

Raytec White-Paper Emergency Lighting Solutions for Hazardous Areas



Emergency Lighting Solutions for Hazardous Areas

Emergency lighting is critical to safety in hazardous areas (where there is a risk of explosion due to the presence of gas or dust) especially where there is a risk of power failures. While emergency lighting is required for a wide range of different applications, hazardous areas are often located in high-risk environments with unstable power sources which make the need for an effective emergency lighting solution even more important.

While non-emergency lighting tends to use mains/AC power (or through a generator if the site is off-grid), emergency lighting is designed to provide light when the primary power source fails. Although there are different methods in how this back-up is supplied, such as through a central battery system or standby generator, the simplest and most common way is to use self-contained emergency luminaires. These emergency luminaires have their own back-up power source designed to initiate when the primary power source fails.

This paper will review a number of key topics surrounding emergency lighting:

- Why emergency lighting is required
- Key factors when specifying an emergency luminaire
- How LED technology has improved emergency lighting solutions
- The importance of maintenance on an emergency luminaire
- Technology developments and the future of emergency lighting

The Need for Emergency Lighting in Hazardous Areas

Safety is the biggest driver behind the need for emergency lighting. Safety measures need to be implemented and maintained to minimise risk at all times and especially in emergency scenarios when mains/AC power is lost. The risk of injury or accident rises dramatically during a blackout, meaning a reliable lighting solution which guarantees output once mains/AC power is lost is essential in ensuring the safety of personnel on-site.

Emergency lighting is especially important if a site has an unstable power supply, such as offshore and mobile applications which rely on the use of generators as their primary source. These generators are prone to power failures which increase the reliance the site has on back-up illumination.

Lifeboat systems found on any offshore vessel or jack-up rig, are a good example of an offshore application where emergency lighting is required. As they are used in times of emergency (when the likelihood of power failures are high), having a lifeboat system with an effective emergency lighting solution is essential. It assists in making evacuation quicker, easier and ultimately safer and is a critical part of protecting the workers on-site. Imagine trying to evacuate an offshore rig. There would be a multitude of challenging elements facing you; now imagine the near impossibility of doing this in a blackout. This is why emergency lighting is so important.



SPARTAN Emergency Flood Luminaire - UAE Jack-Up Rig

***Pro-Tip** Emergency lighting is especially important for applications with unstable power supplies where light failures occur more frequently.*

Aside from offshore applications, safe evacuation is also important for industrial installations. Escape routes must be clearly identified and illuminated to allow safe movements towards and through the exits in emergency scenarios. Specific standards exist to provide guidance on the specification of emergency lighting and every installation should comply with these standards as a minimum in order to protect site personnel.

Specifying Emergency Luminaires

With a better understanding of why emergency lighting is so important, we must consider the criteria and performance that an emergency luminaire needs to meet in order to be effective. Most commonly, the performance of a luminaire tends to be judged on its duration (the length of time the luminaire can provide backup illumination) and/or output (the light output it will provide in emergency operation - generally measured as a percentage of its total light output in normal operation). Let's consider these two factors in more detail, as well as other features which affect an emergency luminaire:

Duration

Given that emergency luminaires are powered by a battery (a limited power source), they are designed to provide output for a set time until the mains/AC power can be restored or the site can be evacuated. As standards between sites differ, and the emergency duration requirement varies, it is important to consider the capability between different luminaires when specifying emergency lighting.

Essentially, the question is: 'Will the luminaire provide adequate light output for a long enough period in order to evacuate or to restore power?' Some applications (such as the lifeboats we mentioned earlier) will require maximum lumen output for around 30 minutes so those on site can be evacuated quickly. Other applications will require longer duration. The majority of industrial applications in the UK will require a minimum of 3 hours, as per guidance from the Chartered Institute of Building Services Engineers (CIBSE).

