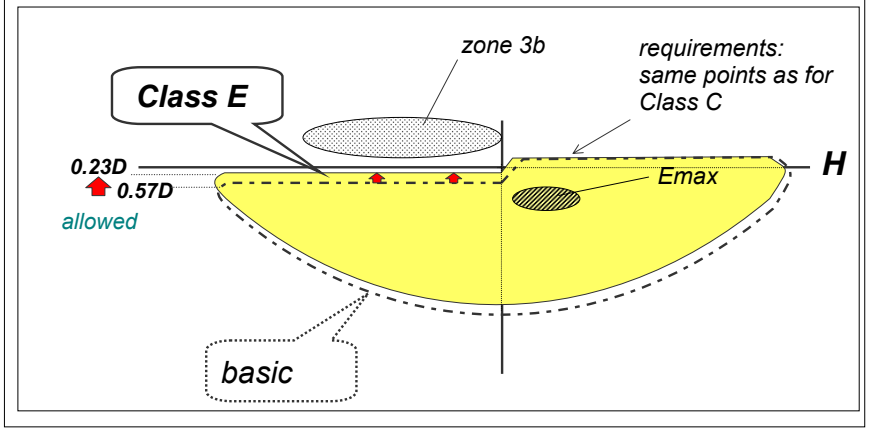
(i) Is provided, except at special points or temporarily, **with separate carriageways for the two directions of traffic, separated from each other either by a dividing strip not intended for traffic** or, exceptionally, by other means;

(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



w203041

Class E (motorway) Passing Beam
The Automatic Activation

When the passing beam is switched on:

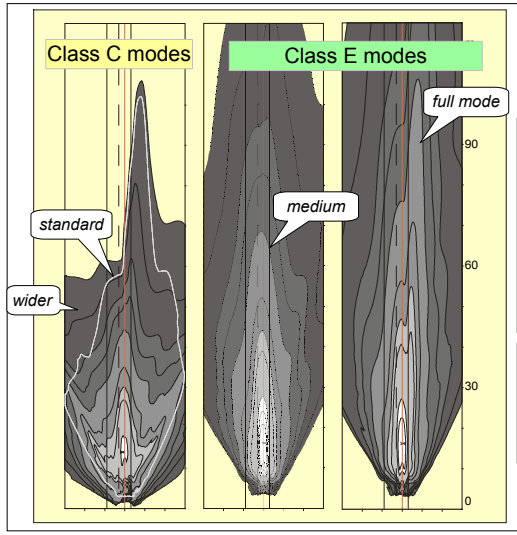
The class E (motorway) passing beam may be emitted, if the vehicle generates the "E-signal".

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

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



AFS - Test Lamp

Class E passing beam for motorways
- *enhanced illumination level*
- *higher adjustment* ***(left side cut-off mainly)***
- *two different modes* ***(e.g. speed dependent)***

Class C (basic) passing beam
- *standard mode* ***(1 lx line only)***
- *wider mode*

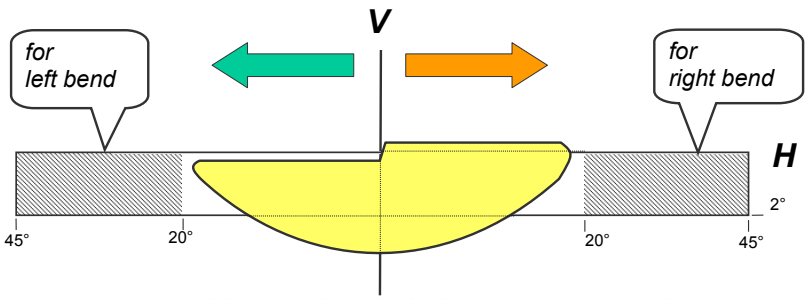
vertical illuminance on ground level (1 - 4 - 10 - 30 - 80 lx)

