FACILITY CARE

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The Evolution of UPS Protection for Diagnostic Imaging Applications

Part One in a Two-Part Series by Tom Stryker

Power anomalies, and their consequences, are not new challenges for healthcare facilities. And the results of external and internal power anomalies are no less dangerous today than in years past: accumulative component damage, downtime during invasive and non-invasive procedures, patient rescheduling issues, high equipment repair costs, increased liability and lost revenue.

Common causes of power problems include aging utility distribution, new electronic devices that solve one problem while creating others, grid switching, power factor correction, accidents (such as a car hitting a pole), electrical equipment failures, weather, or the proverbial 3-foot squirrel. Monthly generator testing can add to imaging equipment problems. And newer digital equipment is also more susceptible to power-related problems.

These issues should no longer be acceptable in the world of diagnostic imaging. But the medical equipment vendor's first reaction to an equipment problem can, in some cases, cause further problems. Evidence of equipment issues is often followed by the installation of a power quality meter in order to create a case for uninterruptable power supply (UPS) protection.

Although UPS installations are becoming more normal today, it is still common for medical equipment vendors to promote UPS systems late in the buying cycle. This approach leads customers to purchase individual UPS for a given modality, which leads to problems finding available space. The solution to this problem often is the purchase of a partial UPS — such as a Fluoro UPS for a cath lab — due its smaller footprint. Partial UPS systems protect the data, and provide table operation (when necessary) and Fluoro operation (when necessary). However, these partial UPS systems do not protect the X-ray generator or gradient amplifier (MRI) — the heart and soul of imaging equipment.

Is there a better way? You bet there is! Let's first look back at recent history and then look forward to a panacea for the future.

The Power Conditioners of Days Past

Ten years ago it was common to install power conditioners to protect miscellaneous pieces of imaging equipment. At that point-in-time, the MRI was probably the most protected device in radiology due to a lower tolerance of power problems. It was very uncommon to install UPS protection for diagnostic imaging equipment. UPS systems required dramatic oversizing in order to support the peak momentary current demands of the radiology, cardiology and oncology modalities. Even with oversizing, older UPS systems could not maintain reasonable voltage regulation. This oversizing requirement also led to the manufacture of large, costly UPS systems that were commonly avoided.

Ten years ago it was uncommon to support most radiology and cardiology equipment on the emergency generator. One or two cardiology labs might be powered from the critical power branch within the hospital, while the remaining labs might be placed onto the normal (non-essential) branch of power distribution. In a few facilities, most or all of the cardiology labs were placed on the emergency power circuit backed by the generator. At that time, the interpretation of national codes was that some percentage of labs required protection from the emergency generator critical branch.

The Move to Higher Voltage

Over the last 10 years, the use of UPS systems to protect

radiology and cardiology imaging equipment against power outages has risen. It has become very common practice to support all cardiology and IR labs on the critical branch of the emergency generator. This ensures that the cardiologist or interventional radiologist can properly guide the catheter through the arteries, heart or brain. But, this process requires unique characteristics from a UPS system.

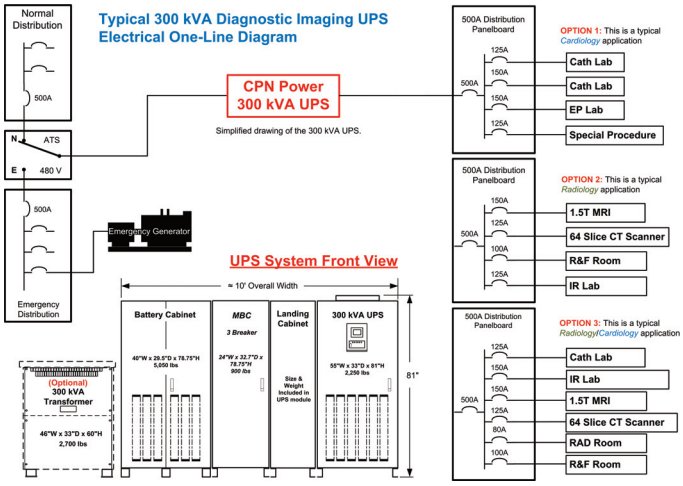
To begin with, these procedures generally take several hours. The Fluoro mode of the cardiology lab allows the cardiologist to see the catheter position within the arteries or vascular circulatory system using a low-resolution, low energy Fluoro image. This image enables the cardiologist to properly maneuver the catheter through the vascular network. A coronary angiogram is a common procedure that checks for blockages in the arteries by injecting dye through the catheter and utilizing the Fluoro mode of the X-ray generator to find those potential blockages. The Fluoro mode would also be used when placing a stent in a narrowed artery in order to open up the restriction to improve blood flow.