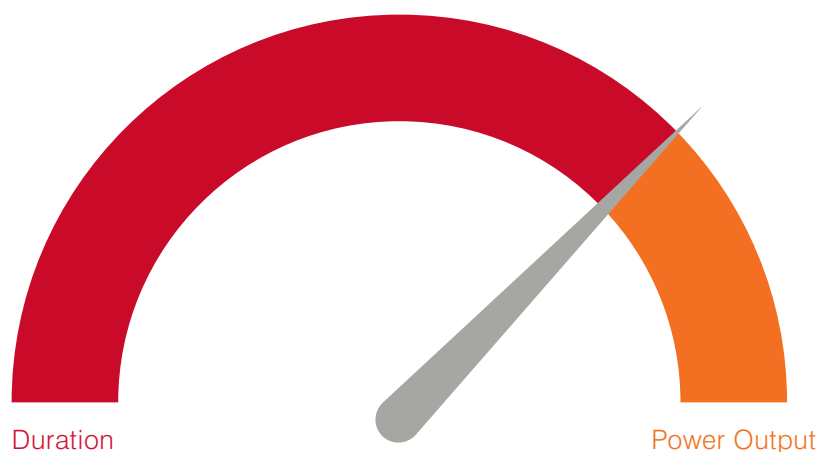
Output

The amount of light output a luminaire can provide during emergency operation significantly affects the overall lux levels achieved on-site when mains/AC power is lost. Each application will have a minimum lux level to which they must comply with during emergency scenarios. This will be guided by emergency lighting standards (which are a completely separate standard to general area, non-emergency lighting standards). However, in practice, higher lux levels are often specified to account for any site specific tasks. The choice and quantity of luminaire affects how easily these lux requirements can be achieved.

Traditionally, the light output of luminaires can drop significantly when switching to emergency mode, i.e. emergency fluorescent luminaires will typically drop to 20% of their light output (at best) under emergency conditions. This may not be a serious issue for some applications, as minimum lux requirements on emergency do tend to be lower than in normal operational mode, but it may cause an issue if higher lux levels need to be maintained. More luminaires would need to be installed to raise lux levels on emergency. However a simpler, more cost effective solution would be to find a luminaire which can offer a greater output on emergency.

SPARTAN LED Emergency luminaires offer up to 100% light output on emergency, ensuring there is no loss of output when switching to emergency mode. Maintaining a high output on emergency means the lux requirements can be achieved with a smaller quantity of emergency luminaires, maximising efficiency.

Duration and level of output should be considered together; essentially they are trade-off, with one aspect directly affecting the other. The higher the light output on emergency, the shorter the duration - and vice versa. It is important for an end user to analyse the requirements of their site to get this balance right.



