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Generator Sizing Pitfalls How to Avoid Costly Mistakes

“Generator Sizing Pitfalls,” a program in Generac’s Professional Development Seminar Series, focuses on identifying and avoiding typical generator sizing mistakes. When it comes to generator sizing, the discussion can focus on sizing an entire facility or on a specific type of concentrated load. The majority of this training module focuses on the particulars of specific types of problematic loads: motors, soft starters, variable frequency drives, various non-linear loads and uninterruptible power supplies (UPS).

Gensets are composed of an engine and alternator. The engine is the source of the power and determines the genset’s frequency response while the alternator is the power converter and determines the system’s voltage response. When an electric motor load is started, a significant transient occurs on the generator system. The effects of motors and various motor starting methods are discussed within this module with the goal of providing a deeper understanding, rules of thumb and help in avoiding potential problems.

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The genset's alternator is a relatively clean power source, but when applied to loads with high harmonic content, the alternator's voltage may become significantly compromised with harmonic voltage distortion. Controlling harmonic voltage distortion levels while operating on the generator is critical to proper generator sizing. If the voltage distortion is too great, the loads may have problems operating correctly. To avoid this issue, various rules of thumb are discussed and the importance of utilizing sizing tools that perform harmonic analysis is explored.

When it comes to UPS sizing, everyone has an opinion about some magic multiplier for generator/UPS compatibility; but there isn't one multiplier that works everywhere. Some applications work perfectly fine at 1-to-1 and other applications have need to be sized 5-to-1. The secret to UPS sizing is some basic understanding and probing questions:

What are the UPS topology/type and input tolerances?

What are the UPS harmonic levels? Are they filtered or not?

Is the HVAC system backed up with the generator?

What are the power factor rating and charge rates?

Generators also have a limited range of operational power factor. If the power factor is leading (capacitive), the alternator has the possibility to self-excite with the result being an over-voltage shutdown.

Typically, engineers rely heavily on manufacturer generator sizing programs, but too often these programs don't incorporate the necessary input data for many of today's more difficult loads. Engineers also tend to rely on simple multipliers versus performing a harmonic analysis when sizing non-linear loads and can unrealistically assume that all the loads are operating simultaneously. This provides little flexibility to model natural load sequencing.



Engineers apply principles learned in Generac's Generator Sizing Pitfalls seminar.

Generally, the problems with correct sizing and generator application involves limiting the generator's transients (voltage and frequency dips) and load-induced harmonic voltage distortion to levels that are acceptable to the loads. "Generator Sizing Pitfalls" focuses on these criteria while evaluating motors, soft starters, variable frequency drives, various non-linear loads and UPS. This class also looks at issues relative to sizing entire facilities and limitations in utilizing generator sizing programs.

For more information on Generac's Professional Development Seminar Series, please contact your Generac Industrial Dealer. To find a dealer near you, please visit www.generac.com or call 888-GENERAC.

E2E: Code Talk

In May, Generac sponsored its first annual Engineering Symposium which drew a crowd of some 150 engineers from across the U.S. During the forum, we solicited timely questions from engineers. In this new column – E2E (Engineer-2-Engineer) – our technical engineers will answer these questions. Our topic this issue: Code Talk.

Q. Please explain Generac's compliance with JCAHO Sentinel Alert EC.7.40 (in conjunction with NFPA 11). What does code (NEC, NFPA) stipulate about limiting the amount of time a generator can be off-line when providing critical load for service (is there a number of hours)?

A. The [JCAHO Sentinel Alert](#) (U.S. Joint Committee on Accreditation of Healthcare Organizations) recognizes the real-world reality that extended outages do occur and equipment does fail. This also matches the intent behind [NEC 708 "Critical Operation Power Systems."](#) Both of these documents confirm that Generac's integrated paralleling and bi-fuel technology address the market issues of equipment reliability and extended run time operation. Though the NFPA standard does not specifically provide a firm time requirement, [NFPA 110.8.1.2](#) states, "Consideration shall be given to temporarily providing a portable or alternate source whenever the emergency generator is out of service." Generac's Modular Power System meets this requirement by providing constant backup power to the emergency system loads through generator redundancy as suggested by [JCAHO Issue 37](#).

Doctors Hospital at Renaissance Weathers Outages Thanks to Modular Power System

Since opening its doors in 1997, Doctors Hospital at Renaissance (DHR), Edinburg, Texas, has grown to be one of the premier healthcare providers in the nation. For the past two years DHR has been placed on the list of the list of 100 Top Hospitals in the nation by Thomson Reuters, a major source of independent healthcare business intelligence. The 100 Top Hospitals award is based on three measures of hospital performance: clinical excellence, operating efficiency and financial health, and responsiveness to the community.

Beginning as an outpatient surgical center, DHR today is a huge, 90-acre medical complex – an east and west campus on both sides of a major highway in downtown Edinburg. The complex includes seven different medical centers (a total of one million square feet), three central cooling plants, and a 506-bed, full-service-care facility with a medical staff of over 500 physicians. DHR today provides a broad spectrum of medical and surgical services, including intensive care, obstetrics, day surgery, skilled nursing care, outpatient diagnostic services, cardiology services, bariatric services, oncology services, behavioral and emergency services.

Backup Power Needed for New Women's Hospital

In 2008, a 200,000-square-foot, 105-bed Woman's Hospital at Renaissance was added to the east campus. The facility provides 24 labor and delivery suites, 24 post-surgical patient suites, 48 post-partum suites, a 36-bed newborn nursery, a 28-bed neo-natal Intensive Care Unit, five surgical suites and 14 medical beds.

