

# Let There Be Light...

## Manufacturers have been forerunners in implementing the use of high intensity LEDs

During the last decade, portable lamps have faced some radical changes when it comes to the requirements set for their features - mainly because of the many directives of the European Union and also because of new innovations. The most radical one has been the ATEX Directive, this directive refers to any equipment used in potentially explosive atmospheres.

Advances in semiconductor and battery technology are also offering new possibilities in design and development of portable lamps. All of this means that users of portable lamps are able to choose between many different types and brands of lamps, batteries and certificates. This article will give you a glance at the different options available.

### General properties of good portable light sources

To a professional user, a portable lamp means the same as a hammer to a carpenter: second best is not an option. For example, in emergency situations the life of fire fighters may depend on their portable lamps.

A large number of requirements are set for professional portable light sources. These vary a lot, depending on the user. There are however, some general requirements that are common for all users.

Ergonomics of a hand lamp is essential. In other words, the lamp should be easy to use and all controls should be within reach. Using the switch and other controls with gloves on should be possible. Also, the design of a portable lamp must be such that if the lamp is placed on a sloping surface, it will not roll away. ▶



There are situations where a portable light source is needed but at the same time both hands are needed for the job. In this case, the answer is a head or helmet lamp. The main requirements for these lamps are comfort, light weight, good light output and, especially, good balance. If there is an integrated battery pack on the headlamp, it should be well balanced. If the battery pack is of a separate type, the cable should be flexible and durable and also be able to withstand very low temperatures. Fitting a helmet lamp tightly on a helmet should be possible; it must not come loose due to vibration.

Generally, a good rechargeable portable lamp is equipped with the following features:

- *Adjustable light output with two or more steps. - This saves battery capacity when full light output is not needed*
- *Battery capacity indicator. - It provides user fast and simple information about remaining utilisation time*
- *Low battery warning. - This gives visual information to user that there is still some utilisation time left but that it is running out. This property is vital in a dangerous environment; it allows the user to return safely from the dangerous environment*
- *Battery deep discharge prevention. - This function protects battery pack from complete discharge*

Some of the above-mentioned functions are completely imperceptible to the user and are activated only when necessary. However, the awareness of their existence offers security and confidence towards the light source.



With fringed light outside the spot you see the surroundings

### Main feature: good light beam

When talking about a good portable lamp, there is one subject that is most important: the light itself.

The principal task of a lamp is to produce a good solid light beam when needed. A light beam is formed with different types of reflectors or lenses which give the desired form and size to the light beam. An intense, spotlight-type light beam is mainly used in searchlights and in fire fighting.

A broader light beam is generally used when working in a close environment, such as in maintenance work where uniformity of light is more important than maximum intensity. In both cases, the best results are achieved by using a fixed reflector in which the bulb is fitted in the optimum position.

In addition to reflectors, special lenses are used to form special shaped light beams. As an example, one can mention a lens that produces a rectangular light figure. Its advantage is a solid-shaped spot of light in the whole illuminated area. Railway operators in railway yards use such a lens.

Generally speaking, a good light beam is solid without any rings, black holes or shadows. These flaws cause the beam to lose its intensity, especially at a longer distance.

An important detail of a good light beam is fringed light outside of the beam. This prevents too high a contrast in the surroundings and allows the user to see possible obstructions or obstacles.

### Good design - less maintenance

The materials used in a professional hand lamp should tolerate different weather conditions: heat, frost, rain, dust, etc. In addition, industrial environments have their own special demands: a lamp is often exposed to different chemicals, solvents, oils, hydraulic fluids and even to acids.

Particular demands for a portable lamp are set in the everyday use of a fireman. The lamp is often used under extreme temperatures, in dense smoke and at the end of the day, it is washed under running water.

Sufficient ingress protection is vital to the lamp in order for it to survive the demanding environments. IP 54 can be considered ►

as the minimum and IP 66 / IP 67 are recommended for professional use. The materials of ex-certified lamps should also be ATEX approved.