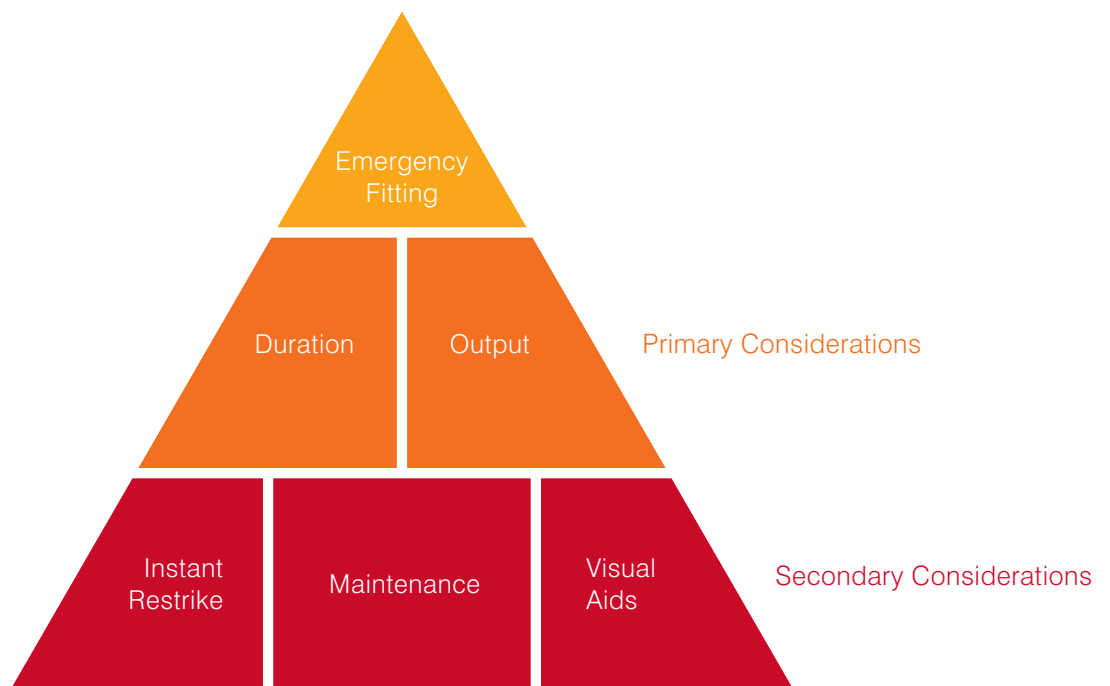
Duration vs Power Output

Other Factors:

Instant restrike – emergency situations tend to arise without any warning, so having an emergency lighting solution capable of instant restrike is important. If there was a delay in the light fitting being able to restrike, the site will be left in darkness with no light to protect personnel or assist an evacuation.

Maintenance – this is something which we'll look at in more detail later in the paper, but an emergency luminaire will generally require greater levels of inspection and testing than a non-emergency luminaire. Understanding the maintenance demands of a luminaire, and how it differs between LED and other technology types, is another important factor to consider.

Visual aids – while not directly affecting the performance of the fitting, visual aids can make emergency luminaires easier to manage and maintain. An indicator or status light, usually as part of a self-testing feature, quickly tells the user the health status of the emergency battery and whether the fitting is working correctly (we will discuss self-testing features and 'intelligent emergency' in more detail systems later in the paper). More simply, manufacturers can incorporate distinguishing features into a luminaire which help users to easily identify which units on-site are an emergency. As an example, SPARTAN emergency luminaires feature a red end cap or casting where the emergency battery is housed.



Important Considerations for Specifying Emergency Lighting

Understanding why emergency lighting is required, and the features and performance criteria that go into an effective emergency luminaire, leads us to look at the technology that enables this. Specifically, we will look at LED technology and how it has helped to improve the performance and functionality of emergency lighting.

LED vs Conventional Emergency Lighting

You might have already read our White Paper 'LED vs Fluorescent' which outlined the performance advantages of LED lighting in emergency fittings, but here we will go into more detail and also consider other conventional discharge lamps in addition to the comparisons with fluorescent.

Discharge Emergency Lighting

Earlier versions of emergency luminaires used traditional discharge lamps, however these were very rare due to their limitations and generally only used for specialist applications. While similar in concept to the emergency luminaires we know today, the battery backup systems they used were very large and very heavy. They relied on large lead acid batteries which were often far bigger and heavier than the actual light fitting itself. These physical restrictions meant the batteries could not be contained within the housing of the luminaire, causing difficulties with installation. Although smaller lead acid batteries are now available as battery technology has developed, the high-consumption of discharge lamps means that any emergency variant would still rely on higher capacity batteries which are naturally larger and heavier.

Discharge lamps are also unable to instantly restrike, which we have already identified as a key feature to any emergency luminaire. Without instant restrike it could be minutes after mains/AC power is lost before the lamp is able to provide emergency illumination to the site. With time critical to safety, using more modern technology which allows an instant restrike is a much better solution.

The size, weight, cost and limitations in performance of emergency discharge lamps generally make them unsuitable for the majority of applications. For this reason, installations of these traditional solutions are rare with the vast majority of modern installations opting for fluorescent, or more recently, LED emergency luminaires.

Fluorescent and LED

When fluorescent emergency lighting emerged, it represented a significant development from discharge solutions. Fluorescent luminaires have lower power consumption than discharge lamps so there is less drain on an emergency battery. This, combined with advancements in battery technology, means significantly smaller batteries can be used and can also be housed within the luminaire itself. Ni-Cd (Nickel Cadmium) batteries are most commonly used given that they boast a significantly better energy density, making them smaller and lighter to a comparable lead-acid battery.

