



Bright Ideas, Brilliant Solutions



A review of future trends in aircraft cabin emergency lighting

Peter Stokes
CEO
STG Aerospace

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1. Abstract

Airlines invest reluctantly in cabin emergency lighting systems, knowing they are like insurance – businesses must have them but hope they never need to use them. However, advances in cabin emergency lighting mean that even this unproductive expense is becoming easier to bear. This paper identifies key trends in emergency lighting and suggests how they might impact product development in the next 3 to 5 years. It explores how the macro trends that impact the aviation sector - financial pressures, weight reduction, concern for the environment, improved safety and greater passenger comfort – will shape the ways in which emergency lighting systems evolve. And it identifies new technologies that will lead to improvements in product performance and cost.

2. Acknowledgements

Peter Stokes:

Peter is the CEO of STG Aerospace. He holds a degree in Production Engineering and Management and spent the early years of his career in Management Consulting. There followed 15 years of self-employment based in Scotland building a flourishing group of oil related engineering companies. Subsequently he focussed on a number of successful company turnarounds before joining STG in 1998 with the task of creating a business from an idea – using photoluminescence for emergency evacuation from aircraft. The team he has built at STG share his vision and innovative credentials, developing new advanced technologies, creating radical solutions to aviation problems and making STG a world leader.

STG Aerospace:

STG Aerospace Ltd is a UK based company with a subsidiary in the USA. It has been in the photoluminescence business since 1986. In 1995 STG developed and patented products and protocols for high performance photoluminescent products in aircraft emergency evacuation guidance. STG has been FIRST in every aspect of the application of this technology on aircraft. In 2007 STG introduced WEPPS™ a 'fit-for-life' system to power electrical emergency lighting systems. It has won worldwide recognition for pioneering innovation, with multiple Queen's Enterprise Awards (the UK's most prestigious business award) and a Crystal Cabin award for Innovation in Cabin Safety. STG has built its business and reputation on innovation and the practical development of products based on that innovation. STG's SaftGlo photoluminescent brand is the leading supplier to aircraft manufacturers and operators in the aviation market, with over 7000 commercial aircraft currently using its products worldwide. The company in recent years has diversified its technology expertise into low energy lighting and power products and continues to develop innovations in cabin lighting systems.

3. Macro trends in the aviation market

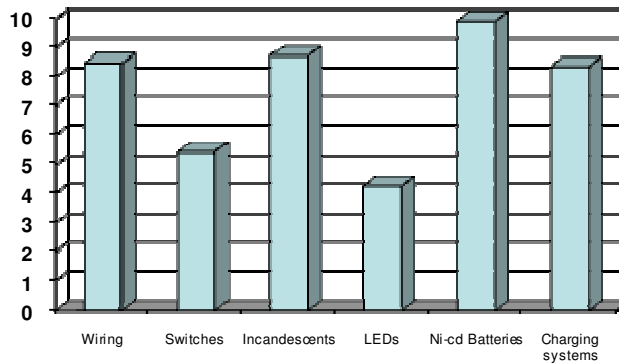
Developments in technology are often in response to macro-trends. For the aviation sector we identify 5 key trends that are likely to stimulate innovation in cabin emergency lighting:

- a. Financial pressure – Airlines continue to operate under intense financial pressures. Results from IATA's quarterly survey conducted in July 2011 show that profit margins continue to be squeezed. Escalating oil prices, a global recession that is dampening demand for business travel and tourism, political unrest in the Middle East and North Africa and natural disasters in Pacific Rim countries have combined to depress the market and increase competition for passengers. Many of these economic pressures are forecast to run for the foreseeable future.
- b. Weight reduction – Closely linked to the theme of financial pressure is the continuing need for airlines to reduce weight. Transport Canada has estimated that the 'fuel penalty' of carrying 1 extra kg of weight for 1 year on an A330 is an additional 42.71 US Gallons (<http://www.tc.gc.ca/eng/programs/environment-ecofreight-air-airtransat-96.htm>). When each battery in an emergency lighting system can weigh 1.6kg this will be an area for close interrogation by operators.
- c. Concern for the environment – aviation has long been a target for the green lobby and concern for the environment will increasingly be a factor in regulatory requirements as well as consumer demand. In July 2011 Ryanair chief executive, Michael O'Leary, having previously labelled global warming as "horseshit" announced it will incorporate its green credentials into its marketing activity. O'Leary claimed that his airline had become the "cleanest" and "greenest" in the world and described his fleet as low on CO2 and noise emissions, in comparison with the "high-fare, fuel-surcharging, flag-carrier competitors who continue to operate older, inefficient, gas-guzzling aircraft".
- d. Improved safety – It is well documented that aviation is statistically the safest form of transport; and the authorities will jealously guard this deserved plaudit by continuing to insist on a total focus on passenger safety. Despite the temptation to cut corners, safety will continue to be high on the agenda.
- e. Improved passenger experience – as competition 'hots up' so does the need to provide the best passenger experience. Airlines are looking to position themselves in any way they can and cabin interiors are an important battleground in the fight for customers. In the course of 12 months Boeing will be introducing new cabin interiors on three of its aircraft models: the 747-800 Intercontinental, the 737 Next Generation Sky Interior and the 787 Dreamliner.

4. Operator attitudes to Emergency Lighting Systems

Original research carried out by STG Aerospace highlights the areas of concern that operators have about emergency lighting systems. STG conducted research among a representative sample of the global airline industry and identified the following:

- For 1 in 4 operators emergency lighting systems represent a problem
- Operators say that incandescent bulbs and Ni-cd batteries are the elements of Emergency Lighting systems that fail most frequently.
- Battery failure is rated as having the most significant impact on emergency lighting systems
- By factoring the frequency of failure with the impact of failure we can generate a failure index for each aspect of the emergency lighting system. This scale shows that batteries have the highest failure index followed by incandescent bulbs and wiring.



- Replacement of batteries is not seen as a major issue with over 85% of respondents rating replacement of batteries as 'easy' or 'very easy'.
- 9 out of 10 respondents anticipate a life expectancy of less than 6 years on their batteries
- Two thirds of respondents rate maintenance of emergency lighting batteries a significant or very significant issue
- When purchasing a new aircraft the requirements rated most important by airlines for the emergency lighting systems are 'ease of maintenance' and 'system status monitoring'.

The research confirmed that although emergency lighting systems are essential equipment they do create issues for operators that are unwelcome when those same operators are seeking commercial advantage.

5. How innovators will respond to macro-trends

With operators under intense pressure to provide more for less in an increasingly regulated environment we believe there will be four key areas of innovation in emergency lighting solutions: photoluminescent systems will continue to penetrate the market and the aircraft cabin; operators will continue to look for simpler alternatives to the wires and batteries that power emergency lighting systems; new wireless and LED technologies will be embraced; emergency lighting systems will move away from complex seat-mounted applications and back onto the aircraft floor where the rules also intended they should be.

a) Photoluminescent systems will continue to evolve, expand market share and find new applications in the aircraft cabin

Photoluminescence (PL), the phenomenon of glowing in the dark after 'charging' with light, is well understood, but the application of that to aircraft is radical and creative. STG Aerospace patented the technology and has been at the forefront of the development of PL for the aerospace sector. Today around 40% of the global commercial passenger fleet has STG products and technology fitted, and all aircraft OEMs offer the technology either as original fit (e.g. Embraer's ERJ170/190) or as an option (95% of all Boeing's B737NGs use STG products from the factory). PL is an effective response to the market pressures that airlines increasingly face: with no bulbs, batteries or wires it is 100% reliable; it is low-maintenance so less costly; photoluminescence is non-toxic, non-radioactive and recyclable, so scores high on the environmental scorecard; and the new generation of colour systems means it can respond to the demands of both marketing and engineering teams.

