Texte zu den geplanten neuen EU-Regelungen zur umweltgerechten Produktgestaltung und zur Energieverbrauchskennzeichnung in der Beleuchtung – Zusammenstellung * des Umweltbundesamtes (UBA), Deutschland

Anforderungen an die Stromeffizienz

Hintergrundtext:

Beispiel I für die Berücksichtigung mehrerer Lichtdienstleistungskenngrößen innerhalb eines Gleichungssystemes – Lichtstrom und Farbwiedergabe (aus der Vergabegrundlage des Blauen Engels für Haushaltslampen, Juli 2010)

Hinweis: Dies ist die englischsprachige Version; die deutschsprachige kann heruntergeladen werden unter **

EN: Information on the coming EU Lighting Regulations – Ecodesign and Energy Labelling – Compilation * of the Federal Environment Agency (UBA), Germany

Requirements on Energy Efficiency

Background information: Examples No 1 for how to integrate a number of product features within an equation system – luminous flux and colour rendering (taken from the ecolabel Blue Angel, July 2010)

FR: Informations sur les futures réglementations de l'UE concernant l'éclairage – l'écoconception et l'étiquetage énergétique – Compilation * de l'Agence Fédérale de l'Environnement (UBA), Allemagne

Exigences d'efficacité énergétique

Informations de fond: Exemple N° 1 qui illustre comment on peut incorporer plusieurs types de service de l'éclairage dans un système d'équation – flux lumineux et rendu des couleurs (de le label environnemental Ange bleu, juillet 2010)

Indication: C'est un texte en anglais. Une version allemande peut être téléchargé sous **

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* http://www.eup-network.de/de/eup-netzwerk-deutschland/offenes-forum-eu-regelungen-beleuchtung/dokumente/texte/

** http://www.eup-network.de/fileadmin/user_upload/Lichtquellen_UBA_Hintergrundtext_04b_DE.pdf

Hinweis : Die auf der vorigen Seite genannte beispielhafte Umsetzung ist in dem Text ab Seite 14 zu finden.

EN: Advice: The example, mentioned on the previous page can be found in the text on page 14f.

FR: Indication: L'exemple mentionné sur la page précédente, vous trouverez dans le texte à partir de la page 14.

Es folgt ein unveränderter Originaltext.

EN: The following is an unmodified original text.

FR: Ce qui suit est un texte original.

Appendix 1

Umwelt Bundes Amt

Für Mensch und Umwelt

Basic Information and Instructions for Applying for the Blue Angel Eco-label RAL-UZ 151 for Lamps

Use of the UBA Approach for Assessing Lighting Technology Products

Umweltbundesamt – UBA

(Federal Environmental Agency)

July 26, 2010

www.uba.de/energie/licht

Author:

Section I 2.4
”Energieeffizienz”
(Energy Efficiency)
Christoph Mordziol

Table of Contents

This present paper provides information on the use of the UBA approach for ”Assessing Lighting Technology Products”[1] within the scope of the Basic Criteria for Award of the Blue Angel and includes explanations and interpretations of various requirements for the Blue Angel eco-label. It is designed to support understanding and, above all, the effective implementation of the compliance verifications with respect to the requirements for the Blue Angel eco-label for lamps and it is attached to the Basic Award Criteria as Appendix 1.

Paragraph 1 provides general information as well as definitions of terms used in connection with several requirements.

Paragraph 2 includes definitions and calculations forming the basis of some of the requirements for the Blue Angel eco-label.

