Light Source Requirements

- In general for UN approved light sources
- OEM situation and AFTM situation

Requirements clustered in
  - Safety
  - Performance
  - Consumer / Customer

SAFETY REQUIREMENTS (UN ECE)
  - Technical
    - Luminous flux incl. tolerances
    - Maximum power
    - “Geometry”
    - ...
  - Information / Communication
    - Rated voltage (and wattage)
    - Category name

PERFORMANCE REQUIREMENTS and TEST METHODS (IEC 60810)
  - Technical
    - Minimum lifetime
    - Minimum vibration resistance
  - Information / Communication
    - Restricted white
    - ...

CONSUMER / CUSTOMER REQUIREMENTS
  - E.g. higher lifetime specifications
  - E.g. heavy duty performance
  - E.g. limited color coordinates
LED Replacement Light Source (LEDr) acc. to R37

- Photometric parameters
  - Same as for LED Substitutes
- Electrical parameters
  - Voltage range
  - FailureDetectionSystem-compatibility
  - PWM operation
  - EMC
- Mechanical parameters
  - Size
  - Mass
- Thermal parameters
  - Behavior under high ambient T.

SAFETY REQUIREMENTS (UN ECE R37 / RE5)
- Technical
  - ...
  - ...
- Information / Communication
  - ...
  - ...

PERFORMANCE REQUIREMENTS (IEC 60810)
- Technical
  - ...
  - ...
- Information / Communication
  - ...
  - ...

CONSUMER / CUSTOMER REQUIREMENTS
- ...

Task for TFSR
Collecting the topics / questions
<table>
<thead>
<tr>
<th>Nr</th>
<th>Topic</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>Voltage range</td>
<td>Does the LEDr have the same voltage - flux behavior as the filament light source?</td>
</tr>
<tr>
<td>#2</td>
<td>PWM operation</td>
<td>Does the LEDr flicker in case of pulse-width modulation (PWM) operation? Also covering PWM dimming for dual-function operation</td>
</tr>
<tr>
<td>#3</td>
<td>Power / electr current</td>
<td>Does the LEDr cause a wrong failure message in the dashboard when it is working correctly? Does the LEDr cause a correct failure message in the dashboard when it has failed? Incl presence detection (Kaltüberwachung)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Possible interaction with other electronics</td>
</tr>
<tr>
<td>#4</td>
<td>EMC / EMI</td>
<td>Does the LEDr cause EMC problems in the vehicle?</td>
</tr>
<tr>
<td>#5</td>
<td>Electrical robustness</td>
<td>Is the LEDr as robust against electrical disturbance as the filament lamp?</td>
</tr>
</tbody>
</table>
# Mechanical

<table>
<thead>
<tr>
<th>Nr</th>
<th>Topic</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>Vibration / Mass</td>
<td>Does the LEDr have the same mass as the filament lamp and is it as robust against vibration as the filament lamp?</td>
</tr>
<tr>
<td>#2</td>
<td>Maximum geometry</td>
<td>Does the LEDr have the same geometry / maximum outline as the filament lamp? Is the sealing affected by the geometry of the heat-sink</td>
</tr>
</tbody>
</table>

Status after TFSR-08: Discussed and agreed
## Thermal

<table>
<thead>
<tr>
<th>Nr</th>
<th>Topic</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>1min / 30 min ratio</td>
<td>Could it happen that the LEDr has higher intensity in the beginning (when switched on) and will reduce its intensity significantly as it reaches steady-state temperature?</td>
</tr>
<tr>
<td>#2</td>
<td>High ambient temperature</td>
<td>Could it happen that the LEDr has significantly reduced intensity when it is operated at high ambient temperature?</td>
</tr>
<tr>
<td>#3</td>
<td>Low ambient temperature</td>
<td>Could the de-icing / de-fogging behaviour of a luminaire be different when an LEDr is used?</td>
</tr>
<tr>
<td>#4</td>
<td>Cap temperature</td>
<td>Could the lamp cap get hotter with an LEDr compared with a filament lamp and could this lead to damage of the material of the luminaire?</td>
</tr>
<tr>
<td>Nr</td>
<td>Topic</td>
<td>Question</td>
</tr>
<tr>
<td>----</td>
<td>--------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>#1</td>
<td>Spectral content</td>
<td>In signalling applications with coloured lenses, is the spectral content of the LEDr sufficiently like the spectral content of the incandescent lamp? e.g.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Red lens</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Amber lens</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Green+red = white</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Green+red=amber</td>
</tr>
<tr>
<td>#2</td>
<td>Minimum red content</td>
<td>Is the minimum red content fulfilled? (for RID applications).</td>
</tr>
</tbody>
</table>
Electrical #1
- Voltage Range

**Question:**
Does the LEDr have the same voltage - flux behavior as the filament light source?

**Answer:**
The electronics of the LEDr is designed so that the voltage – flux behavior is equivalent, or more stable, than the filament light source.