From its early incarnation as 2.5 cm strips of yellow material used in cabins of economy-focused airlines PL has evolved to find a role in every part of all types of cabin interior. New systems have been developed specifically for galley areas (low-profile strips that sit within the galley-floor and are made to withstand the impact of constant trolley traffic), for Premium and Bizjet interiors and for exit signage. The arrival of new colour options has boosted the market for PL amongst long-haul and Bizjet



Case Study –SaFTGlo - Cost reduction and improved passenger experience drive innovation in PL

PL was first used for emergency floorpath lighting in 1995 and for 10 years was only available as 2.5cm strips of yellow. But matching the demands of the market led to major innovations from market leader – STG Aerospace. SaFTGlo ColorMatch was developed in response to the needs of both maintenance and marketing teams. The product is available in up to 300 colours and can even be matched to the pattern of your carpet so it blends in with the cabin decor. PatternMatch was launched in 2011 and has already excited significant interest.

A variant of SaFTGlo was developed to address the problems created by regular replacement of the aisle carpet and the cutting, fitting and binding procedures that add to the overall cost of maintenance. In response to these issues STG Aerospace developed the ColorMatch OC system, designed to dramatically reduce through-life costs for operators. Its unique 'hinged-wing' construction grips, hides and protects carpet edges eliminating the need for binding.

STG Aerospace has been at the forefront of evolving the use of PL in aircraft, responding to market drivers and customer demands. PL can now be seen in all parts of the aircraft and is also used for exit signs where it replaces out-dated Tritium technology.

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operators and we can expect these systems to increase market share at the expense of electrical systems. With over 300 colour options and the ability to match the actual pattern of the carpet, designers are looking at PL in a new light.

In the future we anticipate that new PL paint technologies will improve the light performance of the PL systems and bring into play a wider range of colour options. PL system suppliers will also examine ways of making the systems even easier to install and even more durable. They will explore the effectiveness of systems where colour is printed directly onto the PL paints eliminating the need for a coloured film and reducing the number of elements in the system. Manufacturers will make the systems more durable by experimenting with new polycarbonate technologies and new ways of sealing the systems to prevent fluid ingress. With weight a key consideration PL systems are likely to become even thinner.

Manufacturers will continue to explore ways of improving the light performance of PL systems. Current PL solutions are engineered to provide a balance of powerful initial luminosity and lasting performance; new products will explore ways of increasing performance for both aspects of the product. STG Aerospace has developed and patented a concept product that incorporates two PL strips within a single encapsulation. Each parallel PL strip is engineered with a specific coating formulation to deliver a different optimised performance profile when cabin lights fail. The result is up to 50% greater initial brightness and up to 50% greater 'afterglow' duration.

PL will also become approved technology for other areas of the cabin emergency lighting system. PL is already being used to provide an alternative to the radioluminescent Tritium signs, which are common on older aircraft. In the USA, radioluminescence has been banned for use in buildings after significant radiation was detected in the ruins of the World Trade Centre after 9/11. It is now not a preferred technology for aircraft use either. As a result, TR (Tritium Replacement) PL signs are a popular maintenance-free and extremely cost-effective alternative, reaching out to military as well as civilian aviation markets. PL options will increasingly challenge the accepted wisdom that primary exit signs must be powered electrically.



b) Operators will continue to look for ways of reducing the operational impact of batteries on aircraft

Batteries are a significant downside of emergency lighting systems. Weighing up to 1.6kg each and with 10 batteries required in a typical B737-800 they represent significant potential cost to the operator in terms of additional weight, maintenance and, in the event of failure, dispatch delay. We expect that market pressures and new technologies will lead to renewed efforts on the part of battery manufacturers to introduce new battery technologies and different ways of powering emergency lighting systems.

Interestingly PL has already generated benefits in this respect. One of the side-benefits of STG Aerospace's SaftGlo on some B737 aircraft is the opportunity to remove one of the batteries used to charge the emergency lighting system.

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As far as the future is concerned we believe that newer lithium-ion battery technologies will gain greater acceptance in the airline industry and will continue to supplant traditional lead acid and nickel cadmium batteries. Power technologies proven in other markets and applications will be re-purposed and re-

Case study – Cutting costs increasing safety.

