EMERGENCY LIGHTING - AN INTRODUCTION

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1. What is Emergency Lighting?

Emergency Lighting is lighting which operates in the event of a complete mains power failure, to prevent panic and allow safe passage out of enclosed areas in the event of an emergency situation such as fire. Like all other forms of artificial lighting, Emergency Lighting is provided by luminaires.

Luminaires come in many types, each type designed to fulfil specific requirements. Aside from providing the correct quantity and quality of light, some are capable of being switched or dimmed, either manually or by programming or in response to movement or daylight changes.

Emergency luminaires also come in different types, which are designed to serve a range of functions. They also operate in different ways. These differences are described in the following two sections.

2. Types of Emergency Lighting

Emergency luminaires can function in a number of different ways; the three most common types are listed below:

A. **Maintained** luminaire. This is a luminaire in which the emergency illumination is provided by one of the same lamps which are used to provide the ‘normal’ light. (see **fig. 1** and examples)

B. **Non-Maintained** luminaire. This is a luminaire where the lamp(s) only operate from the emergency supply (battery) after mains failure. When mains power is on, lamp(s) are not lit. (see **fig. 2** and examples)

C. **Combined** luminaire (also known as **Sustained**). This is a luminaire with more than one lamp, where the lamp which provides the emergency light is NOT one of those providing ‘normal’ light. Effectively, the emergency lamp is **Non-maintained**, but in the same enclosure as the other lamps. (see **fig. 3** and examples)

**Maintained** emergency luminaires are a popular choice with many specifiers because they make the emergency part of a lighting installation practically invisible. Usually the emergency running gear (module and battery) is hidden inside the luminaire enclosure, or in a remote gear box concealed in a false ceiling void.
Advantages: Low visibility for ‘designed’ interiors where everything has to look just so!

Disadvantages: The Emergency lamps are in constant use and must be monitored and replaced regularly.

Non-maintained emergency luminaires are used commonly on building sites, one example being the IP rated linear luminaires used to illuminate walkways (commonly known as ‘GRPs or NCFs). Another type of Non-maintained emergency luminaire commonly seen is the directive signs above doorways (‘EXIT’ signs). These can also be operated in maintained mode.

Advantages: Emergency lamps should last a long time as they are rarely in use. No danger of modules or batteries being exposed to high temperatures from other running gear or lamps.

Disadvantages: A luminaire which is lit only when mains power fails is not a useful addition to the ‘normal’ environment, unless it can serve another function merely by its presence, like an ‘EXIT’ sign.

Combined emergency luminaires are often the solution where emergency lighting is required in an area where the ‘normal’ light source is provided by a lamp type not suitable for economical re-engineering (high wattage tungsten halogen or discharge).

Assuming the customer is not willing to accept additional Non-maintained luminaires to provide emergency lighting, halogen or discharge luminaires can be re-engineered to have an additional small lamp fitted (low wattage 12V halogen or high wattage L.E.D.) with its own running gear.

Advantages: Luminaires which could not function as emergency fittings in any other circumstance can do so by the addition of an extra lamp. As with maintained luminaires, the appearance of the re-engineered luminaire is not much changed.

Disadvantages: This type of re-engineering can be relatively expensive, but sometimes is the only acceptable option. Remote emergency gear packs for 12V halogen can be large and heavy.

Some examples of different luminaires and the most appropriate re-engineering for each one can be seen in the illustrations for section 7: Examples of re-engineered luminaires.

3. Types of Emergency Luminaire

By ‘types’, we are not referring here to different lamp types or product ranges, rather to the basic physical layout of the emergency luminaire. For practical purposes all Emergency luminaires fall into one of three types. These types are described in
ICEL 1004:2003 (revised June 2004)

This document, issued by the Industry Commission for Emergency Lighting (ICEL) lists all the requirements for the re-engineering of luminaires for Emergency Lighting use. Poselco Lighting is a member of ICEL.

