3r

October 2012

A Guide to the Specification of LED Lighting Products 2012

This Guide has been produced under the umbrella of the Lighting Industry Liaison Group and is endorsed by its member organisations:

HEA
Highway Electrical Association

PLDA
Professional Lighting Designers Association

Society of Light and Lighting

ILP
Institution of Lighting Professionals

Lighting Industry Association

IALD
International Association of Lighting Designers

1.0 Introduction

The rise of LED lighting is driving a significant transformation of the lighting industry. LEDs can provide a palette of millions of colors and dynamic effects that conventional lighting cannot match in terms of design, scene-setting and ambience. Thanks to their miniaturized dimensions and low heat radiation, they can be embedded almost anywhere. And being digital, they are programmable, offering unlimited scope for creative use and effective management. They offer long lifetimes, energy and maintenance savings, making them potentially an efficient solution.

This is the fourth edition of the guidance notes produced under the umbrella of the Lighting Liaison Group, which is an informal group representing the major lighting organisations in the UK who have endorsed and added their names to this Guidelines document. They introduce a universal set of quality criteria from the IEC/PAS documents. As a user of LED luminaires it is important to apply the same set of standardised quality criteria when evaluating manufacturer's claims. Users of LED luminaires should always ask for LED luminaire specifications measured in compliance with the new IEC/PAS documents. This will allow all interested parties to judge comparison claims on an equal, like-for-like basis serving the interests of end-users, specifiers, designers and manufacturers.

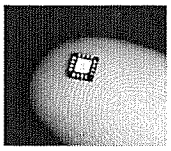
Summary

Typical questions a user should ask are shown below. More detail is given in further sections of this guide.

Question	Answer	Realistic Performance Indications	Evidence required
How is life defined?	By a combination of lumen maintenance and failure fraction.	Life should always be stated as: 1. Light Loss - Usually either L90 or L70 (L50 for decorative luminaires) – no. of hours; and 2. Physical Failures - LED Life F10 – no. of hours E.G. If the rated life of a product is 50,000 hours, this means light loss of L70 and physical failures of Fx (where x is the percentage no. of failures) at the rated life of 50,000 hours. (Note: it should be assumed that the manufacturer has tested to a maximum of 6000 hrs and extrapolated beyond that – unless they explicitly state differently)	See section 2.0
What is the lumen depreciation?	Rate and percentage of light loss	Light output > 90% of initial Code 9 Light output > 80% of initial Code 8 Light output > 70% of initial Code 7	See section 3h
What is the colour rendering index?	The rated CRI should include any shift over life.	Initial CRI and CRI change.	See section 3f
How stable is the Colour temperature?	Defined by the initial colour variation & colour variation through life	Within a 1-step ellipse Within a 3-step ellipse Within a 5-step ellipse Within a 7-step ellipse Greater than a 7-step ellipse	See section 3g
What ambient temperature is the luminaire performance based on?	For indoor 25°C for outdoor 15°		
What is the photometric distribution?	Measurement of the light intensities at various angles in absolute units	Candelas (cd) and degrees	See section 3n
Driver current	The current at which the LED's are driven	Measured in mA	
Power Factor	The power factor for the whole circuit	0.85 or better.	

The following terms are used in the guidance document:

LED Die -
The LED die (or chip) is the funamental light source.



LED Package -
The LED die is contained in a suitable package allowing simplified electrical connection or assembly.



LED Module -
This is the LED together with mechanical and optical components making a replaceable item for use in a luminaire.



LED Luminaire -
This is the complete system consisting of all elements described in Section 1.



