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

AFS Acceptance and Market
Proposed Passing Beams, Customers Ranking

Yes, I need an improved Passing beam lighting for..
Study 1996
France, Italy, Sweden
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

Eureka Project EU 1403
Situations and Possible Modes

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

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

INFORMAL DOCUMENT No.: 28
(48th GRE, 9-12 April 2002 Agenda Items 1.2. and 4.2.)
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. ...
Eureka Project EU 1403
GTB - AFS Nov 2000 to Nov 2001

<table>
<thead>
<tr>
<th>90th GTB</th>
<th>Special Session Mandate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Para 11/2000</td>
<td></td>
</tr>
<tr>
<td>Special 1</td>
<td>First Check and Definition of Tasks</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>91st GTB</th>
<th>Report, Additional Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rome 05/2001</td>
<td></td>
</tr>
<tr>
<td>Special 2</td>
<td>Main Discussion / Solutions</td>
</tr>
<tr>
<td></td>
<td>Light Source Module, R48 Amendment Structure, Photometry, Control, Language / Editorials</td>
</tr>
<tr>
<td>Special 3</td>
<td>Settlement of Open Points</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>92nd GTB</th>
<th>GTB Release</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kyoto 11/2001</td>
<td></td>
</tr>
</tbody>
</table>

2 The Definitions

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

**AFS - Draft Regulation**
**System Definition**

**VEHICLE**

**THE AFS ("SYSTEM")**

- The 'Left Side'
  - Installation Unit(s)
  - Lighting Units
  - A
  - B
- The 'Right Side'
  - Installation Unit(s)
  - Lighting Units
  - C
  - D

**SYSTEM Control**

**Any Supply & Operating Device**

**Control Signals**

**Power Supply**

**LIGHTING FUNCTIONS PROVIDED** at least two modes of passing beam
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.

3 The Functions and Modes

3.1 General / The Class C (Basic) Passing Beam
Passing Beam Requirements
Annex 3, Table 2

**Emax and cut-off provisions**

<table>
<thead>
<tr>
<th>Beam part designation and requirement</th>
<th>Class C (basic) passing beam</th>
<th>Class V (town) passing beam</th>
<th>Class E (motorway) passing beam</th>
<th>Class W (wet road) passing beam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beam part / extend in degrees</td>
<td>horiz.</td>
<td>vertical</td>
<td>horiz.</td>
<td>vertical</td>
</tr>
<tr>
<td>2-1</td>
<td>from H = 0.5L to 1JR</td>
<td>from V = 0.3D to 1.70D</td>
<td>from H = 0.5L to 1JR</td>
<td>from V = 0.3D to 1.70D</td>
</tr>
<tr>
<td>2-2</td>
<td>the cut-off and part(s) of</td>
<td>not above 0.37D and not</td>
<td>not above 0.23D and not</td>
<td>not above 0.23D and not</td>
</tr>
<tr>
<td></td>
<td>beam shall not be positioned</td>
<td>above 0.37D and not above</td>
<td>above 0.23D and not below</td>
<td>above 0.23D and not below</td>
</tr>
<tr>
<td></td>
<td>outside of the rectangle</td>
<td>1.70D</td>
<td>0.57D</td>
<td>0.57D</td>
</tr>
<tr>
<td></td>
<td>extending (above &quot;Segment AT&quot;)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- be positioned with its straight horizontal part
  - at V = 0.57 D

Optional left side cut-off position

Class C (basic)

Optional beam Emax position

Class C and W

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

+ optional for Class E
+ optional for Class V
+ optional for bending modes

+ optional (automatically) for Class E (motorway) and W (wet road)

Zone 3a

upper limits

Emax position

max 350m
max 125m
min 22m
min 19m

0.57D
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)

Passing Beam Provisions
Cut-Off Definitions (1)

Shape of the "cut-off" line

Passing Beam Provisions
Cut-Off Definitions (2)

"Cut-Off" Adjustment

shoulder position and
inclination interval

nominal vertical position

max vertical extend
(linearity interval)

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

Class V (town) Passing Beam
The Situation (2)

Class V (town) Passing Beam
The Beam Pattern, Schematically on Screen

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
3.3 The Class W (Wet Road) Passing Beam
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