Occasionally, a higher resolution image is required to better view a particular area of interest, such as narrowing or blockage in the arteries. Cine is the industry term used to describe high dose rapid sequencing of the X-ray generator to capture continuous high resolution images. Full power operation of the X-ray generator is required in order to capture this high-resolution image. It is common to capture high-resolution images multiple times during a given procedure. The high-resolution image requires a tremendous amount of power for a very short period of time, namely 100-200 kVA for 16 milliseconds (one cycle). The power requirements vary depending on the medical equipment manufacturer, the X-ray tube power rating and the amount of energy required to penetrate the body and obtain a high-resolution image.

The goal in imaging applications is to maintain tight voltage regulation to ensure high image quality. After all, it is all about image quality. But, as mentioned previously, older UPS systems had to be over-sized in order to support this peak momentary power demand. Those older systems were not capable of maintaining tight voltage regulation during these non-linear load events. Today, however, some UPS systems can achieve +1 percent voltage regulation during these peak momentary events.

All UPS Systems Are Not Created Equal

Most UPS systems on the market were actually designed for data center applications. A data center has a very flat load profile. Medical imaging applications have regular, very high, short duration current peaks. During high current peaks, it is more difficult for the UPS system to maintain tight voltage regulation. Remember, most of these high peak current events are very short time duration events (16 milliseconds). The UPS system must be able to sample, send a signal and



create a change in a really quick time period in order to maintain tight voltage regulation during these events. Most UPS Systems on the market today only maintain 5 percent voltage regulation at best when capturing a high-resolution image on cath labs, CT scanners, MRI and most modalities.

Per NEC Article 517.33(A.8), cath and angio labs require emergency system power for task illumination, selected receptacles and selected power circuits. Although this statement leaves room for interpretation, it is usual practice today to support most, if not all, cardiology and interventional radiology labs on the emergency generator distribution. Some states, such as California, are moving toward a mandate that requires invasive procedures, such as those performed in cardiology labs, to be protected by the emergency circuit and must ensure continued operation of the lab. Placing the lab on the emergency generator without a UPS does not meet this requirement. When a power outage occurs, it takes 10 seconds for the emergency generator to deliver power to the lab — so the lab has already shut down as a result of the power outage. Most labs on the market today require approximately 8 to 10 minutes to reboot, assuming everything goes as planned. That time period is just too long for many procedures, especially heart and neurovascular cases, and the results, if not fatal, can invite legal action.

With this understanding of the problems invited by UPS systems in the past, in the second part of this article we'll turn to solutions for today's applications.

About the Author

Tom Stryker is vice president of sales and marketing for CPN Power. Stryker has specialized in power protection equipment and HVAC equipment for data, communication, industrial and medical applications for the past 30 years. For the past 12 years, Stryker has worked in partnership with Joe Briere to provide power quality studies and power protection equipment specific to medical equipment applications. CPN Power pioneered the central UPS approach more than a decade ago. Stryker can be contacted at tstryker@cpnpower.com.

