EU DIRECTIVE SETS LIMITS ON RADIATION FROM LED LAMPS

Lighting technology has experienced a great deal of change in the last ten years. In the past, it was almost without exception the halogen bulb that generated the light in portable lamps. With the evolution of semiconductor technology came powerful LED lamps, the luminous efficiency and life span of which are tens of times better than those of halogen lamps. The radiation emitted by a powerful LED lamp may be harmful to the retina of the human eye. In April 2006, the European Parliament and the Council of the European Union approved the Directive 2006/25/EC to ensure the health and safety of workers using such lamps. The directive emphasises the employers' responsibility to ensure that exposure to artificial optical radiation does not exceed exposure limits.

Laser radiation and non-coherent radiation
In the Directive, artificial optical radiation is divided into laser radiation and non-coherent radiation. Non-coherent radiation relates to any optical radiation other than laser radiation, and is also known as broadband radiation. The consequences of non-coherent radiation are often less severe than those of laser radiation but serious hazards are possible even in the case of non-coherent radiation.

Radiation exists in your workplace, too
In most workplaces there are sources of artificial optical radiation. An everyday example of artificial optical radiation is light emitted by a lamp. Thus there is exposure to artificial optical radiation almost at all times in a workplace, generated by lighting and computer screens. In addition, radiation may be produced either as a necessary part of some process or as an unwanted by-product. In whatever way this radiation is presented, it is necessary to control exposure to it.

The Directive lays down the minimum health and safety requirements regarding the exposure of workers to risks arising from adverse effects caused by exposure to artificial optical radiation. In the Directive the term optical radiation applies to any electromagnetic radiation in the wavelength range between 100 nm and 1 mm. This optical spectrum is divided into ultraviolet radiation, visible radiation and infrared radiation.

Radiation interacts with human body
Whenever electromagnetic radiation interacts with a material, it is likely to deposit some energy at the point of interaction. This energy may cause some effect in the material. In the visible light spectrum, blue light is the most energetic. Ultraviolet radiation, in turn, is more energetic than any visible light.

Optical radiation is absorbed in the outer layers of the body and, therefore, its biological effects are mostly confined to the skin and eyes. Excess exposure may cause for example skin cancer, photoretinitis, cataractogenesis or conjunctivitis. Different wavelengths cause different effects on the body depending on which part of the skin or eye absorbs the radiation. Also, the types of interaction of the wavelengths are different.

The Annexes of the Directive provide exposure limit values for non-coherent optical radiation and laser radiation. The limit values take account of the biological effects of optical radiation, the harms caused by different wavelengths of the radiation, the duration of exposure and the target tissue. The Directive requires exposure of employees to optical radiation to be below these exposure limit values.

There are different ways to assess the risks and it is up to the employer to do so
The first step in risk assessment is to identify all optical radiation sources and groups of employees that are likely to be exposed. This will be done by those responsible for occupational safety in the workplace. The Directive is largely based on Directive 89/391/EEC: The introduction of measures to encourage improvements in the safety and health of workers at work. In carrying out the obligations set out in these Directives, the employer shall assess, and if

necessary measure and calculate, the levels of exposure to optical radiation to which workers are likely to be exposed. The exposure values to optical radiation can be determined using the formulas in the Annexes of the Directive. The results are compared with the corresponding tabulated values.

Device vendors shall verify radiation values of devices
There is also a lighter way to carry out the obligations than radiation measuring. The statement in the Directive allows the employer to determine the employee's exposure levels by means other than measurement. One way is to use data supplied by a third party, such as a manufacturer. Such a procedure is often simpler because the measurement of optical radiation in the workplace is difficult and expensive.

Data supplied by a third party can be for instance results from standard tests. For example the safety classification of non-coherent sources is defined in IEC/EN 62471: Photobiological safety of lamps and lamp systems. The safety classification takes account of the amount of optical radiation, the wavelength distribution and human exposure to the optical radiation. Standard testing may include measurements of the UV hazard to the skin and eye and retinal blue light hazards. Non-coherent radiation sources are grouped into four risk groups - the higher the risk group, the higher the probability it will cause harm.