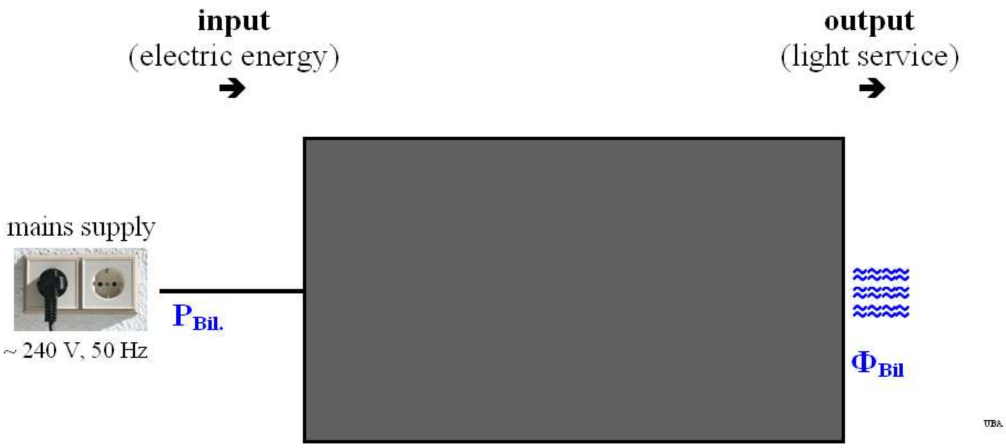
The list of definitions and abbreviations with page numbers in paragraph 3 simplifies looking up terms.

An arrow (↑) preceding a term indicates that this term is explained elsewhere.

1 General Information

1.1 Assessment Boundaries

Explanation: Principle: Power in / Light out



The following is to be taken into account

- all input (electric energy) needed to achieve the required output (light service): “total real power” and
- only the output (lightservice) that is actually available to the user: “useful luminous flux”.

[1] As of today – July 2010 – this approach has not yet been published. This paper only contains that part of the approach which is important for the Basic Criteria for Award of the Blue Angel eco-label. For further information please go to www.uba.de/energie/licht.

1.1.1 Assessment Boundary of Input

Explanation: A look into the above-shown "black box" shows:
There are, among others,
- lamps with and without integrated ballast;
- lamps requiring cooling for operation and
- devices for controlling the luminous flux.

Depending on the design extra electricity consumption may occur in addition to the electricity consumption of the lamp.

→ All electricity consumption shall be taken into account – irrespective of whether it occurs inside or outside the lamp; i.e. all electricity consumed by the consumer (total real power).

Definition:

> ***Assessment boundary of input***
> is the connection to the power supply (230 volts/50 Hz). The assessment boundary comprises all elements required to enable the lamp to achieve the desired light output.

1.1.2 Assessment Boundary of Output

Explanation: There are lamps requiring safety glass or safety grids for operation,
- in order to protect the user from splinters in the case of bursting (occurring, for example, with certain halogen lamps with high luminous flux) or
- in order to protect the user from UV radiation during operation.

Depending on the design this may influence the emitted light in terms of luminous flux level, colour temperature and colour rendering.

→ Only the light available to the user shall be taken into account (useful luminous flux).

Definition:

> ***Assessment boundary of output***
> is the enveloping surface after the passing of which the light emitted from the lamp will be available to the user without (further) restrictions or influences caused by lamp technology. The assessment boundary comprises all elements required to enable the lamp to achieve the desired light output, i.e. for example, UV filters and safety grids for glass splinter protection.
> Luminous flux, colour temperature and colour rendering shall be determined for the light that has passed the above-mentioned enveloping surface.

1.2 Switching Cycles

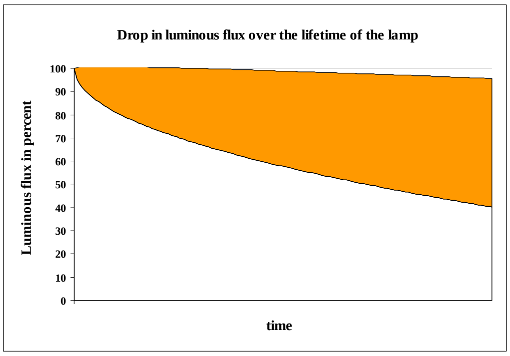
Definition:

> ***Switching cycle S***
> is a sequence of switching on and switching off the lamp with defined intervals.
>
> ***Switching cycle S.165.15*** *(the Basic Criteria for Award of the Blue Angel refer to it in a simplified manner as "long switching cycle")*
> is a switching cycle during which the lamp is switched On for 165 minutes (2.75 hours) and Off for 15 minutes (0.25 hours).
>
> ***Switching cycle S.05.45*** *(the Basic Criteria for Award of the Blue Angel refer to it in a simplified manner as "short switching cycle"*)
> is a switching cycle during which the lamp is switched On for 0.5 minutes (30 seconds) and Off for 4.5 minutes.