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In part one of this series, we discussed some of the challenges faced in the past decade when installing partial uninterruptable power supply (UPS) systems as a solution to energy problems. Today, it is much more common to provide a complete UPS system that protects the entire suite. The UPS also is required to protect the control room computers, hemodynamic monitoring systems, power injectors and other critical loads in the suite that also require uptime during an outage. Rather than supporting just one suite, today's approach takes advantage of the great load diversity associated with diagnostic imaging applications.

A central UPS is a much more effective solution for many installations. Whether protecting two, 10 or 50 suites, the central UPS approach offers dramatic cost and space savings. The central UPS provides protection for all modalities, ensuring more reliable operation and reducing long-term accumulative component damage. The central UPS also provides flexibility for the future.

Further benefits of a central UPS versus multiple individual UPS systems include the following:

- Lower initial cost of power protection equipment and installation.
- Reduced floor space requirements of power protection equipment.
- Lower cost of air conditioning equipment and installation.
- Lower cost of power protection equipment maintenance.
- Lower cost of operation due to much higher energy efficiency.
- Lower cost of battery replacement.
- System sizing to allow for future modalities.
- Protection for the entire suite, not just partial protection of fluoro mode or the CT table/gantry.
- Lower medical equipment service costs due to complete protection from all power problems.

Applying the appropriate UPS initially ensures that the imaging equipment will be properly protected for the next 15 years of operation.

Designing for a Central System

Five years ago, a project with a total of 10 major suites might consider UPS protection for only two, or possibly three, of the 10 total suites. In that era, it was common for the medical equipment vendor to provide individual UPS systems on a per-modality basis.

Today, hospital design teams, MEP consulting engineers, architects, and medical equipment planners often design around UPS support for 70 to 90 percent of diagnostic imaging equipment in radiology, cardiology, nuclear medicine and emergency departments. Nowadays, a project similar to the one mentioned above would likely have more suites, perhaps 12 or 13, and would require UPS protection for at least nine or 10 of those suites. It no longer makes sense to protect 10 suites with individual UPS systems. In most cases, a central UPS protecting 10 suites will in fact protect 12 or 14 suites. This is due to the great load diversity with diagnostic imaging equipment.

It has also become common to protect MRI and CT applications with complete UPS protection. These modalities are more complex today, as are the imaging procedures performed there. Downtime due to damaged gradient amplifiers on an MRI can result in several days to a week without

use of the MRI to scan patients — not to mention the high cost of the repair if not covered under the maintenance contract.

Nuclear medicine applications will sometimes apply a small UPS to ensure continued operation during a typical 20-to-60-minute exam. These scans require patients to swallow small amounts of radioactive material to assist with a diagnosis. Because the scans make use of radioactive materials, the preference is to ensure that the scan is properly completed without interruption, to avoid requiring the patient to undergo the procedure a second time. When a central UPS is applied, it is routine to support the nuclear medicine cameras.

Even general rad rooms that once had analog devices have moved into the digital realm. Digital rad rooms are much more susceptible to power problems resulting in equipment problems. Therefore, it has become standard practice to protect digital rad and R/F rooms in the hospital today. There is also a trend toward providing UPS protection for all imaging modalities in the emergency department. CT scanners, rad rooms and R/F rooms are the most frequently protected.

Selecting a System

The size of the UPS system needed to support the modalities requiring protection will vary. A 225 kVA UPS can commonly protect two suites. A 500 kVA UPS can commonly support 12 or more suites. Larger or parallel UPS systems can support even greater numbers of imaging suites. Though parallel-redundant systems can be applied in diagnostic imaging central UPS applications, it is far more common to apply one central UPS to support multiple modalities and multiple vendors.

Installing a central UPS is a big leap for most healthcare facilities. Designing a parallel-redundant system can drive the cost to a level that results in value-engineering the UPS completely out of the project scope. With that said, larger installations involving 20, 30 or 40 imaging suites might be best served with a parallel-redundant UPS system. The design team needs to evaluate the best solution per the given customer needs and project budget.

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