The three basic types of Emergency luminaire are described as follows:

**4.1 A dedicated luminaire for emergency lighting.**

This is a luminaire which has been designed to provide emergency lighting only, and has no other function (see fig. 4).

**4.2 A luminaire re-engineered for emergency use by the addition of an emergency lighting control module and battery. This luminaire may be self contained or slave.**

This is a luminaire originally designed to function under ‘normal’ conditions, which has been modified so it can provide Emergency Lighting (see fig. 5).

**4.3 A luminaire used as a slave from a central battery power system.**

Like **4.2**, this is a luminaire originally designed to function under ‘normal’ conditions. Unlike **4.2** however, this luminaire has not been modified, but is connected to a remotely controlled system which switches an emergency power supply to it if mains power fails. This emergency power supply is similar to the mains supply, so the slave luminaire will function as an Emergency luminaire without the need for additional components such as a control module (see fig. 6).

**Points to note!**

All the luminaires covered in the following parts of this paper are luminaires re-engineered for emergency use (ICEL 1004:2003 4.2). Dedicated emergency luminaires and slave luminaires connected to central emergency power systems are not covered.

Central battery systems which provide power which is not similar to mains (50V or 110V for example) do require luminaires to be re-engineered, so these luminaires do fall within type **4.2**.
4. Re-engineering for Emergency Lighting

Luminaires can be re-engineered in a variety of ways, depending on the circumstances of the site concerned. There are a number of factors involved in deciding upon the most appropriate form of re-engineered luminaire;

A. The type of emergency lighting required
B. The type of lamps being used in the standard installation
C. The level of emergency illumination required
D. Visual appearance of re-engineered luminaires
E. Available space (inside ceiling voids etc.)
F. Technical requirements (positioning of remote packs, etc)
G. Cost

The mechanical form of the re-engineered luminaire usually takes one of two forms, which we refer to as REMOTE or INTEGRAL.

INTEGRAL
This is a luminaire which has an enclosure (body) which is large enough to allow the addition of an Emergency lighting control module and battery to be fitted within it, without compromising the required standards for safety regarding wiring, maximum temperature etc (see figs. 7, 8, 9 & 10 and examples).
Integral re-engineering is preferable for the following kinds of luminaire:

1. Surface mounted luminaires, which usually fix onto solid surfaces where there is no easy access to a hidden remote gear box, and an exposed gear box is not acceptable.

2. Luminaires with a large internal space, such as recessed luminaires using double-ended lamps, designed to fit into tiled grid ceilings.

3. Pendant luminaires, which may have suspension tubes/wires longer than the maximum distance allowed for the safe operation of a remote gear box.

REMOTE
This is a luminaire which has an enclosure (body) which is too small to allow the addition of Emergency lighting control gear. This control gear is usually housed in a remote enclosure (gear box), with a connecting cable between this box and the luminaire. Usually the remote enclosure is located within 1 metre of the luminaire after installation (see figs. 11, 12 & 13 and examples).
Remote re-engineering is preferable for the following kinds of luminaire:

1. Compact recessed luminaires which are installed into holes, where the emergency gear pack must first be pushed in through the same hole.

2. Compact Emergency luminaires which must look identical to non-emergency ones installed in the same area.

3. Compact high output luminaires (tungsten halogen or discharge) which can have a second, low wattage lamp fitted within the reflector area, powered from a large remote gear box.

4. Exterior luminaires which have a high I.P. rating, where lack of interior space or excessive heat would prevent use of integral emergency gear. In these cases the remote emergency pack can be supplied in an enclosure with a matching I.P rating, and appropriate sealed connecting glands and cable.

The above list of circumstances is not definitive, but does cover most commonly re-engineered luminaires used in commercial or industrial premises.

For the second part of this paper, we will concentrate on the practical aspects of re-engineering luminaires for emergency use (ICEL1004:2003 4.2), which is our specialty here at Poselco Lighting Limited.