Given the advantages of fluorescent luminaires over discharge lamps, you may wonder why a site should consider switching to LED? In our previous 'LED vs Fluorescent' White Paper, we established a number of significant performance advantages and cost savings that could be achieved by switching from fluorescent to LED. Let's recap on these advantages again and consider them in the specific context of emergency luminaires:

- Failures – fluorescent luminaires, especially with older units, have a tendency to fail when suddenly switching to run at a lower power. This is largely due to the deterioration of components, such as the ballast or starter, and being unable to provide the necessary punch to restart the tubes using the emergency battery. As LED fittings tend to use an electronic PSU (power supply unit) without the need for ballasts or starters, they are more reliable with less risk of failure.

- Performance drop – using UK standards as an example, over a 3 hour period when the luminaire is in emergency mode, even in optimum conditions, the lumen output of a fluorescent luminaire will decline significantly. LED luminaires do not suffer from this problem as they use a more advanced electronic PSU than the ballasts used in a fluorescent and the LEDs run at a constant power throughout the emergency duration and will not suffer from any drop in output. Maintaining a constant light output is important in order to achieve the minimum lux levels that are required to evacuate or restore power safely.
- Effect of environmental conditions – the performance of a fluorescent dips dramatically when exposed to extreme temperatures; this severely impacts output in emergency mode. A fluorescent luminaire will generally drop to at least 20% output in emergency conditions as a twin tube fluorescent will light one tube at a maximum 40% power. When taking into consideration the effect of a cold environment (and with the understanding that the lower the temperature, the greater the drop in output of a fluorescent tube) the performance in emergency mode of fluorescent luminaires can be significantly reduced and significantly underachieve the required specification in challenging environmental conditions. In contrast, LED luminaires provide a much more reliable emergency solution; the LEDs will run at the required power, across a much wider temperature range, ensuring the luminaire meets the demands of the application regardless of environmental conditions.

While it is relatively easy to find a luminaire which meets the required output and duration on paper, it's important to consider the other factors which affect the luminaire's performance in real terms. With reliability being imperative to the effectiveness of an emergency luminaire, LED represents a big improvement on fluorescent technology.

Maintaining Your Emergency Fitting

As emergency lighting is so important to site safety, understanding the importance of maintenance and following the correct procedures to ensure the luminaires are working effectively is essential to any site.

Inspection and Testing

Hazardous area luminaires should be routinely inspected due to the nature of the environments in which they operate to ensure they are operating effectively and safely. LED luminaires significantly reduce maintenance by eradicating the need for relamping and by offering a longer lifetime. While these benefits translate to emergency luminaires in the same way, more frequent inspection and testing should be carried out to preserve the life and performance of the emergency battery. Batteries are consumable items and generally need to be replaced every 5-7 years depending on how frequently they are used, but also depending on how well they are maintained.

***Pro-Tip** Emergency luminaires should be inspected and tested regularly to preserve the life and performance of the emergency battery.*

If a fault with a non-emergency luminaire occurs, it is easy and obvious to identify through a loss of light output in normal operation. However, as emergency scenarios and power failures can occur infrequently, any faults with an emergency luminaire may be more difficult to identify (especially for non-maintained luminaires which are only designed to turn on in the event of a power failure). Therefore, having a documented testing procedure is important in order to identify any faults before an emergency scenario arises.

The extent of ongoing inspection and testing will depend on the specification of the battery: it will dictate the level of conditioning which may be required prior to the luminaire being installed and also how often the luminaire and battery should be cycled in normal operation. As an example, every emergency SPARTAN luminaire will be shipped with the battery fully charged and disconnected to ensure there is no drain on the battery. Upon receiving the luminaire, the user is advised to discharge and then recharge the battery before installation to ensure the battery is working at its optimum, while future cycling will vary depending on the requirements of different sites.

The testing procedure itself may be as simple as routinely cutting power and visually checking that all emergency luminaires are working properly. The developments in self-testing luminaires, which automatically cycle batteries and provide visual health indicators, are starting to make this process even easier with more intelligent testing methods.

