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Professional Electrical and Mechanical Engineers
Mission Critical Facilities Design Specialist * Generator Systems Specialist

GENERATOR SYSTEM DESIGN CONSIDERATIONS

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This article is intended to highlight some considerations in designing and specifying backup generator systems for mission critical facilities. They may be pertinent to code required emergency systems as well, except that emergency systems have certain requirements that may not always apply to backup or standby systems, such as starting within 10 seconds and specific circuit and ATS arrangements.

Sizing:

Depending upon the type of facilities this may be a simple exercise or a complex one. Size is influenced by total load, load diversity, type of load, largest motor size, motor starting methods, harmonics content of the load, duty type, load profile and the generators capability to handle these items. Duty types are broadly categorized in Standby, Prime and Continuous.

Location:

Outdoor units are popular for normal application mainly due to lower costs and/or space constraints. For critical applications consider a location that allows servicing in all weather conditions, including snow and rain. An indoor location is most desirable but comes with a cost. Walk-in type outdoor enclosures may offer a good trade-off.

Parallel or not parallel: Paralleling may be required for capacity and/or for redundancy. Deciding on an optimum number of units requires a careful trade off between benefits of redundancy, load management and probability of failure, which increases with the number of units installed.

There is a school of thought that would prefer independent generators and segregate the loads (or buildings) and avoid paralleling. This is either to reduce cost or to avoid perceived complexity or single point of failure in the form of a common paralleling bus. This approach may work well for a campus style distribution. For concentrated loads and critical facilities like data centers, paralleled generator systems have been the norm for good reasons.

Paralleled systems provide a centrally located

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generator plant, which is easier to operate, maintain and monitor. It facilitates a modular approach to obtain N+1 or N+2 type redundancy and provides greater availability of power compared to individual units. A properly designed paralleled system may be able to continue to provide power, should one of the units fail. Although, certain types of failures may be prone to bringing the entire plant down. This can be avoided with proper design and it is here that the skills and experience of the design engineer and vendors become very important.

Not all vendors parallel the generators the same way. More and more vendors/manufacturers are using microprocessors and data network for paralleling controls. While this is great, they are also a source of misapplication or oversights as they are designed and programmed by engineers strong in software and electronics and not well versed in power electrical engineering. Many critical hardwired interlocks, checks and balances are often overlooked that can lead to serious issues and hazards down the road.

Automatic and Manual Controls:

In this day and age, everyone expects plug and play convenience. A fully automated generator plant is feasible, but it does not happen by just writing a specification and relying solely on the vendor. While vendor and manufacturers' expertize is indispensable and they set the trends as to what technology is available, you still need an experienced design engineer who knows what to specify, what to expect and how to verify compliance with specifications.

Fully automatic operation is great while it works, but make sure to have some basic manual controls to operate or maneuver the system when needed , especially when automation fails.

Touch screen interfaces are now common. They do provide a lot of flexibility in operation and monitoring at an affordable price. However, make sure that you have a back up plan or controls, if the touch screen or the display dies.

Voltage Selection:

For small systems, matching the user voltage makes sense. For systems larger than 4000A, medium voltage (MV) may be favorable, both from a cost and technical benefits points of view. Use of smaller conductors (for a given power) in a MV system helps to offset the higher costs of MV equipment. Medium voltage systems also help in keeping the available short circuit current in check at the user level as they inherently involve

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transformers.

Protection Scheme:

This is again where the experience of the design engineer is invaluable. While vendors may have standard packages for protection of "their" equipment, you need a system that will protect "your" system and interest. Modern multifunction relays provides a lot more flexibility and options for selecting a protection scheme. They also have become cost effective compared to the use of discrete relays.

Starting System:

This is among the weakest links in a generator system. A common generator failure mode is failure to start the engines. It is important to have built-in redundancy in starting systems, be it electric starter, battery and chargers or pneumatic starting systems.

Fuel System:

This is also among the weak links, especially if it involves external pumps and piping. Make sure your fuel system is reliable, redundant and maintainable. Many packaged duplex pump control systems have inherent single points of failure built-in, such as a single PLC or power supply, and are often overlooked. This can be addressed by a proper fuel system control and monitoring system design and review. In cold weather locations, take measures to keep the fuel oil from gelling.

Emissions Control:

Comply with applicable EPA emission standards.

Noise Abatement:

Often an afterthought, but a critical aspect both from zoning regulations and a public relations point of view. Specifying a "critical" muffler may not be sufficient in all cases. Acoustic silencers in air intake and exhaust lovers is often necessary.

Vendor Selection:

This is one of the most important decisions to be made in the entire process to have a successful project. In vendor selection, beside the equipment quality, the key is to select the vendor who has the best service network and field service technicians/engineers in your area. Ultimately, how well you are served comes down to who actually works on your project or equipment.

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This is not an all inclusive list and each of the criteria mentioned above can be expanded to fill volumes, but hopefully this article will provide some food for thought.

S&R Engineers, LLC, have extensive experience in design and commissioning of generator for mission critical faculties and would be happy to assist you on your new projects or review of existing systems.

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Your feedback and comments are welcome!
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