Portable Power Devices

John Taylor

There are few pieces of equipment that are common to virtually all healthcare facilities, but portable power devices or power strips (sometimes called portable power taps) are one of them. Whether it is in a hospital, surgery center, doctor’s office, or veterinarian’s office, power strips are pervasive as the expansion of electrical equipment continues. The eternal problem appears to be either that power is not available in the right place and/or that there are insufficient receptacles for the number of devices needed.

While everyone recognizes portable power devices, and almost everyone has at least one at home, there are significant differences between various types and the protection that they afford medical staff and patients. In particular, recent changes in Underwriters Laboratories (UL) standards mean that different products might be purchased in the future. To complicate matters further, different areas of medical facilities require different types of portable power devices.

Current Technology

Current portable power devices can be classified into a number of types, primarily power strips, uninterruptible power supplies, and isolation transformers.

Power Strips

Power strips are the most common type of portable power device. They consist of a plastic or metal enclosure and a number of receptacles. Most power strips also include a cord with a plug, a power indicator, and a circuit breaker. An example of a typical general purpose (non-medical) power strip is shown in Figure 1.

The features of medical power strips that are generally important to users include the number of receptacles, the standards to which they are certified (and thus the uses and locations for which they are suitable—see below), and special features that make their use particularly easy. Figure 2 shows an example of a UL 1363A power strip specifically designed to attach to an IV pole.

Power strips may also include surge suppression, but this is not commonly found on medical-grade devices. Medical power strips usually include either wiring fault protection (primarily protecting against building wiring faults where line and neutral are reversed) or circuit breakers on both line and neutral.

Uninterruptible Power Supplies

Uninterruptible power supplies (UPS) are devices that contain battery backups that automatically connect if line power is lost. Since all general and critical care areas are required by the National Electrical Code (NEC) to have at least two circuits from the normal and emergency power systems, UPS systems are not particularly common.

Isolated Power Systems

The wet procedure locations defined in the NEC have special requirements to protect particularly vulnerable patients from electrical shock or excessive patient touch currents. In particular, they are required to have either a ground fault circuit interrupter (GFCI) protection or isolated power. GFCI devices disconnect power when a fault condition causes a significant current to flow to ground. Isolated power devices use isolation transformers to isolate the patient from currents flowing to ground.

Isolated power devices are relatively large compared to medical-grade power strips—about two to four times bigger and five to 10 times heavier—and they become fairly warm when in use (up to 50–60°C). Isolated power
Portable power devices for use in wet procedure locations within medical facilities are currently limited to isolated power. While isolated power systems are typically part of the fixed electrical systems within a medical facility, the opportunity to further improve electrical safety, particularly with respect to patient touch current, exists with isolation transformer devices local to the wet procedure locations.

While GFCIs are a possible alternative to isolation transformer systems, the systems currently available are not of the type required by the 60601-1 standards; should GFCIs become available that comply with these standards, they could become a very attractive alternative to isolation transformer systems for wet procedure locations where disconnection under fault conditions is acceptable.

For all portable power devices, ease of use is an important factor, and the engineering of innovative designs that ease the installation and use of all types of portable power devices is likely to continue.

Training and Equipment
Training is a key factor for all UL-recognized components as they only become safe as part of a larger system. In the case of portable power devices, the power strip and all the devices connected to it become the medical electrical system and it is the responsibility of the clinical engineer and biomedical equipment technician to ensure that the whole system is safe and meets the requirements of 60601-1, NEC, and other applicable guidelines.

Once the system has been put in service, regular maintenance is also important to ensure continuing patient safety, particularly in regard to patient touch current and other shock hazards. An excellent source of guidance in these areas is the AAMI 2008 Electrical Safety Manual.

Future Developments
The future of medical power strips rests with UL 1363A certified devices. Along with these types of recognized components is the need for comprehensive programs at medical facilities to ensure that these devices are used in patient care areas and that installation and maintenance programs ensure continued patient safety. The availability of power strips designed and certified to a standard/subject specifically for medical power strips makes the decision process much simpler than when power strips were certified to 60601-1 and other standards that were either not medical specific or not solely for power strips.

Current Regulations and Standards
The National Electrical Code defines the basic electrical safety systems required and Article 517 describes in detail special requirements for healthcare facilities. While the NEC defines requirements for building wiring and electrical systems, these will not be discussed here. The code, which has been adopted in virtually every locality in the United States, is enforced by federal, state, and local inspectors, primarily code inspectors. It also forms the basis of most regulatory requirements, including those of the Joint Commission. Other regulatory standards include the Standard for Health Care Facilities and the Life Safety Code.

While the NEC and similar documents set the standards that are required of healthcare facilities, the standards to which electrical and electronic products are tested are set by national bodies, such as the American National Standard Institution, international bodies such as the International Electrotechnical Commission, or nonprofit standards bodies such as UL or AAMI.

The requirements of different patient care areas (see sidebar) can be different. For areas where patients will not normally be present, such as a doctor’s private office or a nurse’s lounge, the requirements are to use listed devices. For general care areas, devices listed for medical use should be used and there must be a total of four receptacles available. For critical care areas, devices...
listed for medical use should be used, there must be a to- tal of six receptacles available, and isolated power may be used. For wet locations, either GFCIs or isolated power systems must be used (depending on the acceptability of power interruption).

