Over the years, Rush University Medical Center has expanded many times to meet the needs of a steadily growing patient population. Along with each new floor or building came a new generator or generators to supply the necessary backup power. Finally, in the mid-1990s, small expansion steps gave way to a master plan for a major renovation of the Rush campus. The master plan called for the construction of a new 14-story hospital, as well as a number of other medical treatment facilities, an office building, and a parking garage.

First, though, Rush would build a central energy plant to house the major equipment that would supply backup power to all of the new facilities within 10 seconds of a utility outage in order to meet code requirements. This would be no easy task. In some cases, power from the plant would have to reach life-safety equipment in buildings up to four blocks away. Today, however, the plant is delivering critical power in time wherever it’s needed, thanks in part to state-of-the-art generators, controllers, and transfer switches from MTU Onsite Energy.

Backup system put in place
Much of the backup power equipment in the central energy plant was supplied by MTU Onsite Energy distributor, Inland Power Group. Key Inland-supplied components of the standby power system include six 2,000 kW generator sets that operate at 12 kV. Each of these three-phase units is equipped with a DGC-2020 digital controller that relays start and stop commands from the switchgear to the generator. Inland also supplied the paralleling and transfer switchgear, all housed in the central plant. Outside the central plant, automatic transfer switches from MTU Onsite Energy help to distribute backup power to loads within in the buildings on the campus.

Rush’s electric power is provided by Commonwealth Edison Co. Illinois code requires at least two utility feeds into each hospital building, according to Mike Craig, electrical and electronics manager at Rush. Some buildings on the campus have as many as five ComEd feeds, Craig reported.

// Who: Rush University Medical Center
// What: Six MTU Onsite Energy 16 V Series 4000 2,000 kW generator sets with automatic transfer switches and paralleling switchgear
// Where: Chicago, Illinois, USA
The medical center’s emergency power system includes six 2,000 kW generator sets from MTU Onsite Energy.

“Still, standby generator power plays a vital role at the medical center. “We need a backup power source to ensure that the operating rooms, life-support systems, monitoring equipment, and anything else that keeps patients alive and safe will operate if utility power is lost,” Craig explained.

Rush chooses equipment, supplier
The project to supply this new emergency standby power equipment went out to bid in 2007. At that time, there were no MTU Onsite Energy generators on the Rush campus. But after considering equipment made by companies that had supplied Rush with generators in the past, Craig and his colleagues decided to go in a different direction. “When we looked at cost and reliability of the generator sets, and at the companies themselves, MTU won out,” Craig said.

One reason for the decision was changing EPA emissions requirements. The generators specified by one company under consideration couldn’t meet the more stringent emissions requirements of an anticipated EPA ruling. “We wanted to make sure that once a new rule was put in place, the gensets would be compliant,” Craig said. The MTU Onsite Energy units chosen for the job meet EPA Tier 2 emissions requirements, according to Scott Sell, an Inland product support manager.

In addition, Craig and his colleagues were swayed by their comfort level with the equipment suppliers. “Knowing Inland and what we were going to get in terms of support, gave us a good feeling to go down that road,” Craig said.

Designing with distribution in mind
Craig worked on the design of the standby power system with Environmental Systems Design Inc., a Chicago-based engineering firm. In the process, one of his main goals was to come up with a fully redundant system. “One thing I’ve learned in my career is that the biggest issue is always distribution,” he said. “You can put as much power in as you want, but without the proper distribution there’s going to be a problem.”

To prevent major power-distribution problems, the Rush system has separate A and B feeds going into each building. “So if someone is digging in a parking lot and knocks out my A side, I still have power on my B side,” Craig noted.

Each of the two sides of the system includes three generator sets and its own paralleling switchgear. Both sides feed 16, 12 kV substations scattered throughout the campus, which in turn supply power to the buildings via two separate feeds. This ensures that the equipment in each building will be powered by at least one of the two sides of the system.

However, the buses for the two separate sides are also connected, Craig noted. So instead of two buses with three generators feeding each one, this allows the creation of a single bus with six generators. “So if one of the generators goes down, I’m not down to two on one side. I have five standby generators feeding the bus to supply what I need,” Craig explained.

