KOHLER® | UNINTERRUPTIBLE POWER

Critical Power Care for Patient Safety

Introduction

Healthcare providers have a duty of care to patients. Along with nursing and medical staff, this duty of care also needs to ensure that appropriate governance arrangements for critical power backup are in place and are managed effectively. Healthcare-specific technical engineering guidance is a vital tool in the safe and efficient operation of healthcare facilities, so if there are disturbances to mains power, patient or staff safety is not in danger.

At Kohler Uninterruptible Power, we understand that the key challenges in protecting critical power in healthcare situations include:

- Compliance with multiple guidelines, regulations and healthcare specific standards
- Maintaining and expanding legacy estates comprising equipment from multiple suppliers
- Handling space, weight and temperature demands of power protection systems in buildings rarely designed to house them
- Defining where IPS, UPS and Emergency lighting Systems are needed and then scheduling servicing
- High variations and/or continual growth in load

There are a lot of considerations and challenges installing and maintaining systems in an ever-changing healthcare environment. Collaborating with suppliers and consultants who understand current and future challenges and who can make this decision-making process much simpler is vital. Ideally, you will want a partner with in-depth knowledge, extensive experience as well as a comprehensive choice of solutions that will fit the healthcare facility's specific needs.

In this white paper, we will be looking at some key considerations to ensure that compliance is adhered to and some thoughts on how best to install, update and maintain systems to suit requirements – while running power solutions safely, effectively, and efficiently.

If you have questions after reading this white paper – or that are inspired by this white paper, please get in touch.

Alex Emms
Technical Director,
Kohler Uninterruptible Power

What sorts of power back up are needed?

With hospitals and medical facilities needing to be operational 24/7, the need for resilient backup power solutions has never been greater. But what happens if a power failure occurs?

Even a short power failure can be extremely damaging to operational continuity and more importantly, patient safety.

These problems can be avoided by using an uninterruptible power supply (UPS), which protects critical devices from power disturbances ranging from fluctuations, spikes and dips to total power failure.

If the power goes out, a healthcare facility also has a duty of care to keep its people – patients, staff, visitors and contractors - safe. Having robust life safety and emergency lighting protection is critical to ensure that evacuations can happen safely, critical procedures can be completed and those unable to be evacuated in the case of an emergency can be properly cared for.

Consideration should be given to risk management for both business continuity and patient safety. When assessing, risks are considered for:

- Business continuity due to loss of supply – Grade IV (low) to I (high)
- Risk to patient due to loss of supply – Grade E (low) to A (high)

System design

When evaluating what power – and back up is required, you need to look at your site, where the equipment will be placed and the type of electrical supply in place.

HTM06-01 suggests various forms of dual supplies but what is Dual Source Supply and why is it important?

The need for a dual power supply

When a facilities team needs to be able to perform maintenance and other work on electrical equipment without taking devices offline - which is often the case in a healthcare environment - then two different power circuits may be installed, with different power supplies to each. There are different ways to achieve a safe, resilient dual source supply to support this.

The rectifier and bypass may have a common supply connection. The ideal connection should provide seperate connections for the rectifier and bypass line.

HTM06-01 suggests that for resilience purposes the UPS may be fed from different Primary Electrical Supply (PES) transformers. A central UPS may not require dual supplies.

Alternatively, enhancing the infrastructure resilience may be achieved by adding a tertiary power source. A single-conversion UPS may be connected to dedicated final circuits of the single cable distribution infrastructure. Enhancing the dual infrastructure resilience and adding additional standby generator units may improve the maintenance opportunities and business continuity for the higher risk areas.

System design

What equipment is needed to support the power requirements?

Traditionally, UPS design involved a large, individual standalone system, which had to cover all the capacity required. Therefore, the whole system was always powered, and frequently would not be operating in its most efficient load band. If redundancy was required, a complete additional system would be needed, further increasing the risk of sub-optimal loading. Nowadays, we have modular UPS designs made up of smaller building blocks where redundancy can more cost effectively be delivered and loads can be spread or concentrated as appropriate to optimise efficiency.

Modular systems (where rackable modules are contained within a single infrastructure cabinet) have made the ‘right-sizing’ of UPS to a given load easier than ever before.