How CanJet benefited from STG Aerospace's new emergency battery power and diagnostics technology

CanJet is one of Canada's largest aviation and aerospace companies with a fleet of new Boeing B737-800 aircraft. The Wireless Emergency Primary Power System (WEPPS) is a radically new application of current technologies for managing and powering emergency lighting systems, with a built-in wireless monitoring and diagnostic capability. It gives airlines a 'fit for life' solution of battery modules that need no charging and no scheduled maintenance, and a means of performing automated daily checks on the whole emergency lighting system in under 10 seconds. WEPPS eliminates the entire maintenance schedule for emergency lighting power systems by replacing conventional NiCad battery/charger packs with 'fit-for-life' non-rechargeable lithium sulphur dioxide battery modules. The system, which has many innovative features with patents awarded or pending, has integrated diagnostics that automatically check itself and all parts of the emergency lighting system against MEL requirements. It uses SecureControl™, STG's own ultra secure wireless protocol, to report dispatch status, and any maintenance requirements, to a small diagnostics panel operable by maintenance or cabin crew.

CanJet and WEPPS

CanJet first installed WEPPS on two of its Boeing 737-800NG aircraft in June 2008. Soon after installation the diagnostic system reported a faulty bulb in one of the emergency lighting units that a visual inspection had failed to spot. The fault was MEL critical but WEPPS identified the precise nature and location of the problem and it was fixed in a matter of minutes. For the 3 years since it was installed, WEPPS has been operating flawlessly and has completely eliminated the maintenance regime required for the previous batteries. An added bonus for CanJet has seen them resell their redundant, old-generation batteries, which makes the investment case for WEPPS even more compelling.

packaged to provide longer-life, no-maintenance power solutions for emergency lighting systems. Already systems exist that replace traditional Ni-Cad batteries and create a 'fit-for-life' system that improves reliability and eliminates the need for maintenance.

Looking even further ahead new technologies for harvesting energy will have a growing role to play in all aviation applications including emergency lighting. Airbus has a vision for the future of the cabin interior which envisages a seat or pod that collects body heat as the passenger sleeps or relaxes and combines this with energy collected from other sources like solar panels to fuel power systems.

c) New technologies such as wireless and LED will be embraced

LED and wireless systems are at the vanguard of new technologies whose applications in aviation are being explored. LED demand is being driven by the inherent through-life cost and flexibility of the technology – LED lamps have a potential life-span of 50,000 hours. Well-designed LED applications are far more reliable than other sources of electrical light generation; and they are far more flexible for the 'mood' lighting systems being introduced to reduce the effects of air travel and provide an improved in-cabin experience. Wireless systems are already used in IFE and personal voice and data communications but in the future, safety-critical passenger cabin systems will also be delivered without wires.

Case Study – LumiNet – a wireless/ LED OEM solution to emergency lighting issues

One of the key challenges facing the aviation industry is the need to reduce the cost of emergency lighting systems. STG's LumiNet concept emergency lighting system was designed to eradicate the failings of traditional wired systems. LumiNet is a wireless system where each light is a self-contained unit comprising latest generation white LED lamps powered by an integrated primary battery. The sealed batteries are easily replaced and cost one-tenth the price of older rechargeable batteries. The ultra-low power consumption of the operating protocol gives a battery life of 4 years. The overall system is controlled by SecureControl – a radio-distributed network that uses ultra-low power spread spectrum technology.*

LumiNet works by transmitting a signal through a network of self-powered, compact transceivers embedded within each light unit. Each unit emits a signal with a 10m radius. Dedicated commands, sensor data and BITE information are constantly transmitted and picked up by the units. Signals 'flood' through the cabin even when individual light units might be faulty, ensuring that the emergency lights illuminate regardless of the condition of the aircraft.

Luminet creates significant benefits over traditional systems including: lower through-life costs, higher reliability, reduced installation costs and radical weight-savings. It is a real solution for the future.