Explanation: The following analyzes conditions the lamp finds itself in after a certain number of switchings or burning hours, respectively. These are times (see para. 1.3) at which at the lamp emits a given luminous flux (para. 1.4) with a given colour rendering (1.6), consumes a given amount of electric power (1.7) and exhibits a given lamp survival factor (1.8.1). The properties, e.g. the lamp survival factor, may depend on the switching cycle. Indices are used to clearly refer to a specification, as for example the lamp survival factor after 3,000 burning hours, to the respective switching cycle in which these 3,000 hours have been reached: "1" stands for the S.165.15 switching cycle while "2" stands for the S.05.45 switching cycle.

1.3 Times

Explanation: Requirements for lamps usually refer to the so-called initial state, i.e. the state the lamp finds itself in at the end of the burn-in time – see, for example, Commission Regulation (EC) 244/2009. However, the ↑ luminous flux drops over the life of a lamp.



For assessment purposes this drop in light output can be taken into account by considering the luminous flux averaged over time and/or by setting a specific admissible drop value.

Definition:

Burn-in time [hours]
denotes the time that elapses until the lamp is “burned in”:

Type of Lamp	h
Discharge lamps	100
Filament lamps	1
LED lamps	3
Other lamps	0

End of burn-in time t_i
denotes the time when after initial switch-on the lamp has been in operation without interruption during burn-in time.

Time after 400 burning hours $t_{1.400h}$
denotes the time when immediately after the end of the burn-in time (↑ t_i) the lamp has been operated in the ↑ S.165.15 switching cycle for 400 burning hours.

Time after 3,000 burning hours $t_{1.3'000h}$
denotes the time when immediately after the end of the burn-in time (↑ t_i) the lamp has been operated in the ↑ S.165.15 switching cycle for 3,000 burning hours.

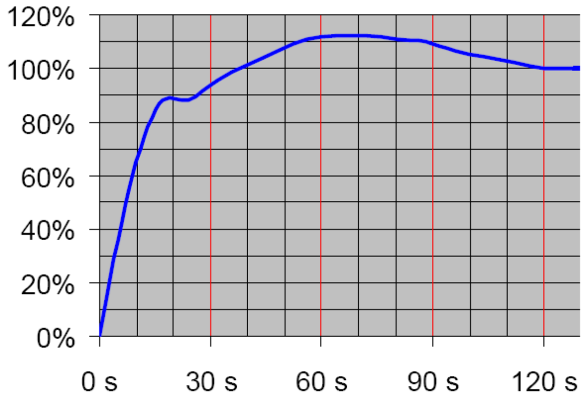
Time after 6,000 burning hours $t_{1.6'000h}$
denotes the time when immediately after the end of the burn-in time (↑ t_i) the lamp has been operated in the ↑ S.165.15 switching cycle for 6,000 burning hours.

Time after 20,000 switchings $t_{2.20'000S}$ [2]
denotes the time when immediately after the end of the burn-in time (↑ t_i) the lamp has been operated in the ↑ S.05.45 switching cycle and has completed 20,000 switchings.

2 Since at this time – unlike at t_{400h} and $t_{6'000h}$ – the index does not refer to the burning hours but to the number of switchings the 20’000 is followed by an “S”.

1.4 Luminous Flux

Explanation:



[luminous flux vs. time; source: SAFE, Switzerland]

Depending on the lamp technology the luminous flux may temporarily reach a value that exceeds the value the lamp reaches after "stabilization".

Definition:

Luminous flux Φ [lumen]
is a quantity derived from the radiant power [3] by evaluating the radiation according to the spectral sensitivity of the human eye.