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**SAFETY REQUIREMENTS (UN ECE R37 /RE5)**
- The luminous flux shall be tested between 9 V and 14 V

**CONSUMER / CUSTOMER REQUIREMENTS**

**PERFORMANCE REQUIREMENTS (IEC 60810)**

**Status after TFSR-08:**
Discussed and agreed
Question: Does the LEDr flicker in case of pulse-width modulation (PWM) operation? Also covering PWM dimming for dual-function operation

Answer:
There are two application cases:

1. PWM for dual function dimming (tail / stop and FrontPos / DRL)
2. PWM for stabilisation (reduce voltage peaks))

→ 1) Dual function is only used for a limited number of categories: e.g., P21W, but not e.g. H7
→ 2) all LEDr are tested for “no visible flicker”

Status after TFSR-08: Discussed and agreed, technical details to be confirmed
Electrical #3
- Failure detection system compatibility

**Question:**
Does the LEDr cause a wrong failure message in the dashboard when it is working correctly?

Does the LEDr cause a correct failure message in the dashboard when it has failed?

Incl presence detection (Kaltüberwachung)

**Answer:**
Failure detection is mandatory for direction indicators (DI)

→ 1) LEDr for DI – The electronics of the LEDr is designed to ensure compatibility.

→ 2) user information for non-DI application (optional failure detection)

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**SAFETY REQUIREMENTS (UN ECE R37 /RE5)**
- Technical requirements for minimum current / power: in case LEDr is working correctly. The limit should be >[50]% of the filament current; use of optional external electronics allowed
- Technical requirements for maximum current / power: in case LEDr is failed (no light emitting); use of optional additional electronics needs to be discussed
- Information / Communication
  - The consumer is informed about the possible impact of the LEDr on the failure detection system and is given additional information / advice
Question:
Does the LEDr cause a wrong failure message when it is working correctly?

Does the LEDr cause a correct failure message when it has failed?

Is the LEDr compatible with presence detection ("Kaltüberwachung")?

Answer:
For all LEDr the electronics of the LEDr is designed to ensure compatibility.

There shall be no light in the first 2ms.
Failure detection system compatibility (non-DI) – two options

Solution A- “high power AND lower power” versions
- „High power“ version for vehicles with failure detection (~[20]% of vehicles for low beam)
- „Low power“ version for vehicles without failure detection and for vehicles with low threshold (~[80]% of vehicles for low beam)
- User information

Benefit:
- reduction of electronic waste by avoiding additional electronics
- optimized energy efficiency
- -> reduced CO2 emission, reduced waste

Disadvantage:
- Increased complexity for the consumer
  “mis-use”:
  Wrong failure message in case of using a “low power” version where a “high power” version is needed “(but the light source is working correctly)

Solution B- only a “high power” version
- Only high power version

Benefit:
- Less complexity for the consumer

Disadvantage
- Increase of electronic waste by adding additional components where they are not necessary
- Artificially increased power consumption where low power consumption could be enabled
- -> increased CO2 emissions, increased waste

Discussion during TFSR-08
End of TFSR-08 meeting on 2019-12-10 in Bonn

Start of TFSR-09 meeting on 2020-01-17 by telephone
Electrical #4
- EMC

Question:
Does the LEDr cause EMC problems in the vehicle?

Answer:
No, the electronics design of the LEDr is made in such a way that no disturbance occurs; this is regulated in ECE R10 for all ESA in vehicles.
Is the LEDr as robust against electrical disturbance as the filament lamp?

Yes, the electronics of the LEDr should be designed so that it can withstand typical electrical overstress, e.g. reverse voltage.

Status after TFSR-09: Discussed and agreed

CONSUMER / CUSTOMER REQUIREMENTS

PERFORMANCE REQUIREMENTS (IEC 60810)

Electrical overstress tests are defined in IEC 60810 for all LED light sources.

SAFETY REQUIREMENTS (UN ECE R37 /RE5)
Question:
Does the LEDr need a specific polarity (+ / -)?

Answer:
The LEDr should either work with both polarities or should be designed to withstand a wrong polarity without damage.

Status after TFSR-09: Newly introduced during the meeting. Discussed without conclusion.
Question:
Does the LEDr have the same mass as the filament lamp and is it as robust against vibration as the filament lamp?

Answer:
No, LEDr have typically a higher mass than a filament lamp, but the mass of filament lamps is not regulated or standardised. A market survey can give guidance on the typical mass of the different categories. For each cap-holder system a mass limit can be determined for which the system is designed. The vibration resistance can be tested on the LEDr directly, using the same test method used to test the vibration resistance of filament lamps.
Question:
Does the LEDr have the same geometry / maximum outline as the filament lamp?