Expansion of capacity is a simple matter of adding a further module and contraction is a simple matter of turning off modules in turn. The initial design must, of course, be sized for the ultimate load. The selection of the module rating should be influenced by the load steps anticipated and the ultimate load. Hence a 100kW ultimate load may be suitable for 10kW modules and a 500kW ultimate load suitable for 100kW. Above 1MW, it is usual to engineer a multi-module scalable solution (eg. of 250kW modules) and provision the switchgear infrastructure for the ultimate configuration, but not necessarily installing all UPS modules or frames on ‘day 1’.

System design

When working out what power back up is needed, you need to evaluate site requirements and the positioning of the UPS units. It is important to consider what power is required so the system can handle maximum load and importantly, critical back up kicks in seamlessly and quickly.

Managing the load

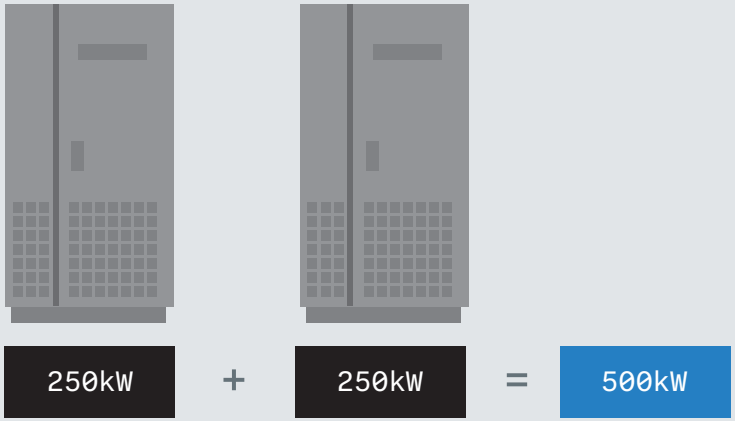
When looking at what power is needed, it is important to size not only for today's maximum load, but also to consider likely future expansion and any redundancy requirements.

For instance if we knew we needed 250kW of power today, we might choose a single, "standalone" UPS of 250kW capacity. However, to expand this would require adding another 250kW system.

In contrast, modern modular design are typically made up of 6-10 modules in a single UPS frame that does not have to be fully populated. Provided the associated cabling and switchgear was installed to support it, additional modules can be added when required. So for instance a 250kW system made up of five 50kW modules might have a sixth one added to expand capacity. The total capacity purchased, and being run, would therefore only be 300kW, as opposed to 500kW with a standalone approach.