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

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

Passing beam requirements comparison

<table>
<thead>
<tr>
<th>lx @25m</th>
<th>Class W grade 2 fully wet road</th>
<th>grade 1 partly wet road</th>
<th>Class C any type of road</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>≤ 100</td>
<td>≤ 80</td>
</tr>
<tr>
<td></td>
<td>Emmax (fixed position area, including 50R and 75R)</td>
<td>≤ 4</td>
<td>≤ 8 lx</td>
</tr>
<tr>
<td></td>
<td>foreground segment D (10m)</td>
<td>≤ 10</td>
<td>≤ 20 lx</td>
</tr>
<tr>
<td></td>
<td>segment C (20m)</td>
<td>≥ 4</td>
<td>≥ 4</td>
</tr>
<tr>
<td></td>
<td>road curb minimum illumination 25RR/LL</td>
<td>≥ 4</td>
<td>≥ 4</td>
</tr>
<tr>
<td></td>
<td>direct illuminance values B50L, BR, BRR</td>
<td>≤ 0.7..5</td>
<td>≤ 0.7..5</td>
</tr>
</tbody>
</table>

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

- Class C Standard
- Class W Grade 1
- Class W Grade 2
- Object at Segment
- Object at 50ft
- Object at 75ft
- upper limitations
- lower limitation

illuminated / lx vs. distance / m
3.4 The Class E (Motorway) Passing Beam

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.
**Class E (motorway) Passing Beam**
The Beam Pattern, Schematically on Screen

```
Class E
```

- requirements: same points as for Class C
- 0.23D
- 0.57D
- allowed

- basic

---

**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

---

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

- Class C modes
- Class E modes
- full mode

---

**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

---

**3.5 The Passing Beam Bending Modes**
Passing Beam Bending Modes

Additional Photometric Provisions

**Bending Modes** (on Screen, schematically)

- for left bend
- for right bend

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

**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

**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)
Passing Beam Bending Modes
The Automatic Activation

\[ \alpha = \text{Movement angle of the beam axis} \]
\[ s < 100 \times \text{mounting height} \]

Passing Beam Bending Modes
Categories, Survey

**Bending modes of a passing beam**

- **Category 1**: the beam’s cut off is moved horizontally
- **Category 2**: beam changed only below the cut-off

**part B of the photometric table applies**

allowed if:
- movement angle is restricted (Regulation no.48)
- not more than 1 lx left of system V-V and above 0.3 IU / 0.57U left from 5L
- system provides automatically straight road conditions in case of failure

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Passing Beam Bending Modes
Category Dependent Photometry

- **in case of category 2**
- **for category 1**

---

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.96)
• activation of the main beam (switching on/off)

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)

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
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

Dimensions in mm:
- A = 400
- B = 600 (400)
- C = 200
- D = 400
- E = 140
- F = 250
- G = 1500

The Photometry
Photometry
Individual Contributions by the Lighting Units

**Photometric requirements per vehicle**

![Diagram showing individual light sources A, B, and C]

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]

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Photometry
Light Sources Provisions

<table>
<thead>
<tr>
<th>Light source</th>
<th>Mechanical status</th>
<th>Power control status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>being exchangeable</td>
<td>voltage from the vehicle's electrical system</td>
</tr>
<tr>
<td></td>
<td>being part of a light source module</td>
<td>-directly-</td>
</tr>
<tr>
<td>R.37</td>
<td>Standard</td>
<td>Basis</td>
</tr>
<tr>
<td>R.99</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>not being type approved**</td>
<td>✓</td>
<td>✓*</td>
</tr>
</tbody>
</table>

** 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)

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Photometry
Different Light Sources

**Measurements and conversion of results**

<table>
<thead>
<tr>
<th>Light source</th>
<th>Operation of the lighting unit</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>replaceable, accord. R.37</td>
<td>with étalon light source at standard luminous flux</td>
<td>1</td>
</tr>
<tr>
<td>Any other</td>
<td>with its own light source and supply / operating device (if any) at vehicle voltage (13.5 V for 12 V system, e.g.)</td>
<td>0.7</td>
</tr>
</tbody>
</table>

---

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)
6 The Safety Provisions
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

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

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
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
- 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***

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Application for Approval
Marking of the System and the Installation Units

<table>
<thead>
<tr>
<th>Passing beam (class, mode)</th>
<th>Marking</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFS</td>
<td>X</td>
</tr>
<tr>
<td>Class C (basic)</td>
<td>C</td>
</tr>
<tr>
<td>Class V (town)</td>
<td>V</td>
</tr>
<tr>
<td>Class E (motorway)</td>
<td>E</td>
</tr>
<tr>
<td>Class W (wet road)</td>
<td>W</td>
</tr>
</tbody>
</table>

**Bend modes**

...«T

- AFS: X
- Class C: C
- Class V: V
- Class E: E
- Class W: W

**Figure 1**

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