Central battery system based emergency lighting is ideal for medium to large installations. For projects where central control and testing is desirable, a central battery system is a viable and cost effective alternative to self-contained emergency lighting products. The main advantages of central battery systems over self-contained systems are:

- Testing and maintenance is much easier to carry out
- Battery replacement is much quicker and less disruptive
- Battery life is generally 10 years or more
- Luminaires can be centrally controlled
- High light levels can easily be achieved
- The emergency lighting system can be completely unobtrusive

Eaton manufactures a wide range of central battery emergency lighting systems. Standard products include AC/AC static inverter systems, with the addition of a new compact, competitively priced unit for smaller installations. A comprehensive range of traditional AC/DC systems are also available, including an economy range designed for use in small premises. Bespoke systems to suit the exact requirements of the specifier are also available.

To complement the range of central battery systems, Eaton also offers a wide selection of slave luminaires and conversion modules for mains fluorescent luminaires. EasiCheck automatic self-testing can be readily incorporated into central systems.

- **Loadstar AC/DC Systems** (See page 443)
- **Economy AC/DC Systems** (See page 450)
- **Loadstar Static Inverter AC/AC Systems** (See page 453)
- **Compact Static Inverter AC/AC** (See page 463)
- **Switchgear Tripping Battery Chargers** (See page 466)
- **EasiCheck 1.5 Slave Emergency Lighting Testing System** (See page 468)
- **Slave Luminaire Technical Data** (See page 471)
Central Battery System Design

When it has been decided that a central battery system is the most suitable system of emergency lighting for a particular site, the designer needs to give consideration to the following:

- Lighting design
- Type of system
- System control and mode of operation
- Battery type
- System sizing
- Battery room ventilation

Lighting Design Considerations

Current legislation and design increases the attraction of using central battery systems to provide emergency lighting in a building. In particular, an increase in the use of static inverter systems, which provide an alternative source of power to normal mains luminaires. These considerations can be summarised as follows:

1. BS 5266 part 7 (EN 1838) specifies increased emergency light levels than previous standards
2. Slave luminaires, operating from AC/DC and AC/AC central systems, offer a higher light output and improved spacing characteristics over comparable self-contained versions of the same luminaire
3. Compact fluorescent lamps make ideal slave luminaires, offering high efficiency and appropriate light output for areas with low ceilings
4. There is an increasing requirement from architects and users to make emergency lighting as unobtrusive as possible, so utilisation of the normal mains luminaires is an ideal solution

Through the use of dedicated slave luminaires and conversion modules for mains fluorescent luminaires, these considerations can be catered for by both AC/DC and AC/AC central systems. An illustration of the increased output that can be expected from 8W slave luminaires compared to self-contained versions is shown in figure 1.

Fig 1. Light output of different types of luminaire (nominal lamp lumens based on standard 8 watt fitting)

When performing photometric calculations for converted mains luminaires with static inverter systems, the full design lumen output of the luminaire must be taken into account, as the lamps are powered by conventional ballasts. It is important to ensure that the use of such high output luminaires in low ceiling areas does not exceed the uniformity factor limitations. The utilisation factor should be taken at zero reflectance in line with BS 5266 Pts. 1 and 7 1999. Typical spacing data is provided at the rear of this catalogue, to assist in the calculation of spacing.
Type of System
There are numerous different combinations of central battery system type and the correct choice depends as much on customer preference as on design criteria. The selection chart below gives some general guidance. Should you wish to discuss a proposed system type for a particular application, our technical department is available to provide assistance. Contact the central system technical sales department, Tel: 01302 303317

Notes
1. Conversion modules are designed to be incorporated into a conventional mains luminaire. During normal conditions the luminaire operates at full brightness (using the normal switched mains supply and conventional control gear). In emergency conditions the luminaire continues to operate at reduced brightness (with the emergency lamp being powered from the conversion module instead of the conventional control gear). Conversion modules are ideal for use with mains luminaires which have louvres with a sharp cut off angle, or for projects where the mains luminaires have multiple tubes, but only one tube is required to be illuminated during emergency conditions.