A professional portable light source is often exposed to shocks and mechanical wear: the lamp may accidentally fall and hit the ground. A well-designed product will survive such accidents without problems.

If the lamp breaks down in spite of all, repairing should be as fast and easy as possible. Good design is a key factor here too: when the structure of a lamp is modular, repairs can be done on the spot, using simple tools and spare parts only. Time and money are saved when there is no need to send the lamp out for repair. Naturally, the user manual should include the basic maintenance instructions.

Modularity is essential in modern lamp design. It enables manufacturing of different versions for different purposes with the same tools and parts. Modular design also enables use of the same charger regardless of the lamp model.

### Rechargeable battery: ready to use!

When choosing a portable light source, energy storage is as important a feature as the amount of light. Most of the low cost models on the market get their energy from a primary battery. If used regularly, the operating costs of non-rechargeable portable lamps will eventually be higher than the costs for lamps that use secondary batteries (rechargeable). In professional use, using primary batteries in portable light sources is not cost-

efficient. It is also more environmentally friendly to use secondary batteries, regardless of the battery technology.

When choosing a portable lamp, one should take some time to think about the use of the device. Battery chemistries work differently under extreme conditions. If a portable light source is used under cold conditions, for example, lithium-based chemistries do not work as well as under normal room temperatures. Memory effect is still present in all nickel-based batteries, but it is easy to live with it by completely discharging the battery every now and then. This is often done automatically in normal use.

Lithium-based secondary batteries should not be fully discharged, because that will reduce the capacity of the battery permanently, whereas NiMH-based cells have a shorter storage time due to the self-discharging feature of the battery. A fully charged NiMH-battery will discharge by itself in only six months.

### Rechargeable battery and operating environment

When choosing a portable light source, one should take into account the environment in which the lamp is to be used. Lithium-based secondary batteries are lightweight and offer most power when compared to the weight of all batteries. However, under cold conditions, lithium-based lamps may have problems as their inner resistance rises when the temperature drops. Therefore, under cold conditions the operating time of a Li-Ion battery may be just a fraction of that achieved in 20°C. On the other hand, Lithium cells permanently lose some of their capacity under higher temperatures. The worst scenario is to store them in a high temperature fully charged. This can be easily seen in the short battery lifetime of laptops. Under extreme conditions, nickel-based batteries (NiCd & NiMH) are still a lot better than the basic lithium-based batteries. These batteries are not very happy with high temperatures either, but their operating temperature range is more extensive. In the cold, both of them are a lot better than lithium, especially the “old” NiCd. The recycling process of the NiCd cells is more complicated as they contain cadmium.

### Charger can make a difference

As professional lamps are in most cases in everyday use, their charging device must also be of top class. Normally, the charger is also a lamp holder: you can always keep the lamp in its charger while not in use. Sophisticated control electronics of the charging stand will assure full capacity of the battery, long lifetime and safe recharging. The charging stand automatically changes to upkeep charge when it detects that the battery is fully loaded. This will prevent the battery from overcharging and the lamp can be left in the charger without fear of damage.

Many users choose the convenience of storing rechargeable lamps in chargers that operate from the power supply of a vehicle. The Electromagnetic Compatibility (EMC) Directive (95/541EC) ▶



came into force 1 October 2002, but many people remain unaware of its significance. Any new electrical equipment manufactured for fitting in passenger cars must now bear the distinctive “e” mark as an indication that the levels of electromagnetic interference are within the safe limits required by the directive.

## High intensity LED - Farewell to bulb changes

Over the last couple of years, the traditional halogen bulbs have encountered a new challenger in the market of portable light sources. The new LED light (Light Emitting Diode) has entered the market with a lot of fuss. The progress in semiconductor technology has made possible the fast development of the illumination LED light sources and especially the high intensity LED light sources, such as LUXEON® LED - and the pace is picking up as we speak!