Fig. 1  **Maintained** luminaire
Fig. 2  **Non-Maintained** luminaire

![Non-Maintained luminaire diagram](image)

Fig. 3  **Combined** luminaire

![Combined luminaire diagram](image)

Fig. 4  **Dedicated luminaire for emergency lighting**

![Dedicated luminaire image](image)
Fig. 5  Luminaire re-engineered for emergency use

Fig. 6  Luminaire used as a slave from a central battery system
Fig. 7 Standard luminaire

Fig. 8 Integral re-engineered luminaire
Fig. 9  Illustration of an Integral re-engineered luminaire

Fig. 10  Illustration of an Integral re-engineered luminaire
Fig. 11  Remote re-engineered luminaire
Fig. 12  Illustration of a Remote re-engineered luminaire I.P rated remote enclosure

Fig. 13  Illustration of a Remote re-engineered luminaire with remote enclosure
Fig. 14  Emergency lighting control modules (left: 12V 50w full output, top right: compact fluorescent 18w 5 pole enclosed, bottom right: compact fluorescent 9w 4 pole open.)

Fig. 15  Batteries (top left: 5 cell NiCd 6V 4ah, top right: SLA 12V 7ah, centre: 5 cell NiCd 6V 4ah, bottom: 1 cell NiMH 1.2V 4ah)
Part 2: Practical matters.

5. What goes into an Emergency Luminaire?

All luminaires which are re-engineered for emergency use require three basic additional components;

i) A method of switching the luminaire on in the event of a mains failure - An **emergency lighting control module** (often referred to as a ‘module’ or ‘inverter’). (see fig. 14 and examples)

ii) A back-up power source to operate the luminaire in the event of mains failure – A **battery**. (see fig. 15 and examples)

iii) A visible indicator to show that the battery is being charged while the luminaire is powered up – An **L.E.D.** (see fig. 16 and examples)

Additionally, most re-engineered luminaires require a modification of the input terminal block(s) to accommodate one extra connection: Permanent Live (sometimes referred to as ‘Unswitched’ or Unswitched supply’). (see fig. 17)

When placing these items within enclosures as part of the re-engineering process, there are many factors to consider. (These are described fully in Appendix A of ICEL1004:2003. The following is a summary of the main points).

1. **Physical layout.** The module and battery must be positioned so they do not impede the performance of the luminaire. Fixing points and cable entry points must be kept clear, as must the lamp holders and any other internal mechanisms such as earth straps or louver suspension cords.

2. **Thermal performance.** The module and battery must be positioned so they are not exposed to temperatures which exceed their design limits at any time. Thermal tests are carried out on prototype luminaires to determine this, and if no satisfactory position can be found within the luminaire housing, the re-engineering may only be carried out with a remote enclosure (a gear box).

3. **EMC safety and conformity.** The module and any re-engineered wiring must be positioned so the electromagnetic disturbance generated does not exceed the level above which radio and telecommunications equipment cannot operate as intended.
Additionally, the re-engineered terminal blocks must be clearly marked, and the L.E.D charge indicator must be placed in such a position as to be clearly visible in **ALL** operational modes when the luminaire is installed.

If a re-engineered luminaire has a remote enclosure (gear box) this should wherever possible be located within 1 metre of the luminaire. In the case of HF (electronic) ballasts, the maximum wire length between the output terminals and the lamp holders should not exceed 1 metre. The **ENTIRE** path of these lamp holder wires (from HF ballast to emergency module, then from emergency module to lamp holder) must be included within this 1 metre. This is the main reason why, when a luminaire is re-engineered with a remote gear box, the original HF ballast is placed in the remote box with the module and battery.

Every luminaire requiring re-engineering presents its own individual questions and problems to be solved in order to produce the best possible emergency luminaire within an acceptable budget.

Examples of re-engineered luminaires, both integral and remote types, are available to examine (refer back to **figs. 7 to 13** for illustrations).

### 6. Emergency lighting circuits

There are two main groups of emergency lighting circuits.