Useful luminous flux Φ_{Bil} [lumen]
is the luminous flux of a lamp reached after switch-on at the end of the stabilization period. It is measured at the ↑ assessment boundary of output. The useful luminous flux Φ_{Bil} of a lamp is the average value of a group of lamps. It is to be distinguished from the nominal luminous flux declared by the manufacturer, for example, on the packaging which may be the rounded off.

Initial luminous flux $\Phi_{Bil.i}$ [lumen]
denotes the value of the ↑useful luminous flux Φ_{Bil} the lamp emits at the ↑ end of the burn-in time t_i .

Luminous flux after 3,000 burning hours $\Phi_{Bil.1.3'000h}$ [lumen]
denotes the value of the ↑ useful luminous flux Φ_{Bil} the lamp emits after a burning time of 3,000 hours (↑ $t_{1.3'000h}$) in the S.165.15 switching cycle.

Luminous flux after 6,000 burning hours $\Phi_{Bil.1.6'000h}$ [lumen]
denotes the value of the ↑ useful luminous flux Φ_{Bil} the lamp emits after a burning time of 6,000 hours (↑ $t_{1.6'000h}$) in the S.165.15 switching cycle.

[3] also called radiant power

1.5 Colour Temperature

Definition:

> ***Colour temperature T_C [kelvin]*** [4]
> is the temperature of the Planckian radiator whose radiation has the same chromaticity as that of a given colour stimulus.
>
> ***Correlated colour temperature T_n [kelvin]*** [5]
> is the temperature of a Planckian radiator whose perceived colour most closely resembles that of a given stimulus at the same brightness and under specified viewing conditions.
>
> ***Colour temperature at the end of the burn-in time $T_{n.Bil.i}$ [kelvin]***
> is the ↑ correlated colour temperature T_n determined at the ↑ assessment boundary of output at the end of the burn-in time (↑ t_i).

1.6 Colour Rendering

Definition:

> ***General colour rendering index Ra***
> is the average of the special colour rendering indices CIE 1974 for a specified set of eight test colours [6] determined according to CIE 13:3:1995.
>
> ***Colour rendering at the end of the burn-in time $Ra_{Bil.i}$***
> is the ↑ general colour rendering index Ra measured at the ↑ assessment boundary of output at the end of the burn-in time ↑ t_i.
>
> ***Colour rendering after 6,000 burning hours $Ra_{Bil.1.6'000h}$***
> is the ↑ general colour rendering index Ra measured at the ↑ assessment boundary of output after a burning time of 6,000 hours (↑ $t_{1.6'000h}$).

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4 according to EN 12665:2002; therein with reference to IEC 50 (845)/CIE 17.4; 845-03-49

5 according to EN 12665:2002; therein with reference to IEC 50 (845)/CIE 17.4; 845-03-50

6 according to EN 12665:2002, therein referred to as „CIE 1974 General colour rendering index“ with reference to IEC 50 (845)/CIE 17.4; 845-02-631

1.7 Real Power

Definition:

Total real power P_{Bil} [watt]
is the real power at the assessment boundary, i.e. the sum of all real powers measured at the assessment boundary required to enable the lamp to emit a luminous flux of the required quantity and quality. This may also include the real power of elements not integrated into the lamps.
The real power P_{Bil} of a lamp is the average of group of lamps. It is to be distinguished from the nominal real power declared by the manufacturer, for example, on the packaging which may be rounded off.

Initial total real power $P_{Bil.i}$ [watt]
denotes the value of the ↑ total real power P_{Bil} the lamp reaches at the ↑ end of the burn-in time t_i .

Total real power after 3,000 burning hours $P_{Bil.1.3'000h}$ [watt]
denotes the value of the ↑ total real power P_{Bil} the lamp reaches after a burning time of 3,000 hours (↑ $t_{1.3'000h}$).

Total real power after 6,000 burning hours $P_{Bil.1.6'000h}$ [watt]
denotes the value of the ↑ total real power P_{Bil} the lamp reaches after a burning time of 6,000 hours (↑ $t_{1.6'000h}$).