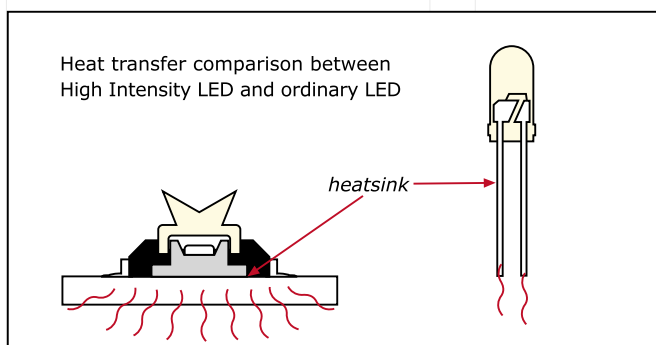
A light-emitting diode (LED) is a semiconductor device that emits incoherent narrow-spectrum light when electrically biased in the forward direction. This effect is a form of electro luminescence. The colour of the emitted light depends on the chemical composition of the semi-conducting material used and can be close to ultraviolet, visible or infrared. At present, LED light sources are used in portable lamps, interior decoration, electronic devices, vehicle taillights and computer monitors, for example. However, LED lights will be found more and more as part of general lighting or illumination in the future, and eventually they will completely replace light bulbs and fluorescent lamps.

Already in 2007, the efficiency (lumens/watt) will reach levels as high as 60-80 lm/w in 2012 150 lm/w and eventually 200 lm/w in 2020. In fact, the progress has been so rapid that the efficiency has doubled every 18-24 months and acts just like the famous “Moore’s Law” in processors!

## In portable lamps, you get most out of high intensity LEDs

Portable lamp manufacturers have been forerunners in implementing high intensity LEDs into their products. There are a couple of reasons for this:

- *Longer lifetime: Firstly, marketing and sales people talked about up to 100,000 hours of lifetime for LED lights, but nowadays it is said instead that after 50,000 hours you still get almost the same light*



*output as from a new LED, and this is naturally more reasonable. However, this is also a huge improvement compared to the traditional halogen bulbs used in portable hand lamps and helmet lamps that normally have a lifetime of 100 to 300 hours. Savings in bulb changes and time will be remarkable!*

- *Lower energy consumption and longer operating times: With the same amount of energy, you get multiple times of the operating time and yet the light output will remain the same! This has also led to smaller and lighter power sources, especially in rechargeable lamps. For example, in the modern rechargeable helmet lamps you can now have the battery pack incorporated in the helmet and because of the light weight, it is comfortable for the user. Especially in hazardous areas and moving installations - such as tankers - the hands free option is more secure and, obviously, leaves your hands free for working*
- *Security: Apart from the hands free option, persons working in hazardous areas will be delighted to know that the high intensity LEDs' longer operating time as well as better impact and vibration resistance will prevent breaking of the lamp*

**“already in 2007, the efficiency (lumens/watt) will reach levels as high as 60-80 lm/w in 2012 150 lm/w and eventually 200 lm/w in 2020”**

Also, you can choose between many different colours of LED (including infrared) and they work very well under cold conditions!

## Problems that can be solved: transmission of heat and controlling LEDs

There are a lot of different portable lamps that use LEDs in the market. Their development requires technical knowledge and - especially with high intensity LEDs - good design. There are a couple of problems that should and can be solved when designing a new lamp model: transmission of heat and controlling the LED.

Lamp designers are often not familiar with the formation of heat inside lamps. These issues are often not adequately taken into account when designing a lamp or when choosing the materials to be used. A high intensity LED creates an excessive amount of heat, and this causes problems as the light output of LEDs is very dependent of the temperature. The temperature and the light output depend on the following: temperature of the surrounding environment, amount of current conducted to the LED, type of the LED and the composition of the lamp. If the transmission of heat is not properly implemented, light output will reduce dramatically as the heat rises! You can see - too often, unfortunately - lamps that use LED lights, for example, 3W LUXEON® offer a good light output for 10-15 minutes but whose light output quickly deteriorates after that. And the lamp ▶

gets very warm! Excessive heat also shortens the lifetime of the LED and that is why the problem with transmission of heat should be solved by using some intermediate substance with sufficient cooling surface. That way, the transmission of heat will be continuous and sufficient.