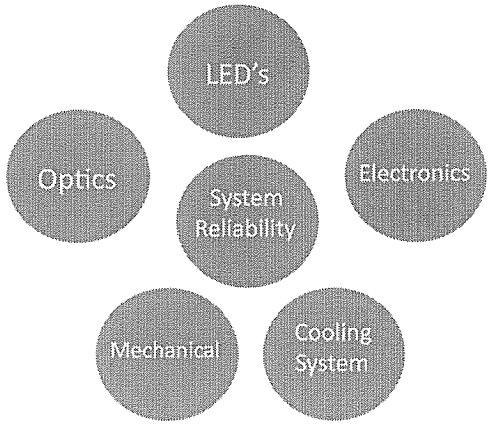
2.0 System Reliability

Most quality criteria are linked to the initial performance requirements of LED modules and LED luminaires. For maintained values 25% of rated life time up to a maximum of 6.000 hours is used. There is no measurement of lifetime above 6.000 hours. Accelerated test methods providing more advanced insight in lumen depreciation over LED module and/ or LED luminaire life are under consideration. However it is important to keep in mind that lifetime claims based on lumen maintenance and luminaire life are two very different things. The lifetime claims based on lumen maintenance refers to the lumen maintenance projections of the LED light sources integrated into that luminaire. Lifetime claims based on luminaire life relate to physical failures.

Currently many LED luminaire manufacturers use test results provided by LM-80 (IES LM-80-08. Approved Method: Measuring Lumen Maintenance of LED-Light Sources – Illuminating Engineering Society of North America, 2008. It consists of a real measurement over the first 6000 hours combined (with an extrapolation out to end of life) as the L90, L70 and L50 lumen maintenance thresholds of LED luminaires. But there is a disconnection between the LM-80 test results made by the LED die manufacturer and the results from the LED luminaire where, for example, issues such as thermal management can change the actual performance. LM-80 requires testing of LED light sources for 6.,000 hours, and recommends testing for 10.,000 hours. It calls for testing at three surface temperatures (55° C, 85° C, and a third temperature to be determined by the manufacturer) so that users can see the effects of temperature on light output, and it specifies additional test conditions to ensure consistent and comparable results. In practice, leading LED light source manufacturers test their products to the LM-80 minima of 6.000 or 10.000 hours, and then apply extrapolation methodologies as described in TM-21 (IES TM-21-11. Projecting Long Term Lumen Maintenance of LED Packages – Illuminating Engineering Society of North America, 2011) to arrive at L90, L70 and L50 figures. Luminaire manufacturers translate these curves into LED luminaire specific curves.

There are two constraints in translating these test results into LED luminaire performance. First catastrophic failures of individual LEDs and other failure modes of light output depreciation are not taken into consideration. Second there is no validated way to translate the lumen maintenance curve of an individual LED-light source into a curve for the LED-luminaire.

Luminaire life, on the other hand, has to do with the reliability of the components of a LED luminaire as a system.



Factors affecting the system performance are:

LEDs -
While LEDs do not radiate heat, with current products half or more of the input energy may be converted to heat that must be conducted away from the diodes.

Optical -
LEDs are directional light sources, giving the lamp or luminaire designer new challenges when compared to existing lamp technology. The use of reflectors, lenses and diffusers allows a designer to direct light in many different ways. The efficiency and depreciation of the optical system must be considered and factored into the overall efficiency of the luminaire.

Mechanical -
The mechanical integrity of a luminaire is important in several different areas including: IP rating to suit the application, heat-sinking that will not become compromised with time, lack of maintenance, vibration resistance so the heat-sink does not become detached from the PCB, bonding mechanisms that are suitable for the life of the luminaire. Many LEDs and specifically phosphor can react to different chemicals. Some gaskets can out-gas chemicals which can affect the performance of some LEDs. A luminaire manufacturer should work with the LED supplier and qualify any new gasket materials.

Cooling system -
The performance of a LED is dependent on its temperature during operation. The design of the luminaire will influence its operating temperature and hence published characteristics. The paint finish/ colour may affect the heat dissipation from the luminaire. A PCB is the interface between a LED and the heat-sink and has a thermal resistance value. The higher the resistance the less efficient the system is at conducting away heat from the LED. This may well impact on the LED lumen output performance and ultimately its life.