1.8 Durability

1.8.1 Lamp survival factor

Definition:

Lamp survival factor LSF [in percent] [7]
describes the probability that a lamp continues to operate at a given time. It gives the percentage of a representative quantity of a type of lamps that continues to operate after a given period of time.

Lamp survival factor $LSF_{t1.400h}$ [in percent]
is the ↑lamp survival factor LSF after a burning time of 400 hours (↑ $t_{1.400h}$) in the S.165.15 switching cycle.

7 according to CIE 97 D:2005;

Lamp survival factor $LSF_{t1.3'000h}$ ***[in percent]***
is the ➚ lamp survival factor LSF after a burning time of 3,000 hours (➚ $t_{1.3'000h}$) in the S.165.15 switching cycle.

Lamp survival factor $LSF_{t1.6'000h}$ ***[in percent]***
is the ➚ lamp survival factor LSF after a burning time of 6,000 hours (➚ $t_{1.6'000h}$) in the S.165.15 switching cycle.

Lamp survival factor $LSF_{t2.20'000S}$ ***[in percent]***
is the ➚ lamp survival factor LSF after 20,000 switchings (➚ $t_{2.20'000S}$) in the S.05.45 switching cycle.

1.8.2 Lamp lumen maintenance factor

Definition:

Lamp lumen maintenance factor LLMF [in percent] [8]
is the ratio of the luminous flux emitted by a lamp over the lifetime to the initial luminous flux of a new lamp. The luminous flux of lamps of all types drops with the number of burning hours.

1.8.3 Service life time

Definition:

Service life time $LD_{N.1}$ ***[hours]***
is the burning time that elapses during the S.165.15 switching cycle from the end of the burn-in time (➚ t_i) until the lamp lumen maintenance factor $LLMF_{min}$ and/or the Lamp LSF_{min} fall below the respective minimum values.

8 according to CIE 97 D:2005; therein not given as percentage but as figure < 1;

2 Requirements for the Blue Angel Eco-Label for Lamps (RAL-UZ 151)

2.1 Re para. 3.1.1 of the Basic Criteria: Input Index

Explanation: Regulation (EC) No 244/2009 and Directive 98/11/EC use the equation »$\mathbf{0.88 \times \sqrt{\Phi} + 0.049 \times \Phi}$«. This equation is also used herein and it provides, like in Directive 98/11/EC, a reference value. However, it does not use the initial luminous flux Φ_i but the luminous flux averaged over the minimum service life time $\Phi_{Bil.N1}$. Hence a input index is calculated.

Definition:

Average service life luminous flux $\Phi_{Bil.N1}$ [lumen]
denotes the ↑ assessment luminous flux Φ_{Bil} averaged over the ↑ minimum service life time $LD_{N1.min.BE}$ [9] as follows:

$\Phi_{Bil.N1} = (0.5 \times \Phi_{Bil.i} + \Phi_{Bil.1.3'000h} + 0.5 \times \Phi_{Bil.1.6'000h}) / 2$ [10]

Reference value $P_{BGN.1}$ [watt]
denotes a reference value resulting from the average service life luminous flux $\Phi_{Bil.N1}$ as follows:

$P_{BG.N1} = 0.01029 \times (0.88 \times \sqrt{\Phi_{Bil.N1}} + 0.049 \times \Phi_{Bil.N1})$

Average total real power $P_{Bil.N1}$ [watt]
is the ↑ total real power P_{Bil} averaged over the ↑ minimum service life time $LD_{N1.min}$ as follows:

$P_{Bil.N1} = (0.5 \times P_{Bil.i} + P_{Bil.1.3'000h} + 0.5 \times P_{Bil.1.6'000h}) / 2$

Input index PGN_1
denotes the dimensionless parameter resulting as the ratio between average total real power $P_{Bil.N1}$ and the reference value $P_{BGN.1}$ as follows:

$PGN_1 = P_{Bil.N1}/P_{BGN.1}$

9 see para. 2.2.2.1 on page 15.

10 This leads to the same result as if one arithmetically averages Φ_{Bil} for a section of about 3'000 burning hours each and then divides the sum of these average values by the number of sections (= 2).