SIZING A UPS SYSTEM FOR EXPANSION

TRADITIONAL STANDALONE / MONOLITHIC DESIGN



MODULAR DESIGN

System design

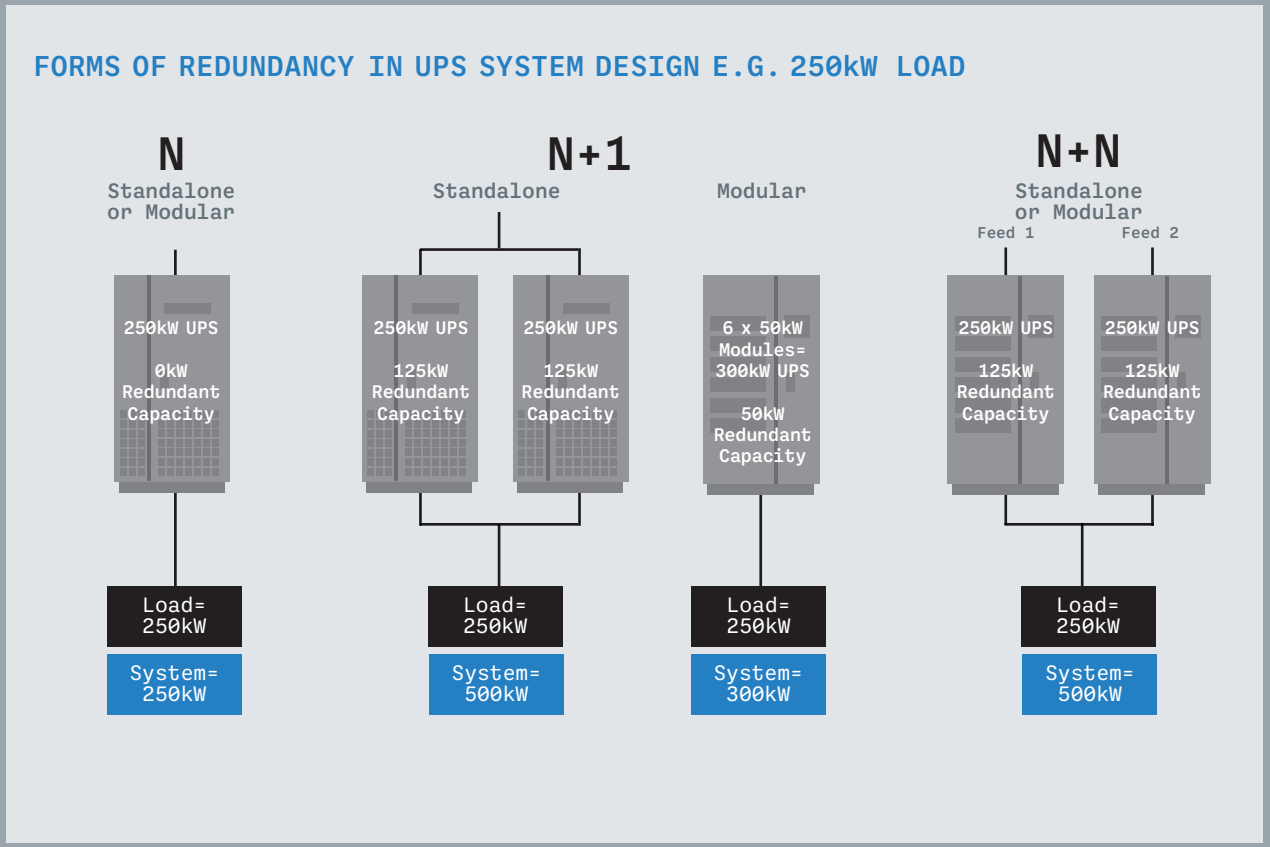
Building in redundancy to the UPS

Next, let us consider redundancy. Where centralised UPS are used, it is recommended to incorporate redundancy so the load is protected during maintenance or equipment failure.

This can take various forms and is denoted in specifications using the format “N + X”, where N is the load and X is the level of redundancy. As such, a system with no redundancy would be denoted an “N” system, a system with 1 level of redundancy would be “N+1” and a system with twice the capacity of the load and fed by separate feeds would be “N+N”. (See diagram).

Note that for N+1 systems the use of modular systems can allow dramatic reductions in the size of UPS system (plus associated battery system and operational costs). This is one of the reasons HTM 06-01 recommends looking at modular systems. (See diagram).

Systems with even higher levels of redundancy exist, such as 2(N+1), ie two N+1 systems fed by different feeds and feeding the load via different lines, but the most commonly seen types in healthcare are N+1 and N+N.