w203043

3.5 The Passing Beam Bending Modes

Passing Beam Bending Modes
Additional Photometric Provisions

Bending Modes *(on Screen, schematically)*



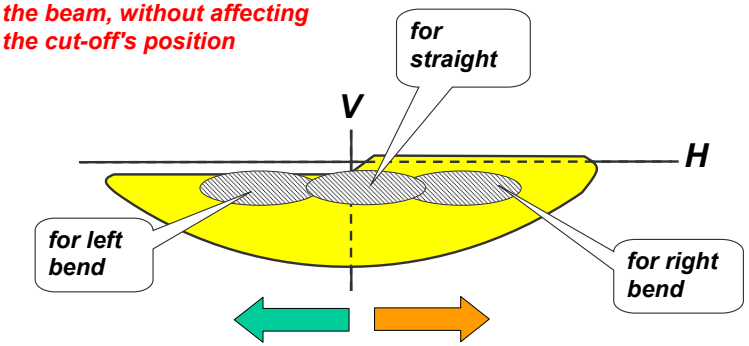
- ***max value within area L or R shall not be less than 3 lx when smallest turn radius***
- ***Emax of the beam: horiz. position within 45° R / L and above 2° D***

w203045

Passing Beam Bending Modes
Categories Definition

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

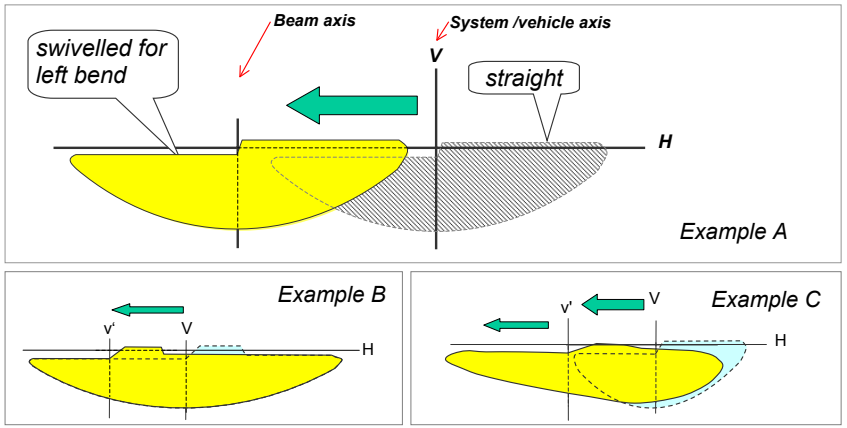
moved or added parts of the beam, without affecting the cut-off's position



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.

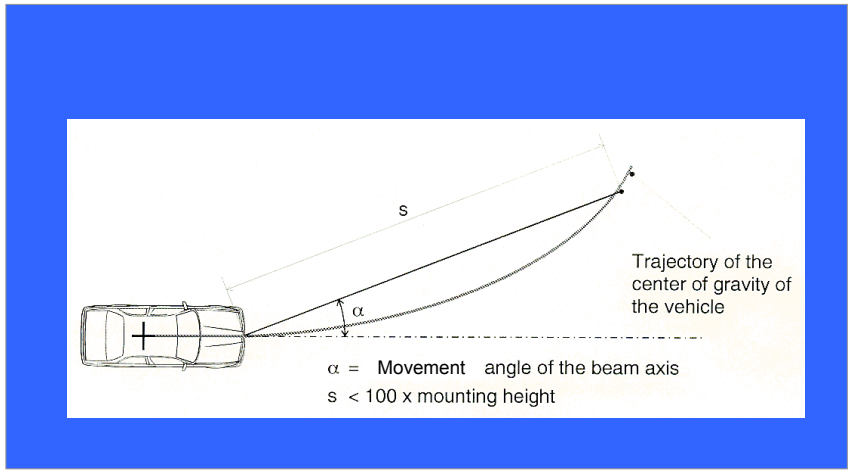
In Addition:

- ***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)***

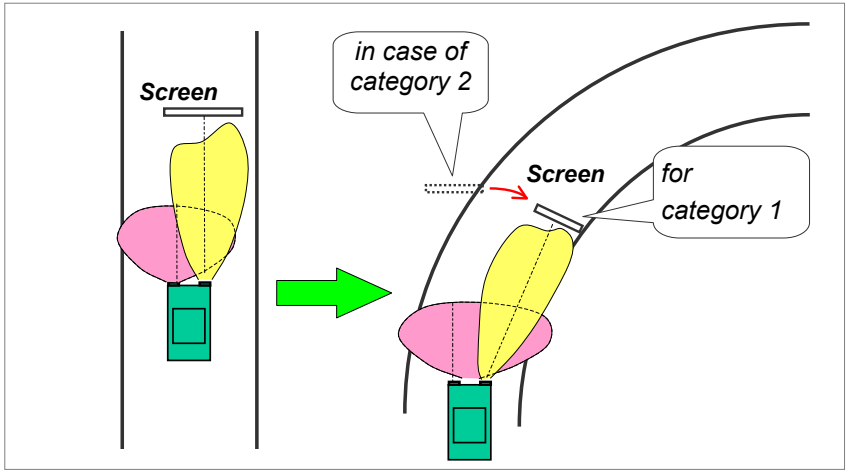
w203048

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

Category 2
beam changed only below the cut-off → **part B** of the photometric table applies

Category 1
the beam's cut off is moved horizontally → **part B** of the photometric table applies with the screen orientation according to the movement angle of the cut-off

allowed if : **movement angle is restricted (Regulation no.48)**

and either **not more than 1 lx left of system V-V and above 0.3U/ 0,57U left from 5L**

or **system provides automatically straight road conditions in case of failure**

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)*

© Eureka Project EU 1403 AFS - working paper - for technical information only - all rights reserved.

w203053

4 The Appearance

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)*

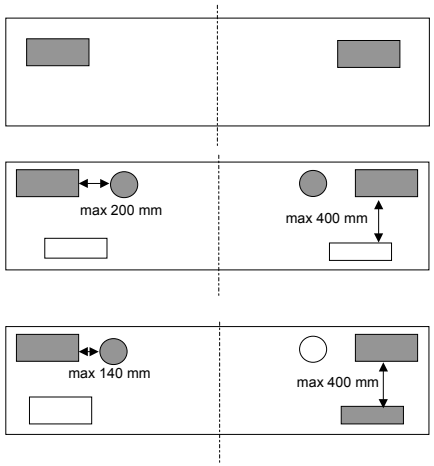
- *photometry minimum requirements*
- *the activation of the DRL* *(switching on/off)*

© Eureka Project EU 1403 AFS - working paper - for technical information only - all rights reserved.

w203054

The Appearance
Installation Provisions (1)

Vehicle's front view, illuminating surfaces, schematically



two symmetrically placed lighting units

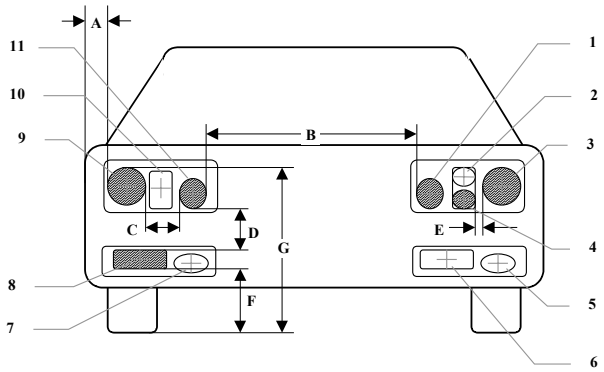
more than two symmetrically placed lighting units, if intended ***to be used symmetrically***

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

© Eureka Project EU 1403 AFS - working paper - for technical information only - all rights reserved.

w203056

The Appearance
Installation Provisions (2)



Dimensions in mm:

A = 400
B = 600 (400)
C = 200
E =140

D = 400
F = 250
G = 1500

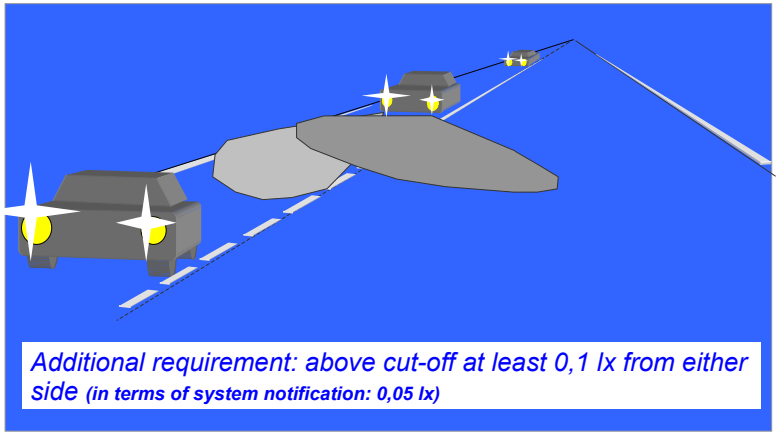
Simultaneously energized for a given lighting function:

two symmetrically placed lighting units	*No. 3 and 9*
two additional lighting units	*No. 4 and 8*
two additional symmetrically placed units	*No. 1 and 11*

w203057

The Appearance
The Right-Left Symmetry

Oncoming vehicle, drivers view ***(schematically)***

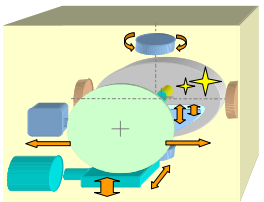


Additional requirement: above cut-off at least 0,1 lx from either side ***(in terms of system notification: 0,05 lx)***

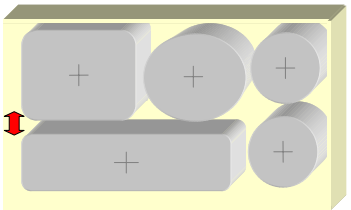
w203059

The Appearance
Adaptability – Necessary Means

A ***Variable Lighting Unit***



B ***Multiple Lighting Units***



C

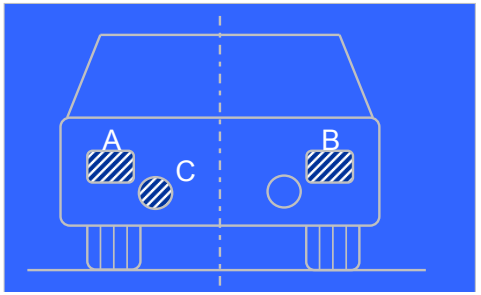
any combination of A and B

w203058

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

½ [Measured illumination values A + B + C]

© Eureka Project EU 403 AFS - working paper - for technical information only - - all rights reserved.

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**

© Eureka Project EU 403 AFS - working paper - for technical information only - - all rights reserved.

w203063

Photometry
Light Sources Provisions

Light source	A Mechanical status: being exchange-able	A Mechanical status: being part of a 'light source module'	B Power control status: voltage from the vehicle's electrical system -directly-	B Power control status: voltage from the vehicle's electrical system -proportional-	B Power control status: specified separately -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)*

© Eureka Project EU 403 AFS - working paper - for technical information only - - all rights reserved.

w203062

Photometry
Non-Approved Light Sources

Supplementary Provisions

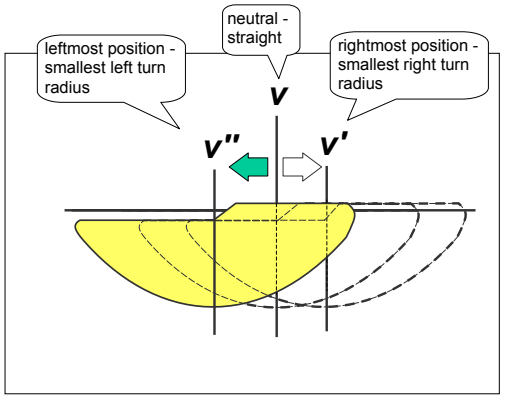
- ***Non-replaceable / as part of a light source module, only***
- ***Annex 8: additional requirements and test specifications***
  - ⇒ *bulb and fixation performance*
  - ⇒ *dimensions and positioning compliance / data sheet*
  - ⇒ *starting, run-up and hot-restrike (from R.99)*
  - ⇒ *minimum red content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

© Eureka Project EU 403 AFS - working paper - for technical information only - - all rights reserved.