2. Static inverters provide mains voltage output during both normal and emergency conditions. They are designed to run conventional mains fittings at full brightness even in emergency conditions. Static inverters are ideal for projects with large open areas, or hazardous areas requiring higher than normal emergency lighting levels, or for powering compact fluorescent luminaires where there is often insufficient space within the fitting to accommodate a conversion module.

3. Static inverter systems operate the emergency luminaires at full brightness throughout the emergency autonomy period, which usually results in significantly improved luminaire spacing for mains slave luminaires compared with an equivalent low voltage AC/DC unit. In addition, the combination of higher supply voltage and the resultant reduced input current reduces installation costs by allowing the use of smaller distribution cables than would be required with a lower voltage AC/DC system.
System Control and Mode of Operation

It is a requirement of any correctly designed emergency lighting system that the emergency lighting is activated both in the event of complete mains failure, and also in the event of a local mains failure. The emergency lighting system can have luminaires that are maintained or non-maintained. Similarly, the central battery unit can also be maintained or non-maintained operation. The following diagrams explain how activation of the emergency lighting is achieved, using the main types of central battery systems.

Central systems with dedicated slave luminaires

a. Non-maintained central battery unit with sub-circuit monitors

With this method, relays are used to monitor the normal lighting supplies. The contacts of these relays are wired in a series loop such that in the event of failure of any of the normal lighting supplies, the loop is broken, sending a signal to the central battery unit to activate all of the emergency luminaires. Details of purpose-made remote sub-circuit monitor units can be found in the Loadstar product section.
b. Maintained central battery unit with the maintained circuit continuously energised

A simple installation where emergency luminaires are illuminated at all material times irrespective of the status of the normal lighting. In the event of a complete mains failure, the slave luminaires are illuminated from the battery supply.

<table>
<thead>
<tr>
<th>Normal mains healthy condition</th>
<th>Failure of normal lighting final circuit</th>
<th>Total mains failure</th>
</tr>
</thead>
</table>

c. Maintained central battery unit with remote hold off relays

The maintained output from the battery unit is fed to a number of remote hold off relays throughout the building. The coil of the hold off relay is connected to the unswitched side of the local normal lighting supply. Assuming this supply is healthy, the relay will pull in, opening the contacts and preventing power from reaching the slave luminaires. In the event of a local mains failure, the relay drops out, the contacts close and the emergency luminaires in that particular area are illuminated from the maintained circuit of the battery unit. In the event of a complete mains failure, the system operates in a similar manner, except that the slave luminaires are illuminated from the battery supply. Details of purpose-made remote hold off relays can be found in the Loadstar product section.

<table>
<thead>
<tr>
<th>Normal mains healthy condition</th>
<th>Failure of normal lighting final circuit</th>
<th>Total mains failure</th>
</tr>
</thead>
</table>
d. Maintained AC/DC central battery with conversion luminaires

With this option, the normal mains luminaires are fitted with a conversion module, enabling them to also operate as emergency luminaires in the event of mains failure. Each conversion module includes a changeover relay which, under normal circumstances, is energised by a permanent supply from the unswitched side of the normal lighting circuit. Whilst energised, it connects the lamp to the conventional mains control gear within the luminaire allowing it to operate as a standard mains fitting, powered via a switched live connection to the mains ballast. Should the normal lighting fail, the relay within the conversion module drops out, disconnecting the lamp from the conventional control gear and connecting it to the inverter within the conversion module. This illuminates the lamp at reduced brightness. In multi-lamp luminaires, the conversion module only operates a single lamp in the emergency mode. All other lamps will extinguish upon mains failure.
Central systems with converted mains luminaires AC/AC systems

e. Static inverter unit with conventional mains fittings

A static inverter runs conventional mains luminaires at full brightness during both mains healthy and mains failure conditions. However, there is usually a requirement for local switching of the luminaires during mains healthy conditions, with automatic illumination in the event of mains failure.

Local switching with automatic illumination in the event of mains failure can be easily achieved by use of the ACM1 module, which is purpose-designed for this application. A detailed description of the ACM1 module, including a typical wiring schematic, can be found on page 330.