System design

Autonomy requirements

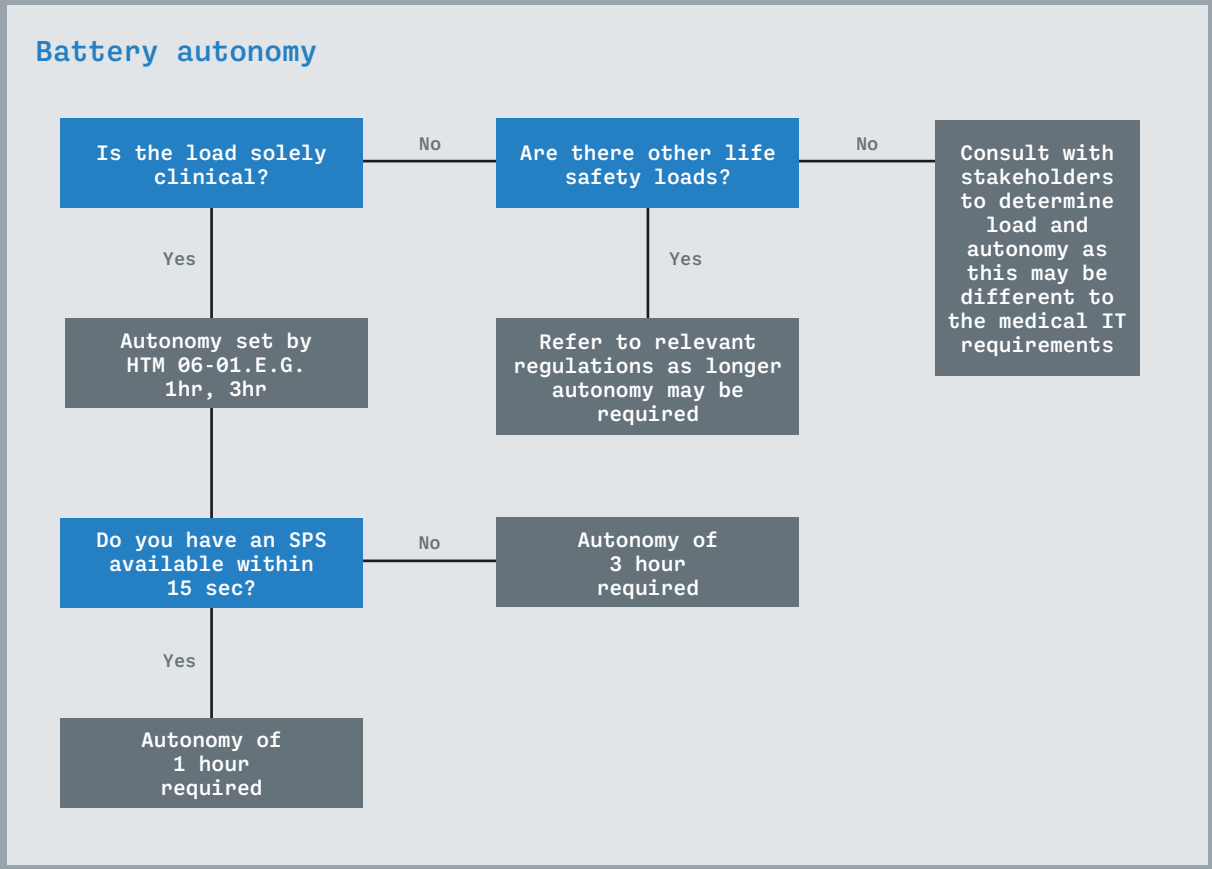
System autonomy is the amount of time that it can provide power to the load if the mains supply is interrupted.

In some cases a secondary power supply (SPS) such as an alternative mains supply or a standby generator might be quickly available. In the case of a generator, the autonomy will be the amount of time the fuel will last.

Similarly, for a UPS system, the autonomy is the amount of time its batteries can power the load for. It is especially important to correctly define autonomy for a UPS system as this will significantly affect the battery system's size, weight and costs.

The load and type of load being supported must also be correctly determined – consider that there may be non-clinical loads that need supporting such as smoke extraction systems.

Check our flow diagram to assess your autonomy requirements in relation to HTM 06-01 and BS 7671.



| *System* design

Emergency Lighting

Healthcare environments are complex and require emergency lighting that operates reliably when called upon and provides sufficient illumination along all escape routes and to all other points where it is required. This can make the difference between safe management of a power disturbance and panic, injury or possibly even death. Emergency lighting is an essential part of any building services installation, and subject to extensive British and European legislation.

The Department of Health's HTM 06-01 document advises on healthcare electrical services, including emergency lighting. The document states that emergency lighting – escape, safety and standby – should be designed to BS 5266-1 and BS EN 1838.

Fully compliant equipment is required throughout healthcare buildings such as hospitals and clinics, covering escape routes to the ultimate place of safety, appropriate exit signage and open area lighting.

Escape and safety lighting can be powered by central battery inverter units. However, operating theatres, which are risk grade A, must have independent battery inverters for the operating theatre lamp(s) and satellite lamps.

Emergency lighting, by definition, depends on a continuously charged battery backup power source. Whilst in some applications these batteries can be local to the light, the need for testing and inability to temperature control their environment (and thus more frequent need to replace them) means in healthcare settings centralised battery systems are often chosen instead.

The lighting can detect a mains power failure and switch to battery backup automatically and immediately. The battery power source must be well-designed, well-maintained, always fully charged and ready for use and,if relevant, compliant to EN 50171 central system standard.

System design

Medical Isolated Power Supply (MIPS)

As well as a power supplied via a battery-backed UPS system, the following will require isolated power provided via a Medical Isolated Power Supply, or Medical IT System.

- operating rooms
- intensive care rooms
- MRI suites
- recovery rooms
- therapy rooms

Backed by best-in-class support, Kohler's UK built system was designed from the outset to fully meet or exceed the requirements of UK HTM-06-01 while being easy to integrate with the many Kohler UPS and generator systems installed in hospitals and other healthcare facilities, or those of other manufacturers.