Like every hospital, DHR is required to have reliable backup power to protect the life and safety of its patients in the event of severe weather or a utility power outage. For the first 10 years of operation, the hospital's planning team relied on the traditional solution for backup power generators – large single-engine units for hospitals and chiller plants. As the DHR expansion began to evolve, the DHR facility managers consulted with a team of MEP design engineers from GPM Engineering, Corpus Christi, Texas.

Introducing DHR to Modular Power Systems

GPM's project manager for DHR was a third-generation master electrician named Randall Eulenfeld. In 2003, during a major growth period at the hospital, GPM was visited by a sales team from Generac® Power Systems, Waukesha, Wisc., and Generac's industrial dealer, WPI (Waukesha-Pearce Industries), San Antonio, Texas. The team came to introduce GPM to Generac's Modular Power System (MPS) – an integrated approach to generator paralleling that is more cost effective than traditional paralleling systems or most large single gensets. The MPS advantages could provide the growing DHR complex with redundancy, flexibility and scalability in a modular type paralleling system.

Eulenfeld recalls being concerned by relying on large single-engine units due to the hospital's rapid development. In



At Doctors Hospital, Generac's modular platform kept all critical systems operating for 13 straight days.

the case of single-engine failure, he knew there would be no redundancy and thus, no standby power for a hospital unit or chiller. That was unthinkable, so Eulenfeld accepted a Generac invitation to visit the Generac factories in Wisconsin to see the MPS equipment and engineering first hand. "It was a revelation; the best thing since sliced bread," Eulenfeld said. "I had to have this system for the next DHR expansion project."

Modular Power Systems vs. the Single Engine

Eulenfeld and his team liked the fact that Generac's MPS combines the output of multiple generators without the need for expensive and space-consuming paralleling switchgear. Redundancy and expandability is built into the system since each genset features onboard paralleling capabilities, making it easy to achieve $n + 1$ or greater coverage by simply adding modular generators of the appropriate size. The

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MPS solution is also scalable, allowing kilowatt (kW) outputs to be tailored more precisely to current and future requirements.

In 2006, DHR came to Eulenfeld with plans for the new Women's Center. It was the perfect occasion to introduce Generac's MPS technology to the growing campus. GPM Engineers joined forces with WPI to install the first MPS system – 6 x 750 kW Gemini® generators (4,500 kW capacity) in April 2007. Because of the generator's flexibility (system outputs from 100 to 9,000 kW), modularity, ease of installation and shorter lead times for delivery than large single-engine solutions (between 12 to 18 months), it wasn't long before Generac's MPS gensets became the backup power solution of choice.

Just in time for the construction of the new Women's Hospital in 2007, Generac brought to market its new Bi-Fuel™ generator – combining diesel fuel (30 percent) with natural gas (70 percent) in configurations of 600 to 9,000 kW of power. Because of the reduced consumption of diesel fuel, run times per tank would be significantly extended. John Rustick, DHR's associate administrator and director of engineering, ordered 12 Bi-Fuel generators – two sets of 3 X 750 kW Gemini Bi-Fuel gensets – 4,500 kW of backup power for the new Women's Hospital and adjacent central cooling plant.

MPS Put to the Test

Packing winds with gusts over 100 miles per hour, Hurricane Dolly came roaring ashore at Padre Island, Texas, on Wednesday morning, July 23, 2008. Causing over one billion dollars worth of damage, the Category 1 storm dumped 16 inches of rain on the Rio Grande Valley and more than 212,000 customers lost power. It was to be the first real test for Rustick's new investment in standby

power. "The Generac engines whirled into action instantly and kept us operating for 14 hours before we got power restored. Not a single venue on campus was without power," Rustick remarked. "The Generac equipment performed perfectly."

It wasn't 60 days later that Rustick and his engineering team were rewarded again for their decision to convert the DHR complex to backup power from Generac. But this time, the trial was more severe. Rustick recalls that in September 2008, a main switching gear literally blew up on the main power supply line to the Women's Hospital from DHR's electric utility AEG Texas® - a unit of American Electric Power, Corpus Christi, Texas. "Without Generac's modular platform, we would have had catastrophic problems of biblical proportion at our newest hospital," Rustick said. "Instead, without a hitch, the Generac units kicked on immediately and ran continuously for **13 straight days**. Not a single chiller, critical care unit or operation at the Women's Hospital was ever compromised. That's an amazing record!"

Rustick praises Generac Power Systems for its systems design and robust redundancy. He said that during the nearly two weeks the Women's Hospital was totally on emergency power, the smaller modular units gave his engineers the flexibility to take an engine off-line occasionally for rest and maintenance without sacrificing any power needs. Rustick explained that under normal circumstances, a standby generator will run about 20 hours a year. Engine oil needs to be changed every 100 hours. So, when an engine runs 24 hours a day over a period of weeks without changing the oil, the life of the engine is seriously compromised.

"The n + 1 redundancy factor we had planned provided us with the highest level of reliability that is so important

for medical facilities – especially those in coastal areas. And finally, having the Bi-Fuel capability enabled us to extend our run time and reduce the consumption of diesel fuel for each engine. These capabilities could not have been possible with a large single-engine unit," Rustick said.

Eulenfeld also explained, "Emergency power systems should be designed around a 'perfect storm' scenario. With the Generac MPS Bi-Fuel solution we were able to provide a reliable system that is capable of weathering any storm and keep the hospital fully functional. Because when the lights go out, it's simply too late."

Out of 25 Standby Generators, Only Two Large Engines Remain

With each campus expansion, more Generac systems have been installed. DHR engineers requested that their older, single engine units be replaced by MPS systems. Today, out of a total of 25 engines on the two campuses, only two 2 mW large engines still remain.

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