Storage

There is no guarantee that luminaires will be installed as soon as it is received on-site. Luminaires may be kept in storage until an existing unit fails and needs to be replaced or until there is a scheduled maintenance break. It could be months after being shipped by the manufacturer before the luminaire is actually installed and switched on: this presents a risk. If the battery is left connected to the luminaire's PSU, the battery will begin to slowly discharge. In time, this could significantly stunt the performance of the emergency luminaire by reducing the battery's capacity. While cycling the battery may partly restore it, the likelihood of restoring the full capacity back to an 'as new' condition, is highly unlikely. The effects of this degradation may render the luminaire useless if it no longer meets the minimum emergency duration and light levels required on-site.

To combat this issue, emergency luminaires should always have the batteries disconnected if they are to be left in storage or switched off for any period of time. This will ensure the battery cannot be drained and maintains its capacity for optimum performance. With this in mind, all SPARTAN LED emergency luminaires are shipped with the battery disconnected.

***Pro-Tip** Until the unit is installed, an emergency luminaire should have the battery disconnected to prevent any drain on the emergency battery.*

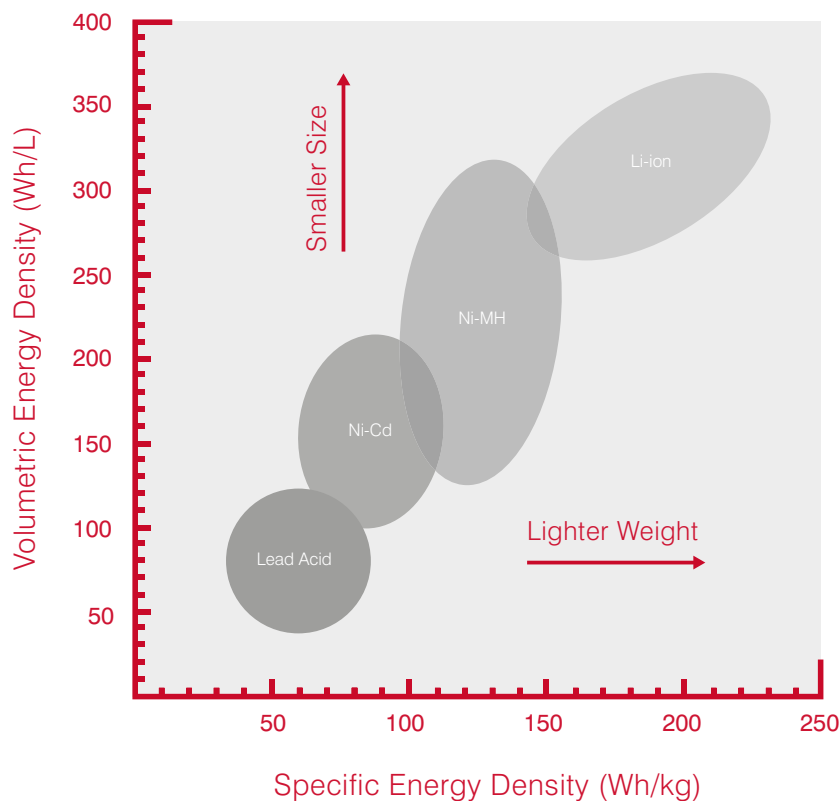
Do	Don't
Check for any specific conditioning procedures prior to installation.	Leave the luminaire in storage with the battery connected.
Ensure a testing/cycling procedure is in place which meets the requirements of the battery/luminaire.	Assume the luminaire and battery will perform as expected – batteries are consumable and ongoing inspection and testing is important
Ensure there is a constant power source to the luminaire which keeps the battery charged.	Charge the batteries with anything other than the PSU provided by the unit.
	Use replacement batteries from anyone other than the manufacturer of the luminaire. Using alternative batteries invalidates the hazardous area certification.

Battery Maintenance: Do's and Don'ts

The Future of Emergency Lighting

Battery Technology

The battery is an essential component of any emergency luminaire, so as battery technology advances it aids the development of new and improved emergency lighting solutions. The progression from lead acid to Ni-Cd batteries has helped to reduce the size and weight of emergency systems thanks to their higher energy density. While other battery technologies with greater energy density than Ni-Cd already exist, such as Ni/MH (Nickel Metal Hydride) or Li-ion (Lithium Ion), other limitations prohibit them from being commonly adopted. Ni-MH suffers from a shorter life cycle and the volatility of Li-ion makes it unsuitable for use in hazardous areas.