What about *batteries?*

Battery Maintenance and Management

Battery failure is the most common cause of emergency power failures, so maintenance is essential. There are three key things that can affect a battery's capacity. These are:

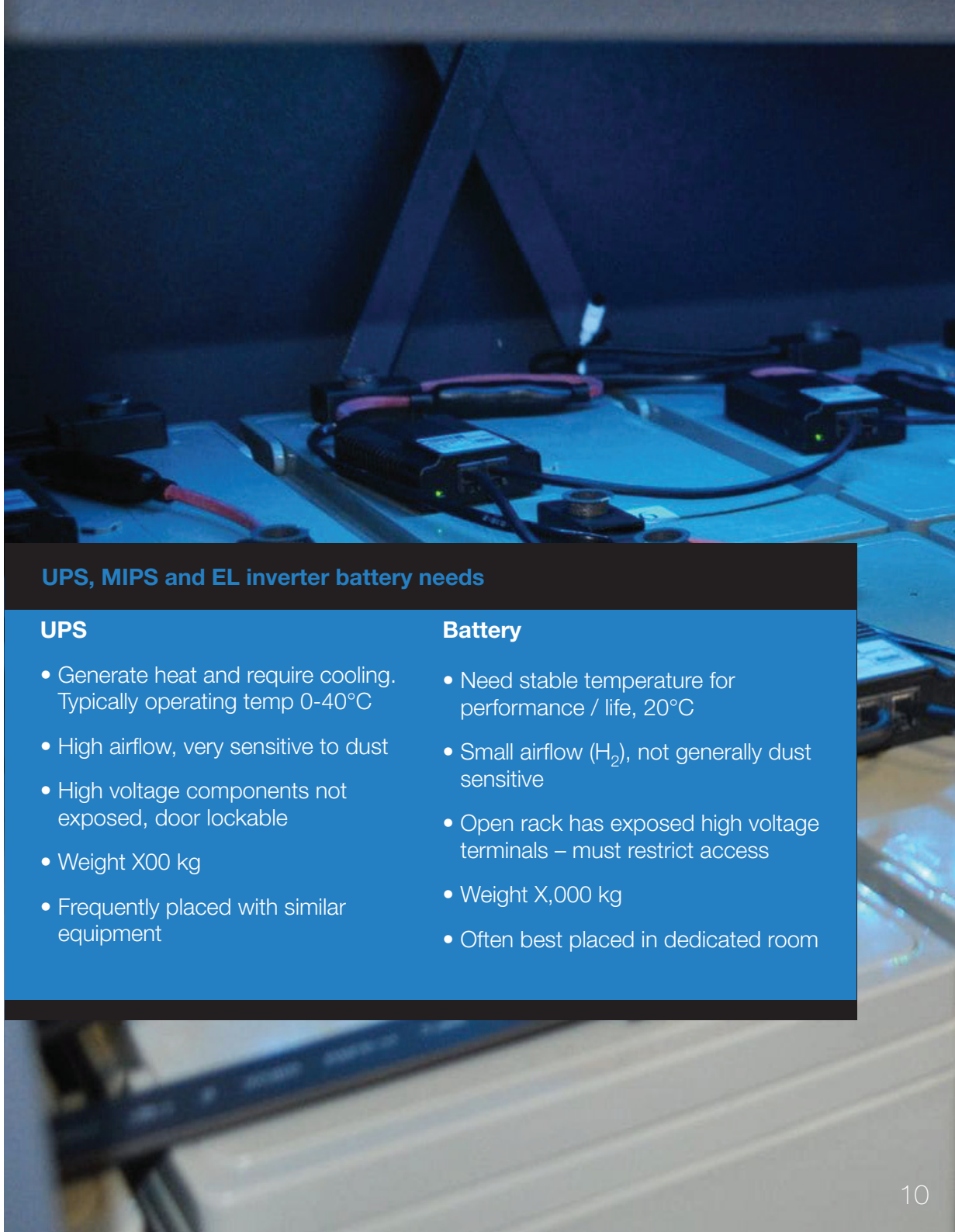
- **TEMPERATURE** control, too hot will reduce life, too cold will reduce performance
- **OVER** charging causes gassing, dry out & potentially, thermal runaway
- **UNDER** charging causes sulphation & loss of capacity

There are also two key things that will help extend a battery's end of life and efficiency. These are:

- **Monitoring** allows identification & replacement of weak batteries
- **Active Management systems** balance charging across batteries, preventing under/over charging and extending service life by up to 30%

With our extensive experience and knowledge of UPS and batteries, we know there are key requirements to ensuring efficient and longer-lasting systems. Batteries and UPS have different needs.