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

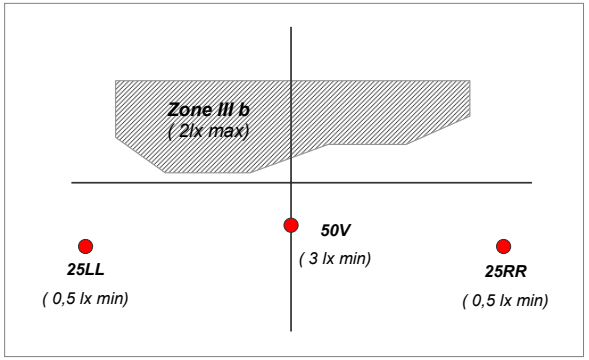
w203065

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

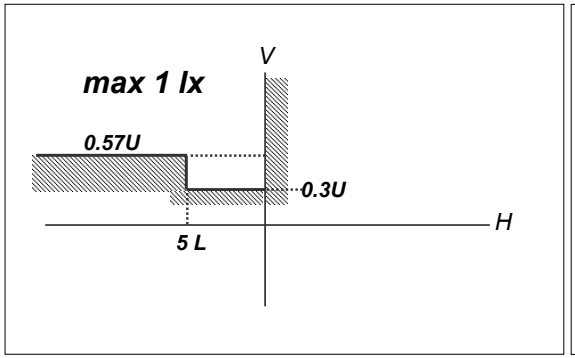
w203067

6 The Safety Provisions

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***

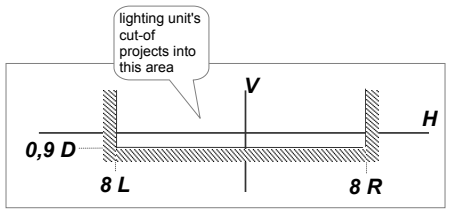
To be indicated in the type approval documents

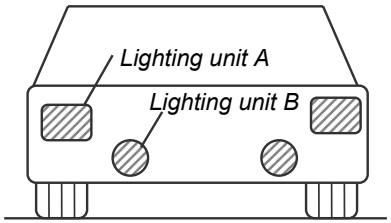
© Eureka Project EU 403 AFS - working paper - for technical information only - all rights reserved.

w203069

7 Documentation & Approval

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***

© Eureka Project EU 403 AFS - working paper - for technical information only - all rights reserved.

w203070

Application for Approval
Documentation

Additional documentation

► ***Description of the system***
lighting functions provided
- modes of these lighting functions
- the lighting unis 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***

© Eureka Project EU 403 AFS - working paper - for technical information only - all rights reserved.

w203072

Application for Approval
Interrelation to Other Lighting Functions

AFS requirements *in case of..*

..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

Application for Approval
Marking of the System and the Installation Units

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

a ≥8 mm (glass lens)
a ≥5 mm (plastic lens)

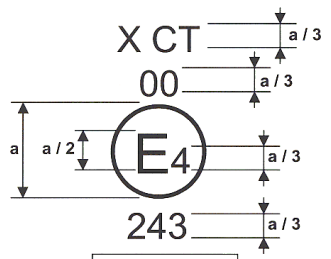
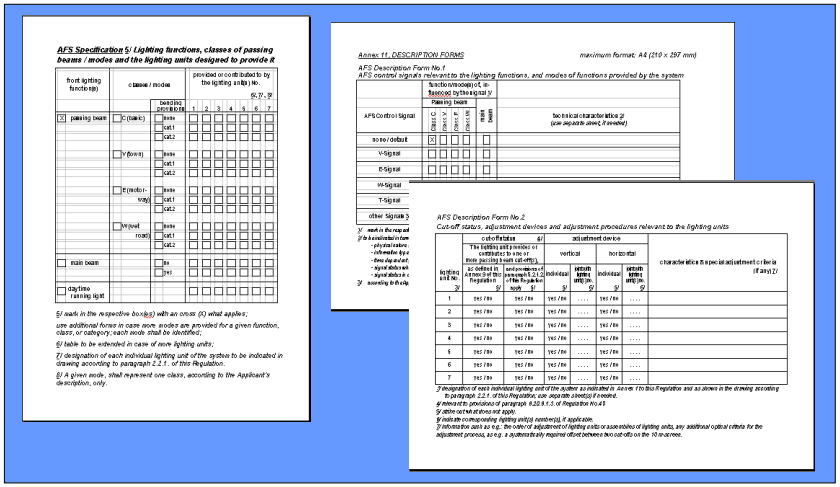


Figure 1

w203075

Application for Approval
Specific Forms



w203074