The LED should also be correctly controlled, that is, control should be continuous and the current should remain steady. This way, light output will remain constant and bright. Too many times is the current conducted through a simple resistor which does not keep the current steady. Also, the current can be deliberately kept too low. The objective in these cases is to lower the heat by reducing the light output.

As a conclusion, one can say that high intensity LEDs are already part of normal illumination and of many electrical devices and portable light sources, and also that in the future LEDs will be even more important. However, the lack of standardisation and some of the above-mentioned problems must be solved before that. It will still take 5-10 years before high intensity LEDs will really start replacing the existing light sources in other sectors. Also, if you need a very powerful light output, the traditional halogen bulbs or HID lights are still better.

### ATEX regulations for portable light sources

A potentially explosive atmosphere means an atmosphere where there is a risk of an explosion due to mixtures of gas and air, vapour and air, dust and air or other flammable combinations. These atmospheres can be found, for example, in petrochemical, aviation, marine, offshore and mining industries and sectors, mostly in enclosed spaces where flammable materials or fluids are stored. The number of potentially explosive atmospheres is rapidly increasing, and that is why the ATEX regulations should be taken into account in all sectors.

In these atmospheres, there is the need to eliminate sources of ignition, such as sparks, hot surfaces or static electricity that may ignite the flammable mixtures. When electric equipment has to be used under these circumstances, the equipment must be designed and constructed so that it will not create sources of ignition capable of igniting these mixtures. Also, before any device can be used in a potentially explosive atmosphere, a representative sample has to be fully tested and certified by an independent authority.

The ATEX 94/EC Directive of the European Union dating back to the summer of 2003 was created to ensure safe design,

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must ensure that the device has both the Ex Mark and the CE marking that indicate compliance with the ATEX regulations. There are a few manufacturers on the market that have especially designed ATEX compliant portable light sources: hand lamps, helmet lamps and torches that are safe to use without comprising effectiveness. All manufacturers are also willing to give advice regarding the ATEX regulations.

## ATEX Equipment Categories

All ATEX approved equipment have certain category classification from Category 1 (most secure) to Category 2 (least secure). These categories inform the user in which zones a lamp can be used.

Category 1 comprises of the following type of equipment:

- *Equipment that is intended for use in areas where an explosive atmosphere is continuously present or lasts for long periods of time*

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- *Equipment in this category must ensure requisite level of protection, even in case of rare incidents relating to the equipment, and is characterised by means of protection that:*
  - *Either - in the event of failure of one method of protection - at least one independent second method will provide the requisite level of protection*
  - *Or, the requisite level of protection is assured in case of two faults occurring independent of each other*

Category 2 comprises of equipment that is:

- *Intended for use in areas where an explosive atmosphere is likely to occur*

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- *Method of protection relating to equipment in this category ensures requisite level of protection, even in case of frequently occurring disturbances or equipment faults that normally have to be taken into account*

Category 3 comprises of equipment that is:

- *Intended for use in areas where an explosive atmosphere is unlikely to occur, only to occur infrequently or to occur for short periods of time*

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- *Equipment in this category will ensure the requisite level of protection during normal operation*

Letters “G” and “D” are also marked in the certificate after the category to indicate whether the equipment can be used in potentially explosive “Gas, mists, vapours” and/or “Dust” atmospheres.

For portable light sources, it is highly recommend for the equipment to be suitable for use at least in Zone 1, and so the category should be 1 or 2. Most equipment have Category 2 (for Zones 1 and 2) marking and in most cases, users of the light sources can be sure of the appropriate security level.

Category 3 (only Zone 2) is not recommended: equipment approvals are handled in different standards, they are more flexible and certification by an independent authority (Notified Body) is not required, but a manufacturer’s Declaration of

Conformity is enough. Consequently, there are a lot of electrical devices under Category 3 on the market, but one could say that they do not comply with the “spirit” of the ATEX requirements. ■

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