**Normal mains healthy condition**

**Failure of normal lighting final circuit**

**Total mains failure**

**KEY**
- LIVE
- DEAD
- LIVE VIA INVERTER
Battery Type
Eaton offers a choice of five different battery types:
- Valve regulated lead acid (10 year design life)
- Valve regulated lead acid (3-5 year design life)
- Vented nickel-cadmium
- High performance plante lead acid
- Flat plate lead acid

Each battery type has specific characteristics. In order to assist with the choice of battery, full details of the characteristics and benefits can be found in the Loadstar and Static Inverter System product pages. The table below (fig. 2) provides a comparative guide to these characteristics.

The most popular battery type is valve regulated lead acid with a 10 year design life. This type of battery is used on approximately 90% of projects due to its competitive cost, good life characteristics, ease of maintenance and compact size.

Battery Room Ventilation
Vented batteries, such as nickel cadmium, plante and flat plate lead acid emit potentially explosive gases under charge conditions. Therefore it is important when selecting rooms for emergency lighting central battery systems with these types of battery, to calculate the amount of ventilation required. The required number of air changes per hour ($A$) is given by the following formula:

$$A = \frac{0.045 \times N \times I}{V}$$

Where:
- $N$ = Number of cells in the battery
- $V$ = Volume of room in cubic metres
- $I$ = Charge rate in Amperes

This formula will give the number of air changes per hour required during boost charge conditions. On float charge (systems are on float charge for most of their service life), the amount of gas emitted is approximately 1.5% of that liberated whilst on boost charge and under most circumstances this will be dissipated by natural ventilation, and will not present a hazard. However, we recommend that the boost charge condition is allowed for at the design stage to ensure the appropriate decision on ventilation requirements is made.

Although Valve Regulated Lead-Acid Batteries require little ventilation under normal operating conditions, it is good practice to apply the formula to calculate the number of air changes required to achieve minimum risk under battery fault or failure conditions. Please refer to: BS 6133:1995
System Sizing
When sizing the system, it is important to allow for the full input requirement of the light fittings rather than the lamp wattages.

AC/DC systems
When using conversion modules fitted to conventional mains fittings, the lamp will be illuminated directly from the mains ballast during normal mains healthy operation and via the inverter during emergency conditions. When being driven from the battery unit via the conversion module, the emergency lamp will be illuminated at less than full output, and as a result, the fitting will consume a reduced input power.

AC/AC systems
When utilising a static inverter system, the fitting operates at full output during both mains healthy and mains failure conditions. When sizing a suitable static inverter to power a particular load, it is important to consider the input VA and the input (not lamp) wattage of the emergency luminaires. The total VA requirement defines the inverter module size, and the total input wattage defines the battery size.

Therefore, to establish the correct inverter module size, the power factor correction (PFC) rating of the luminaires must be considered in addition to lamp wattage and control gear losses. High frequency control gear circuits have excellent PFC ratings, usually of around 0.96 to 0.98. This compares with 0.85 to 0.9 for equivalent lamp magnetic control gear circuits. Care should be taken when low wattage compact fluorescent lamps are used, utilising high frequency gear or high PFC versions where possible. Low power factor versions can have PFC ratings of only 0.45 to 0.5, thereby greatly increasing the inverter rating required for the system. If utilising low voltage lighting powered via step-down transformers, it is essential to allow for the efficiency and power factor of the step-down transformers. Table (fig. 3) and graph (fig. 4) illustrate the relationship between wattage and VA rating for a typical system. For a detailed explanation of conversion operation, please refer to page 330. For details of the power consumption of slave luminaires and converted luminaires (when operating in the emergency mode via a conversion module), please refer to page 472.

Note: BS EN 60598-2-22 prohibits the use of glow starters in fluorescent luminaires used for emergency lighting.