When considering the batteries required, you will need to carefully rate the system as this will affect size, weight and operating costs, regulations and end of life. Also depending on what power is needed, there may be other systems in place that need to be considered and included for backup. Check our flow diagram to see what you need to do for your battery autonomy and how this will comply with HTM 06-01 and BS 7671.



UPS, MIPS and EL inverter battery needs

UPS

- Generate heat and require cooling. Typically operating temp 0-40°C
- High airflow, very sensitive to dust
- High voltage components not exposed, door lockable
- Weight X00 kg
- Frequently placed with similar equipment

Battery

- Need stable temperature for performance / life, 20°C
- Small airflow (H_2), not generally dust sensitive
- Open rack has exposed high voltage terminals – must restrict access
- Weight X,000 kg
- Often best placed in dedicated room

System Maintenance and Planning

When looking at the design of a system, it's always worth looking at how easy it is to install and maintain it. A key consideration for the system installation and maintenance is where the UPS unit will be placed and how it will be monitored?

Will there be a:

- Monthly visual check?
- Daily visual check?
- Remote alarm signal?
- Battery Management System connection?
- Network and email connection?
- Remote monitoring by supplier?

UPS, MIPS and EL inverters

The location and environment of a UPS is critical, both in terms of performance and lifetime during regular operation and in terms of facilitating access for vital and life extending maintenance. Too often however UPS are poorly situated and maintenance access is compromised.

When thinking about your site and your system design therefore, consider the positioning of your UPS.

Ideally, the space needs to:

- Be clean, dry and dust free
- Have a controlled temperature
- Have fire protection
- Be vibration free
- Allow adequate air flow to the unit
- Meet the manufacturer's defined clearances for maintenance

Battery systems

You should consider the cabling and cabinet requirements for your set up for battery monitoring / management system. Make sure you think about the height and reach on the battery racks. Ideally, they should be in a single row or have front and rear access. And they should be checked regularly.

If you are not sure about your technical requirements, speak to us and we will have an initial call with you about the challenges you are facing. We can then come out and do a site survey and give you recommendations. With our experience, the Kohler team can also assist with risk assessments for critical power back up and emergency lighting – you will deal with one supplier, which can make your life easy – while ensuring consistency across your power backup solution.

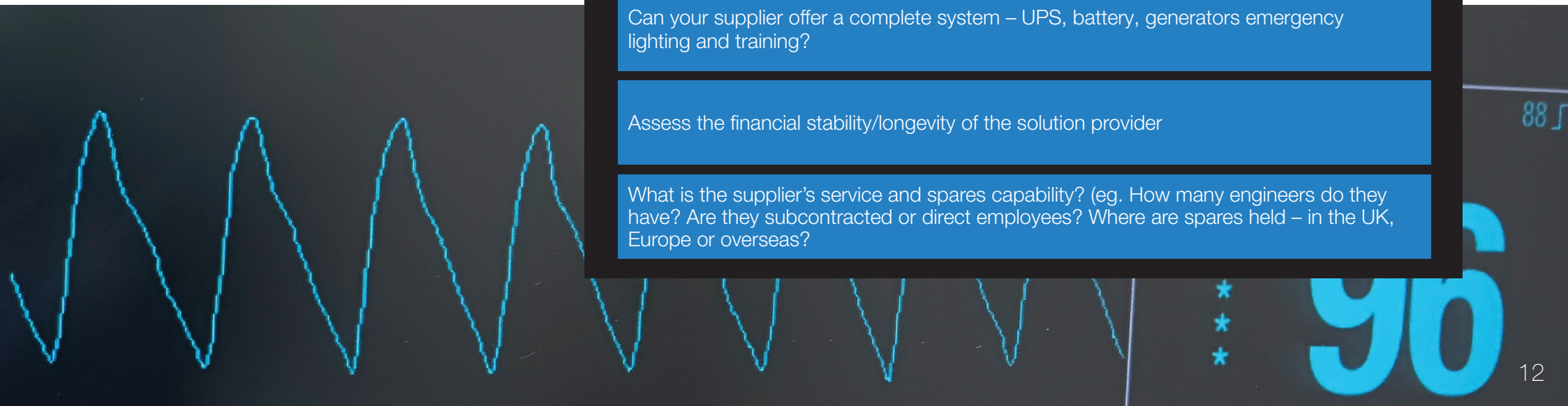
Questions to ask your supplier

Healthcare facility managers need to be informed to ensure the choices they make are right for ensuring mission-critical power backup – for today and for the future.