Electronics -
Electrical overstress is a cause of catastrophic failure of LEDs. Some LEDs contain an on board Transient Voltage Suppression chip (TVS), which provides some level of protection. A well designed lamp or luminaire will feature the necessary design or protection in order to minimise damage at installation or power-up. Failure rate of the external control gear shall be included in the overall assessment of total life/failure rate.

The entire system lasts only as long as the critical component with the shortest life, whether that critical component is a weather seal, an optical element, a LED, an electronic control gear circuit or something else. LED light sources are simply one critical component among many, although they are often the most reliable component in the whole lighting system.

Because the reliability of LED luminaires is in most cases much longer than the practical test times, verification of manufacturer's life time claims need to be made in a sufficiently confident way. For that reason the acceptance or rejection of a manufacturer's life time claim, past 25 % of rated life (with a maximum of 6.000 hours), is out of the scope of both the IEC/PAS documents. In order to validate a life time claim, an extrapolation of test data is needed. There is no validated way to translate the lumen maintenance curve of an individual LED Light source into a curve for the LED Module or LED luminaire.

Life testing of the LED light source is carried out according to LM-80 up to 6000h or 10,000h. Beyond these values statistical predictions are made (see. Fig 1). If LED Light source data from tests carried out to 6000h is available, LED Modules and LED Luminaires may have life testing carried out to 2000h. Accelerated test methods for projecting measurement data beyond limited test time is currently under consideration.

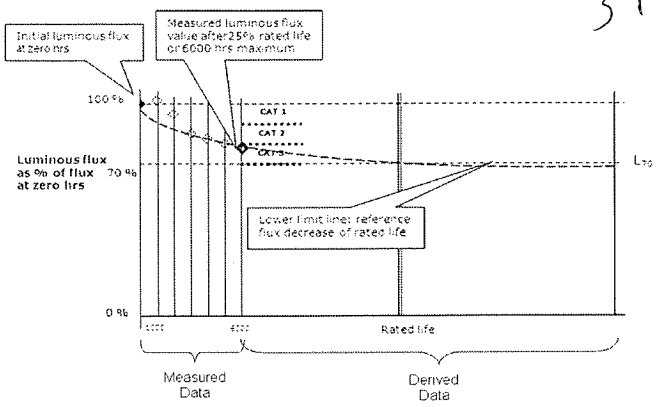


Fig1

3.0 Quality Criteria

The IEC published two Public Available Specification (PAS) performance requirement documents dealing with LED products.

- IEC/PAS 62717 Performance requirements – LED modules for general lighting
- IEC/PAS 62722 Performance requirements – LED luminaires for general lighting

These were developed together to provide:
- the definition of a set of quality criteria related to the initial specifications of a product;
- a standardised description on how to measure these quality criteria.

To ensure consistency in quality criteria, definitions and measuring methods, most of these are defined in IEC/PAS 62717. The luminaire standard IEC/PAS 62722 under certain conditions allows the use of compliant modules to reduce the number of tests for LED luminaires. This makes manufacturers claims of initial specifications of LED- modules and luminaires comparable.

The following list of quality criteria should be considered when evaluating manufacturer's claims:

a) *Rated input power* -
The rated input power shows the amount of energy consumed by a luminaire, including its power supply. It is expressed in watts.

b) *Rated luminous flux* -
This is the light emitted by the luminaire which is expressed in lumens. For traditional (non LED) luminaires it is usual that *Relative* values are measured and multiplied by the lamp flux. For 'LED' luminaires it is recommended that *Absolute* photometric values are used. Absolute photometry results in a LOR=1.

c) *LED luminaire efficacy* -
The measured initial luminous flux divided by the measured initial input power of the same individual LED luminaire. It is expressed in lumens per watt.

d) *Luminous intensity distribution* -
The spatial distribution of the luminous flux graphically depicted in a luminous intensity distribution curve, which is usually expressed in a polar diagram representing the light intensity as a function of angle about a light source. It is expressed in cd.

