

LED TECHNOLOGIES and LAMP FLORA: PROs & CONs

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For eight years Cave Lighting project has been installing LED lighting equipment in show caves. Nowadays about 40 underground facilities successfully use 'Cave Lighting™' LED systems. For eight years we have been watching our systems: we have been assessing the reliability of their work and the influence on the ecosystem of caves. You can find some of our conclusions and recommendations for the use of LED lighting in show caves in this article.

Two and a half years ago the Cave Lighting Project™ team reconstructed the illumination system of the Cathedral Chamber in the Grotte de Remouchamps Cave (Belgium). An energy efficient controlled LED Cave Lighting™ system was installed.

Cave Lighting™ System Operation Summary:

- There has been no system or part failure within its working lifespan (2 years 9 months);
- Energy consumption was reduced 40-fold;
- There has been a significant reduction of lamp flora.

We would like to discuss the last point in more detail. When installing the equipment in May 2010, the walls of the Cathedral Chamber were 75% covered with green and brown biomass. This can be viewed on the interactive accompanying photos. At the end of February 2013 the amount of flora was reduced to 10%, which is demonstrated by the photos.

We must note that it is not the first case of lamp flora reduction in a cave after LED system installation. Since the Cave Lighting™ Project began, we have observed this same effect quite often in other caves. The Bad Segeberg show cave in Germany is a fine example.

What is the value of this effect? Is LED lighting the panacea?

Show caves have been turned into tourist attractions primarily to protect the caves from vandalism, to reduce anthropogenic impact and to control visitor flow. Equipping a cave with routing, constructing stairs, paths and railings harm a cave less, as a result, than disorganized and unauthorized tours.

Naturally, the main purpose of a show cave is to demonstrate the subterranean world and its mysteries and beauty in a delicate manner. It is also important to try to preserve its virgin nature. Lighting, its quality and quantity are of major importance.

Open sources of light (such as torches, kerosene lamps, etc) were used approximately till the end of the 19th Century. Those sources of light polluted the air and dripstones with a considerable amount of grime and ash. Electric light fixtures became an important step forward. They solved the problem of grime and ash. But eventually, a few years later, there appeared another side effect of electric lighting systems – lamp flora. Eventually lamp flora turned into an enemy which is hard to defeat. Algae, moss and ferns change the interior of a cave and also affect dripstone formation.



Cathedral Chamber in the Grotte de Remouchamps, 2010



Cathedral Chamber in the Grotte de Remouchamps, 2013

International public opinion, including cave managers' and visitors' opinions, is relatively accepting of lamp flora. However, it is undesirable and there have been plenty of attempts to stop and prevent its growth. This battle has been going on for decades but the results are contradictory. There are two methods of control:

1. Preventing flora growth,
2. Removing existing flora.

Long proven experience has shown that it is much more effective to prevent flora growth, rather than trying to remove it. It is the same with our health: preventing an illness is easier than treating it. But, unfortunately, neither of these methods guarantees 100% success. Combining those different methods brings the best results.

To prevent flora from thriving, it is necessary to eliminate conditions which promote its subterranean growth. In other words, it is important to create conditions which will make it impossible to grow. There are always inorganic compounds, such as nitrates and phosphates and water in caves, which promote growth.

Therefore, the first step, to eliminate this, is to change the light level. (This is the level of electromagnetic emanation with the waves of certain length.) In this way flora will have no chance to grow and spread.

This is theory. However, let us talk about practical aspects. There are three main trends in experiments.

1. Using yellow and green lighting

This is a very effective solution. But unfortunately, aesthetic outcome is quite pathetic. In some cases flora remains untouched though it is not so visible in the green or yellow light. Besides, it is important to remember that the main purpose of illuminating a cave is to demonstrate its beauty, rather than fight against lamp flora.



Perama Cave with yellow light

The other two methods concentrate on optimizing operation of an illumination system in a cave:

2. Shorter operation cycle of a lighting system. Light zoning of a cave space and the use of 'dynamic lighting'

Lighting in show caves must be zoned, controlled and dimmable. Lighting zones should be relatively small since only the zones occupied with visitors should be lit. Splitting the system into controlled electric circuits allows the dividing of a cave into smaller zones. In bigger parts (chambers) there should be dynamic lighting. A tour guide, or special software, controls dynamic light scenarios in these areas. In some areas of a chamber, light is turned on or off at certain intervals. Such dynamic illumination system draws the visitor's attention to certain parts and details of a cave. Lighting should be dimmed and minimized on route illumination, when visitors walk along the paths or go from one chamber to another.