According to Craig, tying the two buses together improves the stability of the power and frequency going out to the 16 substations on campus. It also helps Rush meet code requirements for rapid and reliable startup of critical equipment following a utility power failure.
Backup system in action
When utility power is lost, the paralleling switchgear starts all six generators at once. At this point, the buses are separated, with three generators on the A side and three on the B side. The first generator on each side that reaches the proper speed and frequency closes to its respective bus. These generators feed the substations that supply power to critical life-safety equipment, which must be up and running in less than 10 seconds to meet code requirements.

Shortly after the first two generators stabilize, the other generators on each side reach the proper speed and frequency and close to their respective buses. Once the generators on both sides are synchronized, the breakers between the A and B buses close, creating a single bus that feeds power to critical and noncritical equipment. To prevent the generators from seeing large transients, the automatic transfer switches linked to noncritical equipment start closing in 5-second increments in a predetermined order of priority. It takes about a minute and a half until the lowest-priority automatic transfer switch closes, at which point emergency power is flowing to all equipment in the buildings served by the system.

If the paralleling switchgear goes down or some other mishap occurs on one side of the system while backup power is flowing, the circuit breakers between the two sides will open again to create two independent buses, one of which is unaffected by the mishap. To understand why this is beneficial, consider a building with two air handlers, one powered by the A side of the backup power system and other by the B side. If the A side goes down, the air handler on the B side will still be working and patient care can still be maintained at a level that meets minimum code requirements.

When utility power is restored, automatic transfer switches disconnect emergency power in reverse order from the sequence in which they received power, with the lowest-priority switch coming off first, followed by the next lowest, etc. Once the critical life-safety transfer switches are off emergency power, the generator sets go into a cool-down mode for 5 to 10 minutes and then shut down.

Steps for system upkeep
Due to its importance, the emergency standby power system must be exercised regularly. Rush personnel run the generators for about an hour each week to meet Chicago and Illinois code requirements, according to Sell.

In addition, Inland does a system test of all six generators on a yearly basis, using a load-bank instead of the actual building loads. Sell describes this as a full-blown test to make sure the units are in good working order and capable of operating at full power. While the generators are running, technicians check them any problems.

While performing maintenance on the generators, service technicians use the DGC-2020 controllers. Among other things, the controllers start and stop the generators, reset parameters, and provide data readouts to the technicians. The controllers give service personnel detailed information about generator operation, according to Sell.
Meeting the needs of a changing campus
Inland personnel handled the startup and commissioning. As the first of the new buildings to be constructed as part of Rush’s multi-year renovation project, the plant also supplies steam and chilled water to other campus facilities.

In addition to providing backup power for its own operations, the new plant will soon be serving seven other buildings, with a total load of about 4.5 MW. These buildings include the new 376-bed East Tower hospital, which opened in January 2012. The old hospital building will be used for a different purpose once all of its functions are transferred to the new facility.

Over time, the old hospital building and most of the others on campus will be added to the list of facilities served by the central energy plant. Within 10 years, Craig expects the plant to provide backup power to 16 of the 18 Rush buildings. As the transition unfolds, new automatic transfer switches will be added to the backup power system and most of the old standby generators scattered across the Rush campus will be decommissioned.

Capable of a maximum power output of 12 MW, the central energy plant can greatly expand its reach as it’s presently equipped. In addition, there’s room in the plant for four more generators of the same size as its current units, giving it a total future capacity of 20 MW.

So far, at least, Craig has reasons to be satisfied with Rush’s new backup power system. “When we’ve had minor utility outages, it has worked flawlessly,” he said. “It does exactly what it’s supposed to do, and we get exactly what we need.”

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MTU Onsite Energy is a brand of Rolls-Royce Power Systems AG. It provides diesel and gas-based power system solutions: from mission-critical to standby power to continuous power, heating and cooling. MTU Onsite Energy power systems are based on diesel engines with up to 3,400 kilowatts (kW) power output, gas engines up to 2,150 kW and gas turbines up to 50,000 kW.