e) *Correlated Colour Temperature (CCT)* -
Although white light is a mixture of colours, not all whites are the same since they depend on their constituent colours. So a white with a higher proportion of red will appear warmer and a white with a higher proportion of blue will appear cooler. In order to classify the different types of white light, the concept of colour temperature is applied which is described as the colour impression of a perfect black-body radiator at certain temperatures. This concept can be best explained with the help of familiar thermal radiators like the filament of an incandescent lamp or an iron bar. When these materials are heated to a temperature of 1000 K their colour appearance will be red, at 2000-3000 K they will look yellow white, at 4000 K neutral white, and at 5000-7000 K cool white. The higher the colour temperature, the cooler the perception of the white light becomes. It is expressed in Kelvin. The initial CCT value classification for the photometric code can be obtained by taking the initial CCT value divided by 100.

f) *Rated Colour Rendering Index (CRI)* -
Although light sources may have the same colour appearance, this doesn't necessarily mean that coloured surfaces will look the same under them. Two lights that seem to have the same white colour appearance may be the result of different blends of wavelengths. As a result a given material may appear differently since the surface may not reflect the constituent wavelengths by the same extent. Its colour appearance will change when it is exposed to one or other light. So, colour rendering is an important criterion when selecting light sources for lighting application solutions. However with new LED technology coming in, with a narrow spectrum, the CRI index is not in all circumstances giving a fair representation of the colour appearance. New definitions and methods for measuring are currently under development in CIE. The initial CRI value classification for the photometric code can be obtained by using the following intervals:

Code	CRI Range	Colour rendering properties
6	57-66	Poor
7	67-76	Moderate
8	77-86	Good
9	87-100	Excellent

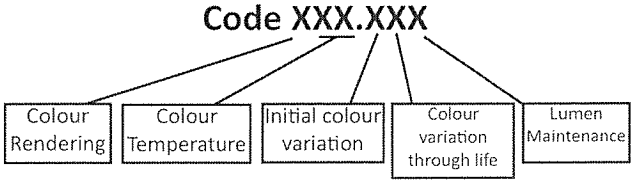
g) *Rated chromaticity co-ordinate values both initial and maintained* -
MacAdam ellipses refer to the region on a chromaticity diagram which contains all colours which are indistinguishable to the average human eye, from the colour at the centre of the ellipse. The contour of the ellipse therefore represents the just noticeable differences of chromaticity. MacAdam ellipses are often scaled up to a larger size of 3x, 5x or 7x the original. This is indicated as a 3-step, 5-step or 7-step MacAdam ellipse. Initial variations in colour, or colour shift with time can be shown by the size of ellipse needed to contain these positions. The initial and maintained chromaticity co-ordinates are measured for the maintained value at 25% of rated life up to a maximum of 6.000 hours. The classification for the photometric code can be obtained by using the following intervals.

Size of MacAdam ellipse, centered on the rated colour target	Colour variation category	
	initial	maintained
3-step	3	3
5-step	5	5
7-step	7	7
>7-step ellipse	7+	7+

h) *Lumen maintenance code* -
As the typical life of a LED luminaire is (very) long, it is time-consuming to measure the actual lumen reduction over life. Also the actual LED behavior with regard to lumen-maintenance may differ considerably by type and manufacturer. It is not possible to express the lumen-maintenance of all LEDs in simple mathematical relations. A fast initial decrease in lumen output does not automatically imply that a particular LED will not make its rated life. In order to validate a life time claim, an extrapolation of test data is needed. In the IEC a general method of projecting measurement data beyond limited test time is under consideration. In the US an extrapolation based on LM-80 test data will be described in IES TM-21. Instead of life time validation, the IEC/PAS has opted for lumen maintenance codes at a defined finite test time. Therefore, the code number does not imply a prediction of achievable life time. The maintained luminous flux is measured at 25% of rated life time up to a maximum of 6.000 hours and expressed as a percentage of the initial value. The maintained value determines the lumen maintenance code.

Lumen maintenance (%)	Code
>90	9
>80	8
>70	7

i) *Photometric code* -
A six digit photometric code that displays the important 'quality of light' parameters: CRI, CCT, chromaticity co-ordinates and luminous flux. The six digit photometric code displays the important 'quality of light' parameters.