Answer:
Yes, the “burner-side” of the LEDr has the same maximum outline as the filament lamp to allow safe insertion into the luminaire.

For the “cap-side” of the LEDr there may be a somewhat larger specification than the filament lamps (per category); this will be reflected in the installation instructions, which can be vehicle-specific.

Status after TFSR-09: Discussed and agreed

SAFETY REQUIREMENTS (UN ECE R37 /RE5)
- Define maximum outline: cap-side
- Define maximum outline: burner-side

- In case the cap is bigger, provide to the consumer installation instructions (can be vehicle specific). These instructions shall be based on a real fitment-test on the vehicles.
Question:
Could it happen that the LEDr has significantly higher intensity in the beginning (when switched on)?

Answer:
No, due to the proposed requirement, there is no significant effect, as the design of the LEDr is such that such excessive lumen-drop from 1 min to 30 min is be prevented.
Thermal #2
- High ambient temperature

Question:
Could it happen that the LEDr has significantly reduced intensity when it is operated at high ambient temperature?

Answer:
LED-technology has a temperature-dependent behaviour. Additional tests are defined to ensure that there is no significant reduction of luminous flux.

The “real-world” temperatures show a function-, vehicle- and climate-specific statistical distribution. This statistical distribution is influenced by:
- Driving or stand-still
- Vehicle ambient air temperature and sun load
- Engine heating
- Light-source self-heating
- Heating by near-by light sources e.g. high wattage filament
## Statistical Distribution

<table>
<thead>
<tr>
<th>Amb Temp</th>
<th>Probability</th>
<th>Flux limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temp1</td>
<td>Prob 1</td>
<td>Flux limit 1</td>
</tr>
<tr>
<td>Temp2</td>
<td>Prob 2</td>
<td>Flux limit 2</td>
</tr>
<tr>
<td>Temp3</td>
<td>Prob 3</td>
<td>Flux limit 3</td>
</tr>
</tbody>
</table>

Status after TFSR-09: Discussed without final conclusion
Could the de-fogging behaviour of a luminaire be different when an LEDr is used?

Yes, the de-fogging behaviour may be different (can become better or worse). It could change due to the different power consumption and energy balance of the LEDr; the consumer is informed about this.

Discussion during TFSR-09:
• „De-fogging“ is referring to avoiding or removing humidity accumulation inside the luminaire
• Temperature cycles with higher „Delta-T“ lead to higher „humidity pumping-effect“ and vice-versa
• There is no test method / requirement defined in UNECE today.
• No test method known in ISO or IEC
• Reference was made to FMVSS 108 and SAE test requirements

Status after TFSR-09: Discussed without final conclusion
Could the de-icing behaviour of a luminaire be different when an LEDr is used?

Yes, the de-icing / de-fogging behaviour may be different (can become better or worse). It could change due to the different power consumption and energy balance of the LEDr; the consumer is informed about this.

Discussion during TFSR-09:
• Term “de-icing” not clearly defined; Is it removal of “frozen fog” in the morning? Or is it removal of snow / ice during driving? Or ...
• No test method defined in UNECE or IEC or ISO
• No test method defined in FMVSS or SAE
• Consequently no test conditions defined (ambient temperature, amount of “ice”, de-icing-time, criteria for being “ice-free”)
• Does this refer to all functions or only low beam?
• Noted that the driver is always responsible to keep vehicle and lighting functions in “clean” state

Status after TFSR-09: Discussed without final conclusion

CONSUMER / CUSTOMER REQUIREMENTS

PERFORMANCE REQUIREMENTS (IEC 60810)

SAFETY REQUIREMENTS (UN ECE R37 /RE5)
• require specific user information to be included on de-icing
Question:
Could the lamp cap get hotter with an LEDr compared with a filament lamp and could this lead to damage of the material of the luminaire?

Answer:
No, a maximum power or temperature limit for the LEDr avoids this situation. So even though LEDr has less power consumption than the filament lamp, cap temperature is considered relevant.
Summary of the proposal

Status after TFSR-09: Discussed and agreed

**LED replacement light source**

**PERFORMANCE REQUIREMENTS (IEC 60810)**
- **Electrical**
  - #5: Electrical robustness
- **Mechanical**
  - #1: Vibration

**SAFETY REQUIREMENTS (UN ECE)**
- **Electrical**
  - #1: voltage range
  - #2: PWM operation
  - #3: failure detection compatibility
  - #4: EMC
  - #5A: Polarity
- **Mechanical**
  - #2: Geometry
- **Thermal**
  - #1: hot-cold-ratio
  - #2: high ambient temperature
  - #3A: de-icing
  - #3B: de-fogging
  - #4: cap temperature
- **Colorimetric**
  - #1,2: Spectral aspects