How to benefit from MULTIPLE PARALLELED GENERATORS in traditional single-generator standby applications

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INTRODUCTION

With the commercial availability of standby diesel generator sets rated up to 3000 kW or more, it is common for many facilities to install a single large generator set to supply all the necessary power in the event of a utility outage. However, in a number of standby and emergency power applications, there are benefits to sharing the total load among multiple smaller generator sets connected in parallel to maximize system reliability, availability, fuel economy and operational flexibility. Provided that the multiple generator sets are designed and installed properly, with special consideration given to adequate fault protection, smaller paralleled generator sets offer a number of operational and practical advantages over a single large generator set. In addition, the availability of easy-to-operate human machine interfaces (HMI) and digital paralleling systems has eliminated most of the operational complexities of older analog systems. This paper will explore the benefits of multigenerator power systems that are primarily designed for standby and emergency power applications.

MATCHING THE SYSTEM TO THE LOAD PROFILE

The first step in evaluating whether the standby power system should be composed of a single large generator set or several smaller generator sets operating in parallel is to determine the facility's load profile. Many facilities have electrical loads that can be grouped according to their priority. Some portion of the load will be considered "essential or critical," such as life-safety systems; security, computer and data systems; communications or certain critical manufacturing processes. Another part of the load may be considered "important, but not critical," such as ventilation systems, general lighting and less vital manufacturing processes. A final portion of the load may be nonessential for life-safety or business continuity - an example might be the HVAC system, unless it is needed for cooling major computer or data facilities. If the total electrical load can be segmented by priority, standby power systems with multiple generator sets offer a number of advantages that include enhanced reliability and availability, operational flexibility, fuel savings, convenient maintenance scheduling and easier system expansion.

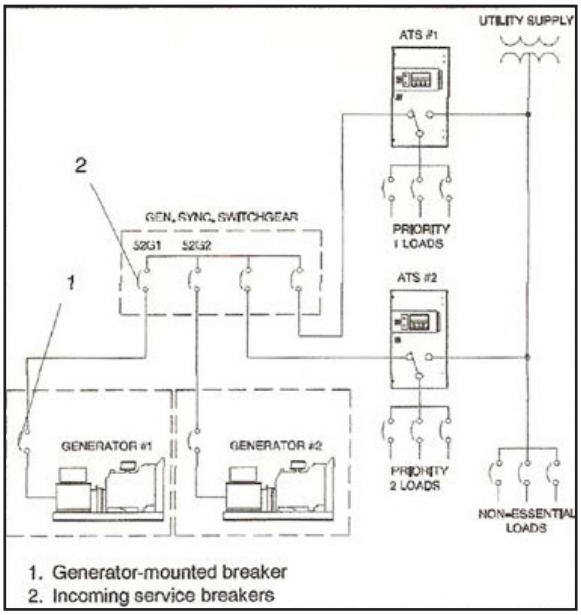

Figure 1. A multiple-generator power system with industry-standard fault protection and prioritized loads

Figure 1 illustrates a standby power system with two generator sets and prioritized loads in the industry-preferred method of paralleling multiple generator sets with multiple levels of fault protection. The generator-mounted breakers are dedicated to the protection of the generator set and can be integrated with alternator protection and other protective devices within the generator set controller. The incoming lines from the generator sets are protected at the switchgear with a service breaker, which is used for synchronization and fault protection at the bus level. These breakers are sized to allow for the total fault capacity of the bus, with all generator sets online, and to protect the cables from the generator sets. Multiple-generator power systems without this level of fault protection risk damage to the power system and degrade overall system reliability.

RELIABILITY

A primary advantage of multiple-generator set systems is enhanced power reliability and availability. Note in Figure 1 that because both generator #1 and generator #2 are connected to a common bus, either is able to supply the primary load. In the unlikely event that one standby generator does not start when needed, the other will start and supply the critical load by shedding less-critical loads. In designing the system, it is advisable–and in some cases required by code–to size the generator sets so that a single unit can supply the critical load. Also, by further segmenting the other loads with additional transfer switches, it may be possible for the remaining single online generator set to supply some portion of the noncritical loads.

For facilities with a larger percentage of critical loads, reliability can be further enhanced by adding a fully redundant generator set. For example, if the total standby electrical load of a facility is 1000 kW, a standby system of three 500-kW generator sets allows one generator set to be offline at any given time without sacrificing reliability or system availability. In facilities with growing electrical needs, this strategy provides enhanced reliability in the early years, when loads are less than the total generating capacity. While the redundant generator set may increase initial installation costs, it will pay for itself through reduced expansion costs, improvements in system availability and maintenance scheduling.