Example:
Initial CRI value of 84 – code 8
Initial CCT value of 3000K – code 30
Initial spread of chromaticity co-ordinates within a 3-step MacAdam ellipse – code 3
Maintained spread of chromaticity co-ordinates within a 5-step MacAdam ellipse – code 5
Maintained luminous flux of 91% – code 9
Photometric Code = 830/359

j) *Rated life (in h) of the LED module and the associated rated lumen maintenance (Lx)* -
The length of time expressed in hours, during which a population of LED modules provides more than the claimed percentage (x) of the initial luminous flux always published in combination with the failure fraction. The recommended series of values for (x) is 70, 80, 90.

k) *Failure fraction (Fy), corresponding to the rated life of the LED module in the luminaire* -
The percentage (y) of a number of LED modules of the same type at their rated life that have failed. This failure fraction expresses the combined effect of all components of a module including mechanical, as far as the light output is concerned. The recommended series of values for (y) is 10, 50.

l) *Ambient temperature (ta) for a luminaire* -
The ambient temperature around the luminaire related to the specified performance. For a given performance claim the ambient temperature (ta) is a fixed value. It is possible to specify performance claims at different ambient temperatures. If the LED luminaire is to be used at an ambient temperature different to that at which it was tested, correction factors will need to be applied to the performance criteria. It is expressed in degrees Celsius.

m) *Power Factor* -
The power factor should be clearly stated in all cases. Although product standards may not require this below 26W, it should be noted that some clients, and in particular contractors and local authorities working with un-metered supplies (the majority of public lighting in the UK), will require power factor correction of 0.85 or better.

n) *Intensity Distribution** -
Photometric data is available in two formats. Absolute Photometry does not require the use of a separate lumen output for the light source. Relative Photometry requires the LED package flux to be quoted. Both methods produce the same result. For LED luminaires Absolute photometry shall be used.

Absolute photometry of LED luminaires should be conducted according to IES LM-79-08 Photometric Measurements of Solid-State Lighting Products. Relative photometry should be conducted according to EN13032-1 (2004) Light and lighting - Measurement and presentation of photometric data of lamps and luminaires - Part 1: Measurement and file format.

These standards contain advice on measurement uncertainty. Photometric results that are calculated by deviation from the tested sample by the use, for example of higher or lower drive currents or dies from bins other than the bin used for the tested device are to be clearly identified as such. Correction factors used are to be provided with the results.

**Applicable for luminaires which modify the distribution of the light source.*

o) *Drive Current* -
For proper operation, the power supply and electronics must provide a well-controlled DC drive current. Drive current affects LED operating temperature and thus life and output. Normally around 350mA is quoted but this can be higher. The higher the LED is driven the brighter it will be but it may have a shorter operation lifetime and be less efficient. Some of the new multi die LEDs are designed to operate and perform at higher drive currents. Declaration of the drive current is important when remote drivers are used.

p) *Optical Risk* -
The Control of Artificial Optical Radiation at Work Regulations 2010 apply to light emitted from all artificial light sources including LEDs. These regulations require employers to protect the eyes and skin of workers from exposure to hazardous sources of artificial optical radiation. Exposure limits defined in the standard EN-62471 are in European regulation (directive 2006/25/CE) These are a combination of source power and exposure time.

Risk Group 0	Exempt
Risk Group 1	Low
Risk Group 2	Moderate
Risk Group 3	High

When light sources are placed in a luminaire, the Risk Group classification can change due to the optics used in the luminaire.

4.0 Luminaire manufacturers design data

When evaluating LED luminaire performance claims it is important to compare a standardised set of quality criteria measured in compliance with the appropriate standard. These quality criteria are designed to ensure that performance claims can be matched against traceable data.