Energy Density of Battery Technology

However, looking at other industries and the efforts being made to improve battery technology, continued developments in this area look encouraging. The automotive industry relies on the development of new and improved battery technology to aid the push towards electric vehicles and provide more effective solutions for its customers. Inevitably, battery technology will progress to combine greater energy density with improved functionality, which can be adopted to further optimise the design and performance of LED emergency luminaires.

Pro-Tip Energy density is the amount of energy stored in a given system or region of space per unit volume. In the context of batteries, those with a high energy density will be smaller and lighter than batteries with lower energy density, while offering equivalent capacity.

Advancement in LEDs

While LED technology has allowed emergency lighting solutions to improve, offering better performance and practicality than discharge and fluorescent lighting, LEDs themselves are constantly evolving. As LEDs become more efficient, the same level of output can be achieved using less power. This will allow smaller batteries to be used to further improve the physical design of emergency luminaires, or alternatively could mean greater duration can be achieved thanks to reduced consumption and a smaller draw on the battery.

Intelligent Emergency

We have already highlighted the importance of inspection and testing of emergency luminaires and touched upon the development of intelligent emergency products which help to make this maintenance aspect quicker and easier for users by automating the process.

Removing elements of reliance on operator interaction reduces the chances of human error or neglect, which may affect the performance of a luminaire in an emergency scenario.

Intelligent emergency solutions are starting to emerge, such as the one employed on SPARTAN Linear emergency luminaires. This uses a microprocessor which is programmed to automatically cycle the batteries - typically every 2-3 months. The results of this self-testing are then highlighted using a tri-colour LED indicator, visually notifying the user if everything is working as it should be or of any faults which require further investigation.

SPARTAN luminaires have two important features built into the design of their intelligent emergency system:

Testing at 100% output - when a SPARTAN luminaire automatically enters a discharge cycle there is no drop in light output and the luminaire will continue to operate at full power. This is an important feature given that it is difficult to control when a luminaire will enter a discharge cycle. Without this, there is a risk of a drop in light output under normal operation while an important task is being carried out.

Random testing - the microprocessor in SPARTAN's emergency system is programmed with a random factor to prevent self-testing occurring at the same time. Without this, testing cycles between luminaires may occur at the same time; presenting a risk of the entire installation of emergency units being at low charge should an emergency scenario suddenly occur.

Reserve capacity - during a testing cycle SPARTAN will not discharge to below a third of its battery's capacity, ensuring every luminaire will still be able to provide emergency output regardless of whether it's in a testing phase.

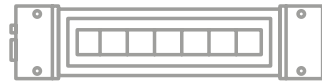
These design features are important in ensuring there is no disruption caused from the luminaires being tested, and keeping disruption to a minimum when mains/AC power is lost. As technology develops further, more features will become available to further enhance the ease of maintenance.

***Pro-Tip** Intelligent emergency systems makes the process of maintaining emergency luminaires far easier and increases safety on-site by reducing the chances of human error and neglect.*

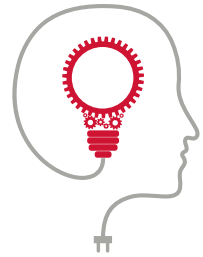
Future Trends in Emergency Lighting



Improved Battery
Technology



Increased LED
Performance



Intelligent
Self-Testing

Summary

LED technology has had a significant impact on emergency lighting, improving design and performance of the luminaires compared to traditional discharge and fluorescent solutions. Ultimately this improvement increases safety to those who work in areas where emergency lighting is required.

The nature of hazardous area equipment means maintenance and inspection of emergency luminaires still plays an important role in ensuring they are operating effectively, while the development of intelligent emergency systems have made this easier and safer for users. As LED and battery technology develops further the opportunity to make more improvements to the design and functionality of emergency luminaires increases.



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