In the case of portable power devices, the standards that are of interest include the various international and national versions of the 60601-1 standard (IEC 60601-1, ANSI/AAMI ES60601-1:2005, UL 60601-1) and various UL standards for portable power devices, such as UL 1363, UL 1363A, and UL962A.

**60601-1 Medical Electrical Equipment Standards**
The international standard for the safety of medical electronic equipment is IEC 60601-1 which is now in the third edition. There is an ANSI/AAMI version of this standard, also in the third edition, which is the same except for a very few national differences, which are mainly related to the NEC and National Fire Protection Association (NFPA) 99. UL60601-1 is in its first edition and is based on the second edition of IEC 60601-1; thus, there are significant differences between the current IEC and UL versions of 60601-1 (these are detailed in a separate 30-page UL document). There is also a publication from AAMI that details the differences between the second and third editions of the IEC standard. 60601-1 is a very long, detailed document that deals with all aspects of electrical safety for all types of medical electronic equipment; the parts that are relevant for portable power devices are those dealing with general construction requirements, enclosure and component maximum temperatures, case strength, and electrical safety (component separation and overload tests).

**U.S. Standards for Power Strips**
In the United States, UL has published a number of standards for relocatable power taps (their term for portable power strips), including a general standard, UL 1363. Until late 2006, UL was testing general purpose portable power devices to UL 1363, devices for attachment to furniture to UL 962A, and medical use devices to UL 60601-1. In late 2006, UL published UL 1363A, an outline of investigation that it now uses to test portable power devices designed, and then certified, for use in patient care areas. UL 1363A details tests in both UL 1363 and UL 60601-1 that must be passed to receive recognition under UL 1363A. UL no longer certifies medical power taps to 60601-1 or any other standard, but only to 1363A.

To be considered listed for purposes of the NEC, a product must be certified by a Nationally Recognized Testing Laboratory (NRTL), which are approved by the Occupational Safety and Administration (OSHA). There are currently 17 NRTLs, including such well-known names as UL, MET Laboratories, the Canadian Standards Association (CSA), and TÜV Rheinland. All the NRTLs maintain databases on their websites that list all certified products, although some are easier to use than others.

This is a good point to discuss the differences in certification by UL and other certifying bodies and between listed products and recognized components. A listed product is one that is certified for its intended use as sold. A recognized device is one that is certified to be used as part of a larger system. In the case of portable power devices, UL 1363A recognition is certification that the product has been tested to UL 1363A and can be built into a larger medical electronics system by a trained and competent person. For example, a biomedical equipment technician or clinical engineer could assemble a system consisting of a portable power device with a number of patient monitors or IV pumps plugged into it, test such a

**Patient Care Areas**
One important definition in the NEC is that of patient care areas. “General care areas” are places where patients receive general medical treatment and include bedrooms, examining rooms, treatment rooms, clinics, and similar areas where patients will come in contact with ordinary appliances. “Critical care areas” are places where patients undergo invasive procedures and include special care units, intensive care units, coronary care units, angiography laboratories, cardiac catheterization laboratories, delivery rooms, operating rooms, and similar areas where patients will be connected to line-powered medical devices. There is also a definition of “wet procedure locations,” which are places where there are either standing fluids on the floor or fluids drenching the work area and that these are “intimate” to either the patient or staff. “Patient care vicinity” is the space with surfaces that patients, or attendants who can touch patients, are likely to touch. In a patient room, this is typically an area six feet beyond the perimeter of the bed.
Portable Power Devices

system for electrical safety, and then deploy it for use in patient care areas.

Since the introduction of UL 1363A, UL (the best known of the NRTLs) has announced that it will no longer certify medical related portable power taps (the UL term for power strips) to any standard/outline other than UL 1363A (the guide for UL 1363 now explicitly states that it is not suitable for certifying products for general or critical care areas). The process for manufacturers of power strips to negotiate new standards and subjects is difficult as evidenced by the fact that, at the date of writing this article, only one device has been certified to UL 1363A.

Resources
Underwriters Laboratory (UL), www.ul.com.


John Taylor holds a BS in materials engineering from the University of Aston (UK) and a PhD in metallurgy and materials from the University of Birmingham (UK). He also completed an executive program at the University of California, San Diego. He is currently director of engineering, QA, and regulatory at AIV, a developer and manufacturer of medical devices and portable power devices. He has over 25 years experience of developing products and technologies for the medical device, aerospace, and automotive industries.

The Fundamental Collection

Features 34 detailed articles that explore the fundamentals of:
- Diagnostic Ultrasound
- Infant Incubators
- Smart Pump Technology
- Computed Radiography
- Robotic Surgical Systems
- Computed Tomography
- Ultrasound Equipment
- Magnetic Resonance Imaging
- Batteries
- Acoustic Stethoscopes
- Endoscopes
- Indoor Positioning Systems
- Electrocardiograms
- And much more!

These practical articles—many were first published in AAMI’s journal—provide essential information and guidance on device technology, management and maintenance of devices, troubleshooting, and training and service requirements. Articles also include questions to test a reader’s knowledge. Conveniently packaged on one CD.

List price: $125 | AAMI member price: $75 | Order code: FUND | Source code: HI
To order, call (877) 249-8226 or visit http://marketplace.aami.org.