1. **Maintained.** (see section 2) These are usually used for linear or compact fluorescent luminaires, and sometimes for tungsten halogen fittings where the main lamp wattage is relatively low (50w or less).

2. **Non-maintained.** (see section 2) These are usually used for high wattage tungsten halogen or discharge luminaires, where an additional lamp has been installed in the reflector just to provide emergency light.

**Maintained** emergency circuits involve diverting the lamp output wiring from the original running gear (usually an HF ballast) to the emergency lighting module. Other wires from the module then go to the lamp holders. This diversion of wiring allows the module to ‘take over’ operation of the emergency lamp in the event of mains failure. The back-up power supply (battery) is then used by the module, which converts the low DC voltage to current which will run the lamp at reduced output for a set duration.

Maintained circuits require a second ‘Live’ connection, known as ‘Permanent Live’, which is never switched off unless all mains power fails. This second Live allows the luminaires to be switched by cutting the ‘Switched Live’ without the module switching over to the battery supply.
(One exception to this is a luminaire designed for continual operation (24 hours a day). Such a luminaire would require only a Permanent Live). Because there are many types of running gear, both Switch Start (metal choke) and HF (electronic), circuits can vary in complexity. See figs. 18, 19, 20 & 21 for an example of four different circuit layouts involving the same emergency lighting module.

Additionally, figs. 22, 23 & 24 for illustrations of how the module behaves depending on the status of the mains power supply.

Points to note!

These diagrams are for illustration only, and have been simplified for ease of understanding. The descriptions used on them are not all correct technical terms, and some components have been omitted to aid clarity.

Non-maintained emergency circuits involve the lamp output wiring running from the module to the lamp holders. There is no other device present to run the lamp, as it only operates when mains power fails. Non-maintained circuits do not require a ‘Switched Live’, just Permanent Live, Neutral, and usually Earth. See fig. 25 for a typical Non-maintained circuit, also see figs. 26 & 27 to see how it would operate.

Note! Whether Maintained or Non-maintained, all circuits require a permanently connected Neutral. Disconnection of Neutral should never occur except during a mains failure, and such disconnection, should any Live still remain connected, could possibly damage emergency lighting modules.

7. Examples of re-engineered luminaires

An illustrated example of the re-engineering of one specific luminaire will be given in the next edition of this paper, along with a step-by-step guide to how decisions were taken and how the re-engineering was carried out. In this edition a list of questions has been included, with brief notes on how each question is usually answered.

When a luminaire arrives for re-engineering, certain information is required before work can begin;

1. Has this particular job been done before?

A search of our technical files will determine this. If the answer is yes, checks will be made that nothing has changed since the job was last done (such as a new module on the market). The job can then proceed, based on information from the technical file. If the answer is no, there are further questions to answer.
2. Do we have all the information we need?

It should be clear what kind of re-engineering is being asked for (remote or integral etc.) and if there are any special requirements such as I.P. rating. Also the price needs to be checked to make sure it matches the work to be done!

3. Where are the emergency components going?

We have a standard layout which works for most of our remote emergency gear boxes, but if the re-engineering is to be integral, we have to decide on the best positions for the module and battery (see section 5, and Appendix A of ICEL1004:2003)

4. Where is the L.E.D charge indicator to be positioned?

Wherever we decide to put it, the L.E.D should ideally be placed so it is clearly in view all the time, so a person checking the luminaire can tell whether the battery is being charged. This can be a difficult problem sometimes, as some luminaires are designed with visual impact in mind and placing an L.E.D can involve drilling a hole. Wherever possible we will consult our customer in advance if we feel the L.E.D position might compromise the appearance of a luminaire.

5. Will our re-engineering affect the way the luminaire is to be installed, or the way it will function?

For example, if the re-engineering is to be with a remote emergency gear box, and the luminaire is recessed into a circular hole, will the remote gear box fit through the hole? If it will not, and the customer tells us that the entire luminaire must go through the cut out (no other access to the ceiling void) then an alternative remote gear box will have to be used. This can add cost and time to a job, so our range of remote gear boxes is as compact as it can practically be.