3. Lower intensity of light

Human eyes easily adapt to certain conditions. Our irises adjust to low light if necessary. Therefore, lighting placed at one's eye level can be minimized. In other words, visitors' heads can be in shade and should not be affected by unnecessary or diffused light. But, there should be controlled lighting fixtures in a cave in order to meet this requirement. Excessive or unnecessary lights should be turned off or dimmed. However, paths and stairs must have separate lighting. As a result of this lighting, it becomes possible to achieve almost complete darkness on one's eye level and reduce overall illumination. At the same time it is important to point out that stairs and path illumination should meet all safety requirements.

High quality equipment in a show cave is a perfect method of fighting against lamp flora!

What makes LED equipment different from other kinds of lighting?



Perama Cave without yellow light

LED equipment allows the reduction of illumination levels in a show cave significantly. This was impossible with older equipment.

LED lighting fixtures can be dimmed or turned off. This in its turn means that the illumination level can be varied without changing the light temperature.

LED luminaries allow the use of different lenses, so that various and proper angles of lighting can be chosen when designing illumination of a cave. It also helps to avoid 'unnecessary light'.

LED lighting fixtures can be manufactured with different spectrums of light temperature. This allows the adapting of illumination to a cave environment. Light show colors can range from 'cold' to 'warm' lighting.

Frequent turning on and off doesn't affect LED fixtures. It makes them perfect for 'zoning a cave' or creating various light and dynamic shows.

The most frequently asked question concerning LED lighting system in caves is:

Can lamp flora growth be reduced if a cave is equipped with LED equipment?

The answer is:

Definitely!

In the case of a poorly designed and installed LED system and too long switching time, flora will continue to

grow rapidly. Power consumption will be reduced significantly.

It is not out of the question that, even if a lighting system is properly designed and well balanced, there will still be few spots of vegetation caused by some sources of light. In such cases authorized eco-friendly measures should be used to remove the flora germs. Such preventive measures will reduce and gradually exterminate lamp flora completely. These measures must be taken on a regular basis.

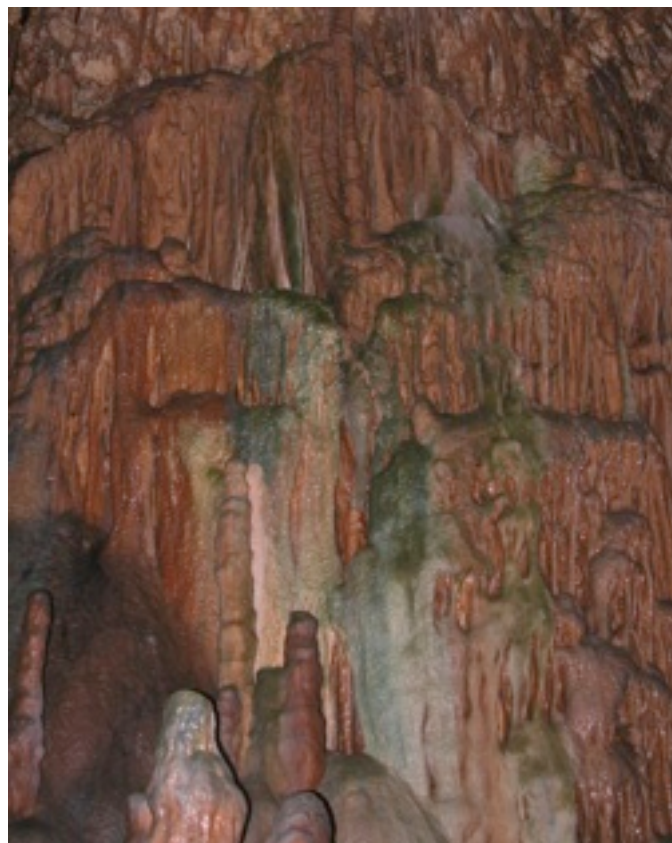
LED technology makes it possible to minimize possible harm and to preserve fragile eco-systems within a cave!

Conclusion:

Back to the question that we asked at the beginning of this article: "Can LED lighting be panacea for all woes"? We have to admit that LED technologies are neither panacea nor a magic wand as many mistakenly believe. Alongside LED technologies make it possible to bring eco-friendly and esthetically attractive lighting equipment into show caves. The key point is proper implementation and a new approach to cave lighting design.

In professional hands LED equipment can become a true panacea!

[Editor's note: This article was taken, with permission, from the Cave Lighting Project website (<http://www.cavelighting.com>). The article has had minor editing.]



Lampenflora in Scocjan Cave, Slovenia 2005. Photos: Steve Bourne