Fig 3. Typical system. VA rating with and without power factor correction

<table>
<thead>
<tr>
<th>Qty of Luminaires</th>
<th>Description</th>
<th>Total Circuit Watts</th>
<th>VA Rating (Compact lamps without PFC)</th>
<th>VA Rating (Compact lamps with PFC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>1 x 58W T8 (wire wound ballasts)</td>
<td>1725</td>
<td>1925</td>
<td>1925</td>
</tr>
<tr>
<td>40</td>
<td>1 x 28W 2D (wire wound ballasts)</td>
<td>1360</td>
<td>2960</td>
<td>1560</td>
</tr>
<tr>
<td>15</td>
<td>1 x 16W 2D (wire wound ballasts)</td>
<td>315</td>
<td>690</td>
<td>375</td>
</tr>
<tr>
<td>15</td>
<td>1 x 13W TC-D (wire wound ballasts)</td>
<td>270</td>
<td>600</td>
<td>315</td>
</tr>
<tr>
<td>5</td>
<td>1 x 40W GLS incandescent</td>
<td>200</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Inverter Rating</td>
<td></td>
<td>3870</td>
<td>6375</td>
<td>4375</td>
</tr>
</tbody>
</table>

Note: Use of compact fluorescent luminaires with power factor correction (PFC) leads to a reduced inverter module size and therefore savings in space and capital costs.

Fig 4. Typical system. VA rating with and without power factor correction
Additional Considerations

Spare capacity
With any central battery system it is important to bear in mind that it is difficult to extend the system at a later date unless capacity has been allowed for at the design stage. For this reason, we would strongly recommend that some spare capacity is included when selecting the central battery system rating. Our technical department is available to provide assistance. Contact the Central System team, Tel: 01302 303317 or E-mail: CBUsystemsUK@Eaton.com

Fire protection of cables
Cables should be routed through areas of low fire risk. The following cables and wiring systems should be used.

a) Cables with inherently high resistance to attack by fire
   i) Mineral-insulated copper-sheathed cable in accordance with BS 6207: Part 1
   ii) Cable in accordance with BS 6387. The cable should be at least category B

b) Wiring systems requiring additional fire protection.
   i) PVC-insulated cables in accordance with BS 6004 in rigid conduits
   ii) PVC-insulated cables in accordance with BS 6004 in steel conduit
   iii) PVC-insulated and sheathed steel wire armoured cable in accordance with BS 6346 or BS 5467

Systems should be installed in accordance with IEE Regulations and BS 5266. Additional fire protection may apply. For example, if cables are buried in the structure of the building.
Cable sizes

When selecting cable sizes, due regard should be paid to limitations imposed by voltage drop and physical strength. Each conductor shall be of copper, having a nominal cross sectional area of not less than 1mm². BS 5266 states that the voltage drop in cables connecting a central battery to a slave luminaire should not exceed 4% of the system nominal voltage at maximum rated current.

Using copper conductors, volts drop can be calculated per pair of conductors as shown in table fig. 5. Total volts drop on a circuit can be calculated according to the formula:

\[ V_{DT} = I \times V_{DM} \times D \]

Where:
- \( V_{DT} \) = volts drop total
- \( I \) = maximum load current
- \( V_{DM} \) = volts drop per amp per metre (obtained from fig. 5)
- \( D \) = cable run in metres

Example:

Fig. 6 and 7 show an example comparison for a central battery system with a total connected load of 1500W and a 50m run of 16mm² cable supplying the luminaires.

This example shows that for this configuration, a 230V system would be most suitable to meet the requirements of BS 5266. The low current value combined with greater allowable volt drop would enable much smaller cables to be used.

Comparison Data

<table>
<thead>
<tr>
<th>Comparison Data</th>
<th>24V System</th>
<th>50V System</th>
<th>110V System</th>
<th>230V System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. permissible volt drop (V)</td>
<td>0.96V</td>
<td>2.0V</td>
<td>4.4V</td>
<td>9.2V</td>
</tr>
<tr>
<td>Volt drop (BS 5266)</td>
<td>62.5A</td>
<td>30A</td>
<td>13.6A</td>
<td>6.52A</td>
</tr>
<tr>
<td>Total current for total connected load of 1500W</td>
<td>8.43V</td>
<td>4.05V</td>
<td>1.84V</td>
<td>0.88V</td>
</tr>
</tbody>
</table>

The use of larger cables or multiple outgoing circuits may permit the use of 24, 50 or 110V systems in the above example.