6. Will the person installing the re-engineered luminaire have all the information they need to complete the task?

There is a ‘standard’ set of paperwork which we include with every re-engineered luminaire when it leaves our factory, (in addition to its original instruction sheets). See figs. 28 & 29 for an example of these. Sometimes additional instructions may be required if the re-engineering has unusual or complex features. This will be made up and stored in the technical file for future use, and a copy included with each re-engineered luminaire, alongside the ‘standard’ set. See fig. 30 for an example.
Once these and any other relevant questions have been answered, the job will proceed.

8. Trouble shooting

Despite our best efforts, things can go wrong on site. Very often these problems are caused by factors which are beyond our control. Sometimes these problems can be solved without the need for a site visit or recall of the luminaires involved. Listed below are some of the more common questions a customer may ask after an installation of emergency luminaires. Each point has some counter-questions you may ask, which could provide a solution. The customer’s query is in red, counter-queries in blue, possible solutions in green.

Q1. We tested the fittings and they are not staying on in emergency mode for three hours…why not?

How long have the fittings been installed for? Battery packs require 24 hours of continual charging to reach full capacity. If they have been charging for enough time, then suggest the following;

Sometimes the chemicals inside rechargeable batteries ‘settle’ over periods of time without use. Fully charge (24 hours) then fully discharge (3 hours) the fittings three or four times. If the customer says this has been done then contact us for further assistance.

Q2. Lamp ends are blackening in the emergency fittings and lamps are failing too quickly…why?

Is it just in the emergency fittings? If the answer is no, then there is probably a fault with the lamps themselves. If the answer is yes;

Is ALL the power in the building (including Permanent Live) being switched off every night? If the answer is yes, then suggest the following;

Maintained emergency fittings are designed for infrequent use, not to be discharged regularly such as every night. Operating lamps in emergency mode does do minor damage to the contacts inside the lamp. This is not serious enough to affect lamp performance or lamp life, unless it is done too frequently. A warning to this effect is included as part of the standard emergency installation paperwork which we include with all our re-engineered luminaires. The customer should be advised to discontinue this practice, or the problem will persist. If the customer says the power is not cut off every night, ask them to check.

Are you sure the emergency lights are not coming on at night when people leave the building? If they say yes, then the Permanent Live IS being cut, possibly
because of a wiring fault in the building. If the answer is a definite no, then contact us for further assistance.

**Q3. The emergency lights are not working...why?**

This is too vague to be useful, so ask the following three questions and make a note of the answers given.

  a) Are the lamps operating in normal (mains on) mode?
  b) Is the emergency lamp operating in discharge (all power off) mode?
  c) Is the L.E.D charge indicator lit when mains power is on?

These questions can be answered in one of six different combinations. Possible problems are listed after each combination.

**a) No  b) No  c) No**

Possible external power supply failure. Check external wiring; make sure **Permanent Live** and **Neutral** are powered.

Alternatively:
Check fuse (1A) on **Permanent Live** terminal inside luminaire or gear box. Double check there are no loose connections, especially **Permanent Live** and **Neutral**

**a) Yes  b) No  c) No**

Battery may be disconnected. Check that it is properly connected to the module. Check the polarity of the connection.

Alternatively:
Possible external power supply failure. Check external wiring, make sure **Permanent Live** and **Neutral** are powered.

Alternatively:
Check fuse (1A) on **Permanent Live** terminal inside luminaire or gear box. Double check there are no loose connections, especially **Permanent Live** and **Neutral**

**a) Yes  b) No  c) Yes**

Battery may be severely discharged. Ensure fitting is powered up for at least 24 hours then test again.

Alternatively:
**Battery may be faulty.** Contact us for assistance.