**STG's proprietary wireless 'backbone', SecureControl is a compact, low-weight, radio-distributed network that uses ultra low-power, spread spectrum techniques. Some of the many potential applications envisaged for the network include: Cabin Alert Monitoring, oxygen deployment, fire and smoke detection, sensor networks and emergency lighting.*

Because they improve reliability and reduce the maintenance burden, the overall weight and the cost of operation wireless and LED technologies will play an increasing role in emergency lighting systems.

LEDs, of course, have lower power consumption so 'tick the box' of environmental pressure as well.

LEDs are already widely used in emergency lighting in other industry sectors and, in aviation, are seen as the way forward for cabin lighting. Recent research by STG Aerospace indicates that over 75% of operators would say yes to an LED lighting system and the main drawback to implementing it is the cost of installation. In the future newer OLEDs (Organic LEDs) will be used for in-cabin applications including emergency exit signage. This new generation of lights are based on thin films of organic molecules that create light with the application of electricity. Thinner and more flexible than traditional LED lights, they will be used to enhance the cabin appearance and reduce weight and power consumption.

d) Emergency lighting systems will move away from seat-mounted applications and back onto the aircraft floor

In recent years some operators have pursued a principle of clearing the aircraft aisle of all systems, leading to the growth of seat-mounted systems. However shifting from floor to seat-mounting may not bring all the benefits that airlines expect; indeed, seat-mounted systems can bring their own problems:

- Mounting an emergency lighting system in the aircraft seat will certainly remove material from the floor of an aircraft but it also puts potential problems with the system further out of reach as well, making them harder to resolve. It's a lot easier to tackle a faulty system

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when it is easily accessible than when it is locked away inside a seat that itself is packed with a growing array of sophisticated systems

- Seat-mounted emergency lights do not always perform as they should. New LED lights designed to illuminate an area around a seat can operate less effectively under smoky conditions. The sideways beam of light may produce a spotlight effect, illuminating the smoke rather than the escape route as it should.

Seat-mounted systems were a response to floor-mounted electrical systems that failed because of excessive traffic or 'hard knocks'. But a new generation of PL systems means that these problems need no longer be an issue.

- New sealed PL systems with more durable exteriors can withstand the repeated battering by footfall and trolley traffic
- The twin-track application of PL means that most traffic falls between the PL tracks
- And this focusing of footfall can bring about an unexpected benefit – a dramatic reduction in the cost of replacing carpet.

PL systems have a unique twin-track installation which creates a natural border between the high-traffic area in the centre of the aisle and the low-traffic areas under the seats. This means that when the aisle carpet needs replacing you only have to replace the section between the two strips of PL. With a seat-mounted electrical system the high-traffic area is not bordered in the same way and so you end up replacing all of the carpet from seat-track to seat-track. On a standard configuration 737-800 with seat-mounted emergency marking that means you could find yourself replacing up to 20 sq metres of carpet more than you would in the same aircraft with a twin-track PL system. Aircraft Commerce magazine suggests that aisle carpets (that can cost around \$50 per sq. metre) may be changed 3-4 times a year; so if you have PL on your aircraft your annual savings on carpet costs could amount to \$4,000 a year. Even with a floor-mounted electrical system the savings could be as much as \$2,000 a year.

6. Conclusions

Commercial pressures in the aviation sector are such that all aspects of an aircraft's operation will come under increasing scrutiny. Emergency Lighting Systems will not avoid this examination. But new technologies and the re-packaging of existing technologies will lead to new solutions for emergency lighting:

- Photoluminescent systems will continue their inexorable penetration of market in both retro and OEM at the expense of less reliable electrical systems
- New solutions to powering emergency lighting systems will emerge – these will be lighter, less maintenance-intensive and more reliable.
- New technologies such as wireless and LEDs will become accepted technologies for emergency lighting solutions
- Emergency lighting systems will move away from seat-mounted applications and back onto the aircraft floor.

If you have any thoughts or questions about the opinions we have expressed here please do not hesitate to get in touch.

Peter Stokes, STG Aerospace
0044 (0)1760 723232
www.stgaerospace.com