This means collaborating with suppliers and consultants who understand current and future challenges and who can make this decision-making process much simpler. In-depth knowledge, extensive experience as well as a comprehensive choice of solutions that will fit the data centre's specific needs should be considered. And this level of expertise must be continued throughout the life of the protected power installation, to meet the challenges of providing timely UPS, Medical IPS, generator and emergency lighting system maintenance and adapting to evolving site requirements.

If you are looking to update your critical power system, here are some considerations to ask your supplier.

- What is the basis of your supplier's claims for their equipment? Are they proven-in-field? Factory tested? Or extrapolated from technical research?
- What is the availability and historical on-time delivery performance?
- What are the running and maintenance costs of the solution?
- Can your supplier offer a complete system – UPS, battery, generators emergency lighting and training?
- Assess the financial stability/longevity of the solution provider
- What is the supplier's service and spares capability? (eg. How many engineers do they have? Are they subcontracted or direct employees? Where are spares held – in the UK, Europe or overseas?



Conclusion

As healthcare facilities and operating rooms rely heavily on continuous power and more advanced technology for patient care, it is crucial to have reliable power protection solutions in place. There are many considerations on the most suitable systems, how they are designed to work together – and integrated with other legacy equipment.

There are compliance requirements from HTM 06-01 and BS 7671 with regulation on the integration of UPS, IPS / medical IT and emergency lighting systems into the electrical infrastructure to ensure a well-designed, reliable and resilient system in a hospital or medical facility.

Certainly, with medical IT systems, there's no standard one size fits all solution. Facilities managers, healthcare engineers and system designers must evaluate Risk to Business continuity, fault clearance, batteries and options for location selecting a UPS. And that's not touching a system's carbon footprint, new installations or who on the team has the correct technical knowledge to hand.

Ensuring critical power and backup is covered – to keep patients safe and literally keep the lights on in medical facilities is a big ask. Collaborating with suppliers and consultants who understand current and future challenges and who can make this decision-making process much simpler are as important as the vital signs routinely monitored by medical professionals and health care providers.

Training

Kohler offers a series of CIBSE (Chartered Institution of Building Services Engineers) accredited CPD options including its new Healthcare focused Training Academy, which has been developed for healthcare estate engineers or design engineers who work with critical power within healthcare environments.

Aimed to explain the principal design aspects of uninterruptible power supplies (UPS) and secondary supplies discussed in HTM06-01 guidance, Kohler's new academy course looks at how the HTM06-01 regulation integrates a UPS into the electrical infrastructure to design a reliable and resilient system in a hospital or medical facility.

For groups of 12-14, Kohler will arrange to visit a Healthcare Trust to provide the training session on its site. Please contact us for more information.

Continuing Professional Development

Ideal for consultants and electrical engineers, Kohler Uninterruptible Power offers free technical seminars to keep you up to date with the latest power protection specification and selection requirements and the latest technology available. Check the website for future dates or email us at uksales.ups@kohler.com

KOHLER® | UNINTERRUPTIBLE POWER

Our range of UPS, IPS / medical IT systems, generators and emergency lighting products are ideally suited to healthcare applications, and we deliver to and support many of the largest NHS Trusts in the UK.

Clients include:

Aneurin Bevan University Health Board
Birmingham Children's Hospital
Cambridge University Hospital
Countess of Chester Hospital
Dorset County Hospital
Manchester Royal Infirmary
Newcastle Freeman Hospital
Royal Marsden Hospital
Sheffield Children's Hospital
St Mary's Hospital
St Thomas' Hospital
The Wessex Nuffield Hospital

Backed by Kohler Co.'s 100+ years of power protection experience and innovation, Kohler Uninterruptible Power is well resourced and well positioned to provide the necessary depth of advice and support. It provides expertise, remote support facilities and an extensive network of field service engineers offering fast 24/7 availability.

Contact us at uksales.ups@kohler.com or call Kohler on 0800 731 3269.

www.kohler-ups.co.uk