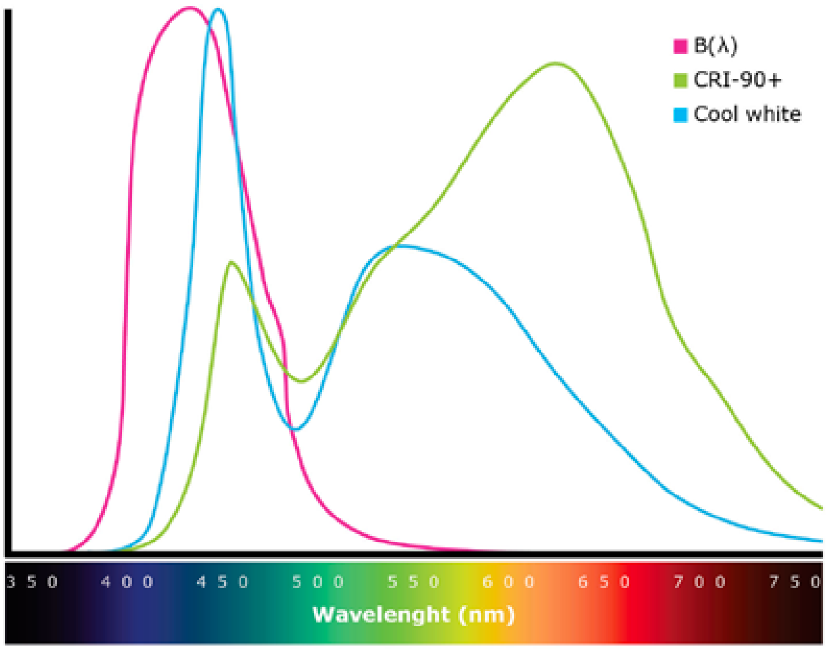
The standard divides radiation amounts into four different groups according to radiation intensity (IEC/EN 62471):

Exempt Group
-No photobiological hazard under foreseeable conditions.
-No immediate risk of optical radiation is reasonably foreseeable, even for continuous and unrestricted use.
Risk Group 1
-Low-risk group, the risk is limited by normal instinctive behavioural reactions to exposure.
-The products are safe for most applications, except in very prolonged exposures where direct ocular exposures may be expected.
Risk Group 2
-Moderate-risk group, the risk is limited by the aversion response to very bright light sources or the thermal discomfort. However, such responses are not always triggered.
Risk Group 3
-High-risk group, even a momentary or short-term exposure may pose a risk.
-Safety measures are essential.

A blue LED provides a broad light spectrum, including different hues of white.
There are two widely used techniques to produce white light with LEDs. One is to combine different coloured LEDs such as red, green and blue which together produce white light, another and a more popular one is to use a blue (or UV) LED combined with a yellow fluorescent material usually applied as a thin layer on the surface of the LED chip. The blue light of the LED stimulates the fluorescent material which glows and emits a yellow light. Part of the energy of the blue LED is thus converted into white light.

Cool white LED is the most efficient – therefore the most common
Where LED lamps are used, people often notice that the colour temperature of the light produced by them is bluer, or cooler, than in halogen lamps. This is due to the way in which LEDs produce white light. The white-light LEDs currently in use are mainly based on blue LEDs and one or more fluorescent materials. The spectrum thus produced shows a peak caused by the blue LED with a more evenly-spread peak beside it which extends over the entire visible light spectrum.

A LED lamp may also radiate at invisible wavelengths.
Visible light is one type of electromagnetic radiation as are ultraviolet light, infrared light, and radio waves. The luminous flux of visible light is expressed in lumens; it tells how much light a lamp will give out. Thus the lumen value does not take into account electromagnetic radiation which is outside the eye's sensitivity range. Just by looking at the lumen value one cannot, therefore, say anything certain about the adverse effects of a light source to a human.



Risks of LED lamps to retina
Due to the way white LEDs produce light, their light does not contain significant portions of infrared or ultraviolet radiation. Thus, of the radiation types defined in Directive 2006/25/EC, it is reasonable to only apply the retinal blue light hazard to LED lamps. The diagram shows the blue light spectral weighting function B (λ) as well as the spectra for a typical white LED (Cool White) and MICA CRI90+ LED.

Quality of light
The colour rendering index CRI tells a lot about the quality of the light. If a lamp has a high CRI (more than 90), the radiation is concentrated mainly on wavelengths comfortable to the human eye and the eye sees different colours as natural colours. A large part of the radiation power of the MICA CRI90+ LED lamp, which has a very high colour rendering index, is concentrated on the red end of the spectrum, which means the risk for the human eye is clearly smaller than with typical cool white light.

A responsible manufacturer mitigates risks
The MICA IL lamps manufactured in Finland by Mica Elektro Oy Ltd are tested in an establishment run by an impartial third party and the lamps are properly classified according to their radiation types. The safety of the lamps in their intended use can be easily determined on the basis of the results from standard tests.

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References:
1) Directive 2006/25/EC of the European Parliament and Council
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:114:0038:0059:EN:PDF

2) Non-binding guide to good practice for implementing Directive 2006/25/EC
Link: http://ec.europa.eu/social/BlobServlet?docId=6790&langId=en

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