OPERATIONAL FLEXIBILITY

A standby power system with multiple generator sets offers operating flexibilities that can increase reliability, reduce operating costs, improve equipment longevity and enhance operator convenience.

EASIER MAINTENANCE SCHEDULING

With a single large generator set, the standby power system is unavailable while undergoing routine or unscheduled maintenance. With a two-generator system, the generator set that is not offline is available to supply the critical loads and, when sized properly, some portion of the noncritical loads. Scheduling of maintenance is easier with multiple generator-set systems, making it more likely that periodic maintenance will be performed without negatively affecting the availability of standby power. Since the vast majority of standby generator set failures are related to neglected maintenance, ensuring maintenance occurs at proper intervals adds to system reliability.

ENERGY COST SAVINGS

Even in the face of fluctuating fuel costs, large businesses are still considering onsite power systems, which, in addition to serving as standby power, also help to control overall energy costs. When configured to run in parallel with the local utility, these power systems can take advantage of utility interruptible-rate programs available from many service providers. These programs give a credit on the electric bill for allowing the utility to interrupt the flow of power to the facility during periods of peak demand. Utilities that offer this incentive benefit by shedding part of their load and reducing strain on their generation and transmission system. In turn, the customer facility benefits from lower electric rates that save money. In most cases, these savings are over and above the additional cost of fuel.

AVOIDING PARTIALLY LOADED GENERATOR SETS

If the facility has an electrical load that varies based on the time of day or day of the week, a standby power system with multiple generator sets allows for running one or two units at certain times rather than the less fuel efficient method of running a lightly loaded large generator set. In multiple generator-set applications, the generator management feature in the paralleling switchgear can adjust for variations in load and make certain that the minimum number of generator sets is online to serve the load.

EASIER SYSTEM EXPANSION

If the electrical needs of the facility are expected to grow over time, the multiple-generator approach allows for incremental increases in capacity through the addition of supplemental generator sets. With controls and paralleling switchgear already in place, expansion is easier and less costly.

SYSTEM DESIGN CONSIDERATIONS

- One of the key factors in evaluating potential paralleling systems is ensuring that the system is a completely engineered solution. Avoid piecemeal designs that neglect careful design considerations of the downstream emergency bus and related controls, thereby raising concern over fault capability, load-shed operation and accurate project costs.
- During the last several years, advances in digital control technology have simplified paralleling and greatly improved reliability and reduced cost. Traditional paralleling systems utilizing analog metering, custom control devices and significant engineering effort can be costly and require more space and higher skill levels to operate. Digital paralleling controls allow for user-friendly features such as an active touch screen interface, trending reports, and alarm and event recording. Other benefits may include increased reliability, smaller equipment footprint and lower project cost.

CONCLUSION

A multiple-generator paralleling system option may present the owner with an opportunity to improve site reliability without significantly impacting initial expenditures. However, the lowest cost should never be the sole consideration when implementing a standby power system. Care must be taken to review the total project requirements, capabilities and cost trade-offs, including:

- The facility's load profile and priorities
- The impact of enhanced power system reliability and availability
- The impact of enhanced operational flexibility on improved maintenance scheduling
- The potential fuel cost savings and electricity rates for participation in utility interruptible-rate programs
- The impact of load growth and reduction of future expansion costs

When deciding whether to install a standby power system using a single large generator set or a system with multiple smaller, paralleled generator sets, careful consideration of all these factors will result in the best solution.

ABOUT THE AUTHOR

Tom Ferry was the Sales and Marketing Manager-Switchgear Systems for Kohler Power Systems-Americas, which manufactures generators, paralleling switchgear, automatic transfer switches and enclosures. He was responsible for field sales, integrated system designs, engineering support and market development. Prior to coming to Kohler in 2002, Ferry spent 25 years with GE Zenith Controls and last held the position of director of marketing and product management. Ferry holds a bachelor of science degree from Elmhurst College and was a member of the Electrical Generating Systems Association (EGSA), American Society for Healthcare Engineering (ASHE), 7x24 Exchange, as well as many other industry groups.

Mike Pincus is currently the Director of Industrial Sales Operations for Kohler Power Systems. He leads a team responsible for product application engineering support, custom product quotations, and paralleling switchgear application engineering and sales support. He is also responsible for account management for both corporate accounts and distribution. Prior to his current role, he was the Manager of Switchgear Engineering where he was responsible for both development and application engineering for the paralleling switchgear product line. Pincus joined Kohler in 1995 and holds a bachelor of science degree in electrical engineering from the University of Wisconsin-Madison and an M.B.A. from the University of Wisconsin-Milwaukee. He is a member of Institute of the Electrical and Electronics Engineers (IEEE) and a registered professional engineer in the state of Wisconsin.

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