Explanation: The Basic Criteria shall be extended at a future development stage to products of lighting technology which can adapt the luminous flux supplied to a changing demand. An adequate assessment of these products requires an examination of the input/output ratio, i.e. the ratio between electric energy and luminous energy, for a duty cycle to be regarded as typical.
No duty cycles have yet been defined for household lamps. Therefore, a duty cycle is, temporarily, assumed for the Blue Angel which leaves the luminous flux demand unchanged: duty cycle Z85.
Though this does not bring any immediate benefit it simplifies the future development of the requirements since the use of duty cycles is introduced already now. Thus, it won't be necessary to adapt the requirement system in the future.

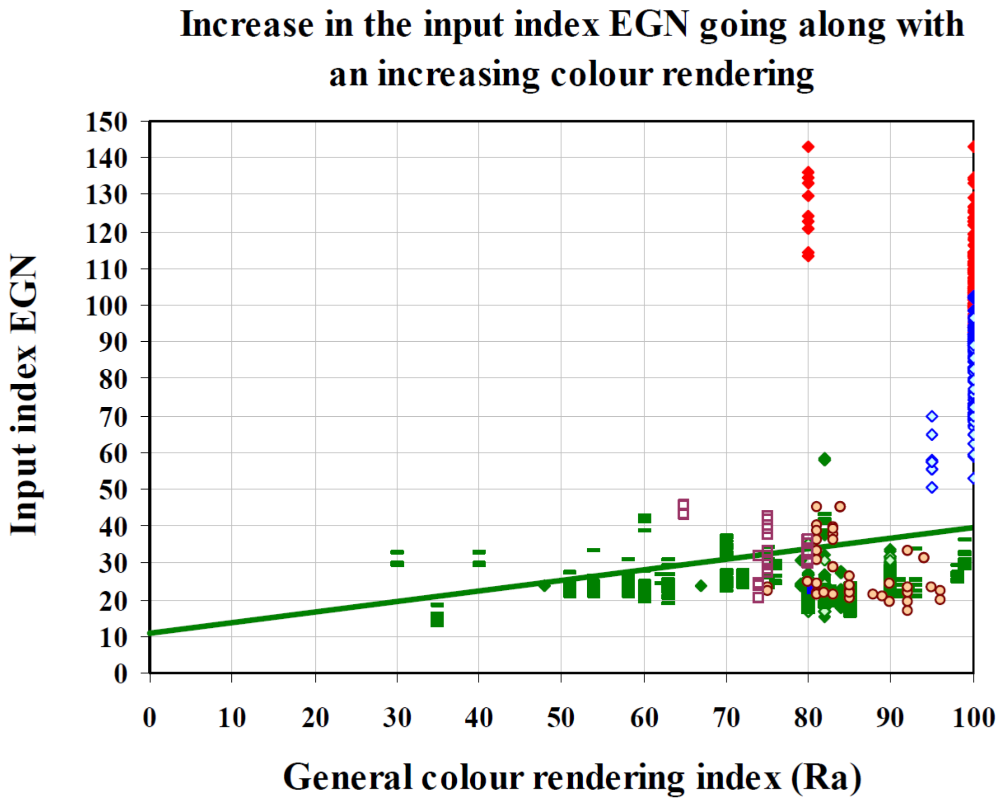
Definition:

Duty cycle Z85
denotes a duty cycle where the demand for luminous flux permanently amounts to 85 percent of the initial value $\Phi_{Bil.i}$.

Input index EGN_{Z85}
denotes the dimensionless input index of electric energy resulting for the duty cycle Z85. Due to the particularity of the Z85 cycle the following shall apply:

$EGN_{Z85} = PGN_1$

Explanation: An essential dependence of the demand of lamps for total real power and hence for electric energy results from the amount of the ↑ colour rendering index Ra.



Note: The coloured dots stand for different lamp technologies, e.g. red dots for incandescent lamps.

That is why the Blue Angel sets a maximum value that is made up of a base value and a supplement value with the latter depending on the amount of the general colour rendering index.