This data is summarised below:

1) Rated input power (in W)
2) Rated luminous flux (in lm)
3) LED luminaire efficacy (in lm/W)
4) Luminous intensity distribution
5) Photometric code
   5a) Correlated Colour Temperature (CCT in K)
   5b) Rated Colour Rendering Index (CRI)
   5c) Rated chromaticity co-ordinate values (initial and maintained)
   5d) Maintained luminous flux
6) Rated life (in h) of the LED module and the associated rated lumen maintenance (Lx)
7) Failure fraction (Fy), corresponding to the rated life of the LED module in the luminaire
8) Ambient temperature (ta) for a luminaire
9) Power Factor
10) Intensity Distribution
11) Drive Current
12) Optical Risk

Product Type	Safety Standard	Performance Standard
Self-ballasted LED-lamps for general lighting services >50V	IEC 62560 Edition 1Publication expected 2010	IEC 62612/PAS Publicly Available Specification
Control gear for LED modules	IEC 61347-2-13 Published 2006	IEC 62384 Published 2006
LED modules for general lighting	IEC 62031 Edition 1 Publication 2008	IEC/PAS 62717 Published 2011
LED luminaires	IEC 60598-1	IEC/PAS 62722-2-1 Ed. 1: Luminaire performance - Part 2-1: Particular requirements for LED
LEDs and LED modules	IEC TS 62504 Terms and Definitions for LEDs and LED modules in general lighting	
CIE Technical Committees	TC2-46 CIE/ISO standards on LED intensity measurements	
	TC2-50 Measurement of the optical properties of LED clusters and arrays	
	TC2-58 Measurement of LED radiance and luminance	
	TC2-63 Optical measurement of High-Power LEDs	
	TC2-64 High speed testing methods for LEDs	

3 r

HEA
Highdown House
Littlehampton Road
Ferring
West Sussex
BN12 6PG

Highway Electrical Association

Institution of Lighting Professionals
Regent House
Regent Place
Rugby
CV21 2PN

Institution of Lighting Professionals

PLDA
Office Administration
Haller Str, 209
33334 Gütersloh

PLDA
Professional Lighting Designers Association

Westminster Tower
3 Albert Embankment
London
SE1 7SL

Lighting Industry Association

Society of Light and Lighting
222 Balham High Road
London
SW12 9BS

Society of Light and Lighting

The International Association of Lighting Designers
440 N. Wells St., Ste. 210
Chicago, IL 60654
USA

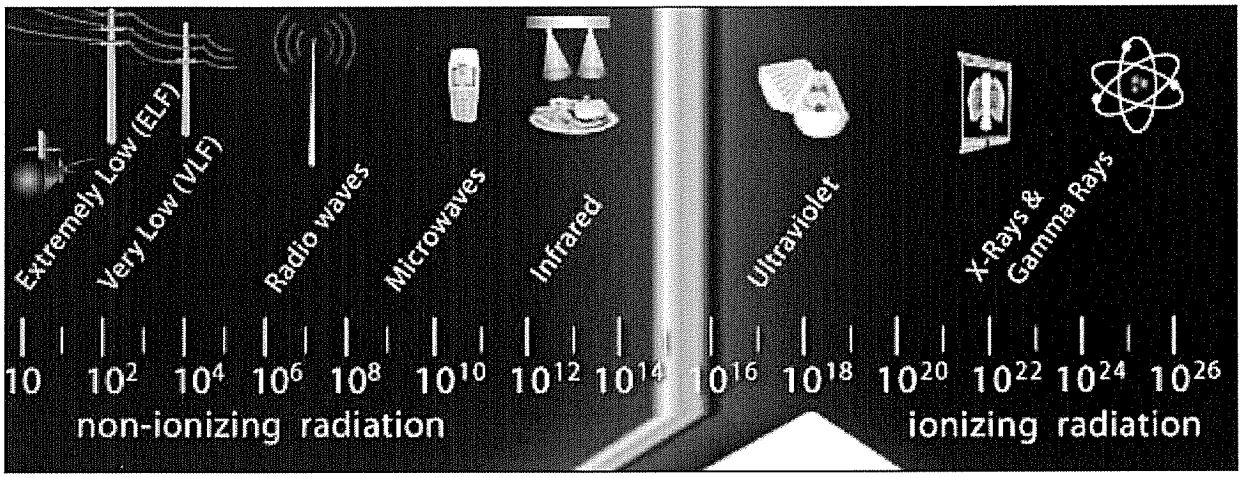
IALD
International Association of Lighting Designers

What Are The Uses For UV LED Light?