**a) Yes  b) Yes  c) No**
L.E.D. may not be connected correctly. Check connections into module, check polarity is correct. Sometimes L.E.D connections can come loose directly beneath the L.E.D. itself. Check these.

Alternatively:
L.E.D. may have failed. Contact us for assistance.

Alternatively:
Battery is not charging properly due to an internal fault. Contact us for assistance.

\begin{itemize}
\item[a)] No \hspace{1em} \item[b)] Yes \hspace{1em} \item[c)] Yes
\end{itemize}

Possible external power supply failure. Check that Switched Live is powered.

Alternatively:
Check the fuse (if it has one) in the Switched Live terminal inside the luminaire.

Alternatively:
Original running gear may be faulty. Contact us for assistance.

\begin{itemize}
\item[a)] No \hspace{1em} \item[b)] No \hspace{1em} \item[c)] Yes
\end{itemize}

Lamps could be faulty. Change lamps, and check old lamps for blackened areas or cracked glass.

Alternatively:
Possible external power supply failure. Check that Switched Live is powered and that Permanent Live is powered. If Switched Live is powered but Permanent Live is not, ensure Permanent Live is restored as soon as possible. If fitting still does not work it may have been damaged by Permanent Live being disconnected while Switched Live was still powered. Contact us for assistance.

Alternatively:
The emergency module may have failed. Contact us for assistance.

\begin{itemize}
\item[a)] No \hspace{1em} \item[b)] Yes \hspace{1em} \item[c)] No
\end{itemize}

This luminaire may be suffering from more than one fault!

Possible external power supply failure. Check that Switched Live is powered.

Alternatively:
Check the fuse (if it has one) in the Switched Live terminal inside the luminaire.

Alternatively:
Original running gear may be faulty. Contact us for assistance.

Alternatively:
L.E.D. may not be connected correctly. Check connections into module, check polarity is correct. Sometimes L.E.D connections can come loose directly beneath the L.E.D. itself. Check these.

Alternatively:
**L.E.D. may have failed.** Contact us for assistance.

Alternatively:
**Battery is not charging properly due to an internal fault.** Contact us for assistance.

Should a customer ask a question which we have not attempted to answer here, please contact us? We will do our best to help.

However, if you do require our assistance, please ask the customer the following questions before doing so. The more of these they can answer, the better chance we will have of diagnosing their problem.

**Question 1** Have you ensured all external power supplies are powered as they should be?

**Question 2** Is the problem affecting
   a) All the luminaires in a certain area?
   b) All the emergency luminaires?
   c) A random number of emergency and 'standard' luminaires?
   d) A random number of emergency luminaires only?
   e) Only one luminaire?

**Question 3** If a number of luminaires have failed
   a) Did they ever work, or have they been faulty since day one?
   b) Did they all fail at the same time?
   c) Did any other luminaires or other electrical equipment fail at roughly the same time?

**Question 4** How long have the luminaires been installed?

**Question 5** How long have the luminaires been powered?

**Question 6** Does the building have ALL power (including Permanent Live) cut each night?

**Question 7** Has the building had all power cut off at night as a regular occurrence at any time since the luminaires were installed?
**Question 8** Have there been any problems with lamps, in emergency or ‘standard’ luminaires (blackened ends, shortened lamp life etc)?

**Question 9** Has anybody been carrying out Insulation tests on the building’s wiring (known sometimes as ‘megger’ tests)?

**Question 10.** Have there been any known power supply problems affecting any part of the building (not just the lighting), including ‘spikes’ in the mains, incorrect mains voltage etc.?

The trouble shooting list can never cover every possibility, but it may help with solving some of the most common problems that occur during or after site installation. If there are any questions concerning the re-engineered luminaires supplied by Poseco Lighting, please contact us and we will do our best to help.

Our technical department can be reached on the following number:

Tel. 0208 813 0101

Or contact us by fax or e-mail:

Fax: 0208 813 0099

E-mail: sales@poselco.co.uk