Definition:

Colour rendering index $Ra_{Bil.N1.M}$

is the ↑ general colour rendering index Ra, measured at the ↑ assessment boundary of output and averaged for the ↑ service life time LD_{N1} from the ↑ colour rendering values at the end of the burn-in time $Ra_{Bil.i}$ and the ↑ colour rendering after a burning time of 6,000 hours $Ra_{Bil.1.6'000h}$:

$$Ra_{Bil.N1.M} = (Ra_{Bil.i} + Ra_{Bil.1.6'000h}) / 2$$

Requirement:

Maximum input index for the Blue Angel $EGN_{Z85.max.BE}$

$$\mathbf{EGN_{Z85.max.BE} = 10.697 + 0.291 \times Ra_{Bil.N1.M}}$$

2.2 Quality and Serviceability

2.2.1 Re para. 3.2.1 of the Basic Criteria: Lamp Light Quality – Colour Rendering

Explanation: In some lamps colour rendering changes during the lifetime.

Definiton:

***Colour rendering index** $Ra_{Bil.N1.T}$*
is the lowest value of the ↑ general colour index Ra measured at the ↑ assessment boundary of output occurring during ↑ service life time LD_{N1}. It equals the lowest values of $Ra_{Bil.i}$ and $Ra_{Bil.1.6'000h}$.

Requirement:

***Minimum colour rendering index for the Blue Angel** $Ra_{Bil.N1.T}$*

$Ra_{Bil.N1.T.min.BE}$ = 80

2.2.2 Re para. 3.2.3 of the Basic Criteria: Durability of the Lamp

2.2.2.1 Service Life Time

Definition:

Minimum lamp lumen maintenance factor for the Blue Angel** $LLMF_{min.BE}$ **[in percent]

$LLMF_{min.BE}$ = 85 percent

Minimum lamp survival factor for the Blue Angel** $LSF_{t1.6'000h.min.BE}$ **[in percent]
is the minimum ↑ lamp survival factor $LSF_{t1.6'000h}$. It amounts to

$LSF_{t1.6'000h.min.BE}$ = 50 percent

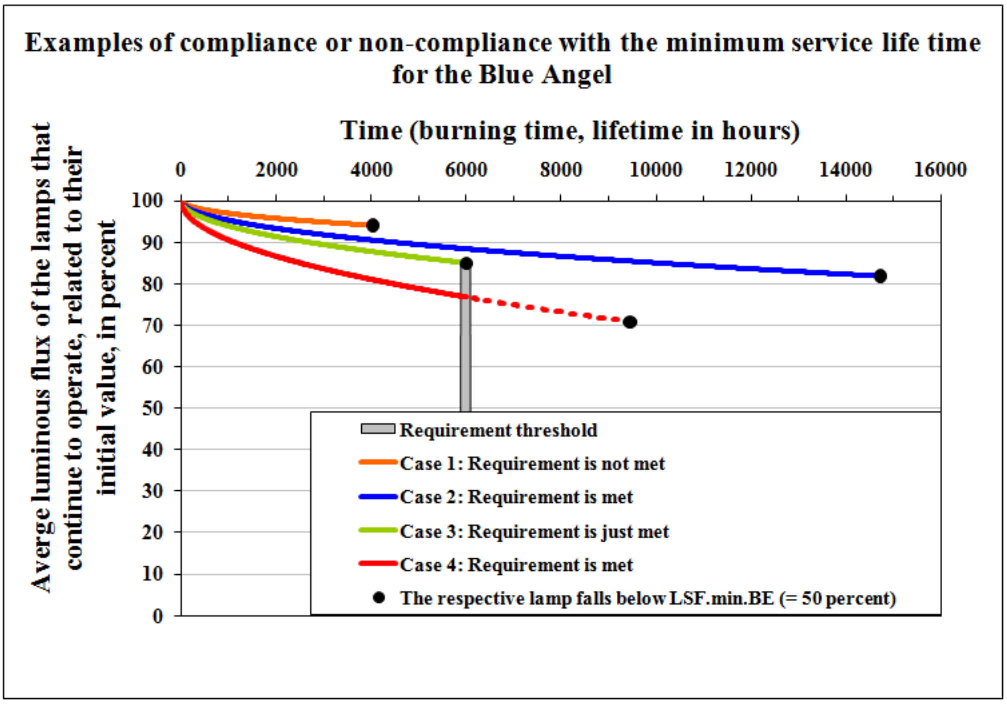
Requirement:

Minimum service life time for the Blue Angel** $LD_{N.1.min.BE}$ **[hours]
The ↑ service life time $LD_{N.1}$ of the lamp [11] shall at least equal the following minimum value:

$LD_{N.1.min.BE}$ = 6,000 hours

[11] See the definition in para. 1.8.

Explanation: The following diagram shows examples of four theoretical cases where the drop in luminous flux varies and up to what extent the minimum service life time $LD_{N.1.min.BE}$ is met:



Case 1: The requirement is not met because the lamp survival factor reaches the value of $LSF_{min.BE}$ (= 50 percent) prior to the end of the required 6,000 hours.

Case 4: The requirement is not met because the lamp lumen maintenance factor falls below the minimum value $LLMF_{min.BE}$ (= 85 percent) prior to the end of 6,000 hours.

2.2.2.2 So-called Switching Endurance

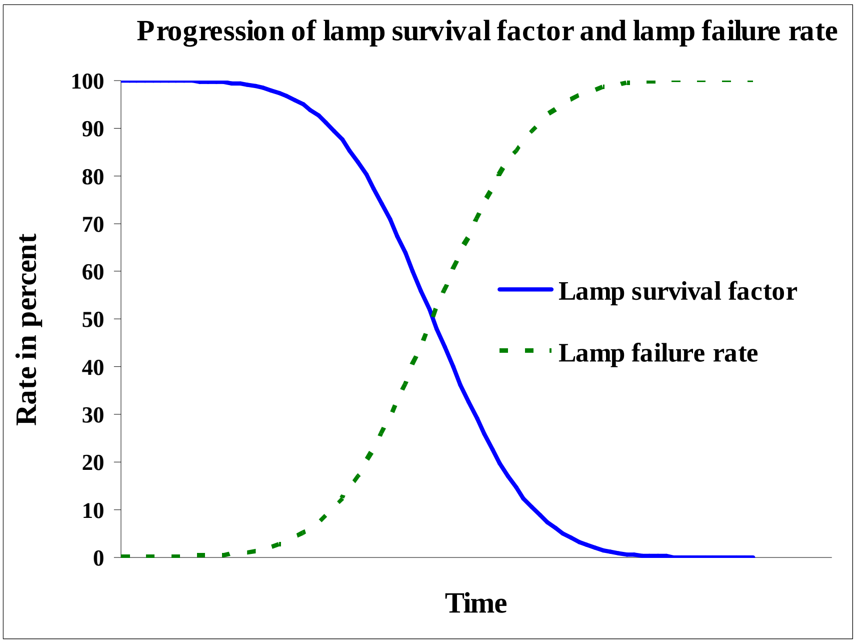
Requirement:

Minimum lamp survival factor for the Blue Angel $LSF_{t2.20'000S.min.BE}$ ***[percent]***

$LSF_{t2.20'000S.min.BE}$ = 50 percent

2.2.2.3 So-called Premature Failure Rate

Explanation: The ↑ lamp survival factor describes the percentage of lamps which at a given time continue to operate, i.e. survived. On the other hand, the failure rate describes the percentage of lamps which do no longer operate at a given time, i.e. failed. That means: The sum of lamp survival factor and failure rate is always the same. Each one of these two parameters results from the other one.



Example: A premature failure rate of 2 percent corresponds to a lamp survival factor of 98 percent.

Requirement:

Minimum lamp survival factor for the Blue Angel ***$LSF_{t1.400h.min.BE}$ [percent]***

$LSF_{t1.400h.min.BE}$ = 98 percent

3 List of Definitions/Index

Note: To simplify searching each definition is listed with the **term** and its **abbreviation**. In some cases parts of the terms are repeated.