Posted on Jul 28, 2014 in Commercial, Industrial | Comments Off on What Are The Uses For UV LED Light?

Until relatively recently there was no such thing as a commercially available ultraviolet (UV) LED light. But as LED technology continues to develop and power densities increase, UV LED lights are expanding into the market and replacing more traditional alternatives.

Ultraviolet (UV) light is an invisible form of electromagnetic energy (light energy) that travels at a higher frequency and carries more energy than visible light. UV lightwaves were originally called "chemical rays" when first discovered in the 19th century because of their ability to cause certain substances to change at the molecular level.



Here are a few examples of the many applications for UV LED lighting:

Industrial and Cosmetic Curing

UV curing is a process that uses UV light to instantly cure (or "dry") inks, coating and adhesives through cross-polymerization of photosensitive materials. UV LED technology is emerging as an ozone gas- and mercury-free option for chemical curing with both industrial and cosmetic applications.

Nail polish cures have traditionally been done using unregulated UV lamps, but controversy arose earlier this year over a study published in the Journal of the American Academy of Dermatology which reported a potential danger of skin cancer. The study found that LED lamps were much safer for this application, due to the lower frequency of UV light they emit.

Analytic Tools

Due to UV lighting's ability to make certain materials visible to the human eye, it has been used for quite some time as an analytic tool. One common use for ultraviolet light sources is checking UV watermarks to validate currency, or identifying bodily fluids in forensic crime scenes.

Scientific and Biological

A 2012 study published in Applied Entomology and Zoology showed that UV LED lights were an effective method for dealing with the West Indian sweet potato weevil. This disagreeable insect is

known for decimating sweet potato crops, and detection is difficult due to the fact that most adult activity happens during the night.

The study used a diffused UV LED light trap and a sacrificial sweet potato. This easily detected the pests, allowing farmers to take appropriate actions in response.

Sterilization and Disinfection

UV lighting is an excellent tool for air and water purification. In fact, in addition to avoiding the energy hungry dryer, another reason for hanging clothes outside to dry is that the sun's natural UV light kills potentially harmful bacteria on clothes.

According to a 2007 study published in Medical & Biological Engineering & Computing, UV LED light sources were able to deactivate bacteria in water. Due to the safety advantages and compact size of LED lights, the study reported that UV LED devices have great potential as water sterilization solutions.

Indoor Gardening

UV LED lights are playing an increasing role in the trend toward indoor urban gardening. Using UV LED lights for your indoor harvest can increase production of polyphenols, which are believed to have antioxidant and anti-aging qualities. In addition to edible gardening, UV lights supposedly have beneficial applications for resin-producing plants such as medical marijuana by increasing potency of its medicinal properties.

Health Properties

Faroese physician Niels Finsen, the father of modern phototherapy, developed the first artificial UV light source to treat smallpox lesions. Although later eradication of smallpox rendered his technology irrelevant, UV phototherapy is used today to treat certain skin conditions including psoriasis and vitiligo as well as inhibit the growth of a certain type of skin cancer. According to the American Cancer Society, researchers found that when used alongside other treatments, UV lights resulted in long-term remission among many patients in early stages of the disease.

For psoriasis, an inflammatory skin condition caused by immune system malfunction, UV light works to suppress the immune system and reduce the inflammatory response.

Dangers of UV light

Exposure to UV radiation can damage skin and eyes if used without protection. Safety precautions should be used with UV LED lighting, with skin and eye protection used whenever possible.

Contact Flexfire LEDs to learn more

Are you interested in purchasing a UV LED light, or do you have any unanswered questions? Contact us or give us a call at (925)273-9080 and let one of our lighting specialists help you realize your LED project today.