White Paper

Specifying Load Banks for Outdoor Use

ASCO Power Technologies®

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Load banks provide important testing and corrective functions in backup power systems. Proper load bank specification and installation is necessary for correct operation. This document reviews information needed to successfully select load banks for outdoor applications.

BACKGROUND INFORMATION

Load banks are used to apply load to diesel-powered generators to ensure proper operation and improve efficiency. The minimum varies by engine manufacturer and model, but is typically 30% to 40% of the total kilowatt rating. Underloaded operation results in "wet stacking", a condition where unburned fuel residues accumulate in an engine's exhaust system. Sufficient accumulations can impact performance and reliability. Review our paper entitled Adverse Effects of Low Load Operation on Diesel Generating Sets for more information.

Typical diesel engines operate most efficiently at 50% to 80% of rated output. A load bank is also used to increase loading during operations to keep output in the desired range to improve efficiency. It is also used to apply sufficient load during warm up periods, until engines reach their normal operating temperature. Operating at design temperatures is critical for gensets to ensure compliance with regulated emission levels.

CODE COMPLIANCE

Mission-critical facilities such as healthcare institutions and data centers must comply with National Fire Protection Agency (NFPA) codes that include NFPA 70 – National Electrical Code and NFPA 110 – Standard for Emergency and Standby Power Systems. These specify installation, performance, and testing requirements for backup power systems. Section 7.13 of NFPA 110 specifies the type and duration of load tests for generator sets in these applications. Our document entitled Load Bank Testing to Ensure Generator Set Performance provides further information on this subject.

LOAD BANK CAPACITY

When specifying load banks, the first step is to determine the necessary voltage and kilowatt ratings. For voltage, the operating voltage of the load bank must match the voltage of the genset or power source. Load bank manufacturers offer models across a range of single and three-phase voltages. It is vitally important that the supply on test voltage is within the tolerance of the load bank. Overvoltage on a load bank could result in catastrophic damage. Under voltage on a load bank will result in a de-rated (lower) kW capacity.

For capacity, some applications require a load bank to provide total load to match the kilowatt rating of the generator(s) it will serve. When planned loads will be added at a future date, a generator set with excess capacity may be specified. For example, a 1000 kW genset might be installed in a building that has a present total load of only 100 to 200 kW. In this instance, a load bank can be provided to bring total genset loading to at least 30% to avoid the effects of underloading.

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MOUNTING CONFIGURATION

The next step is to determine the type of load bank that works best for the application. The two most common outdoor rated load banks are freestanding and radiator-mounted. These are described in the following sections.

Figure 1: Typical freestanding load bank.

Figure 2: Typical radiator-mounted load bank.

Freestanding Load Banks

Freestanding load banks are installed outdoors on a concrete pad or a rooftop. Freestanding load banks use integral cooling fans to dissipate the heat that results from loading. Because they contain their own cooling circuitry, they do not add any additional back pressure to the diesel genset.

The voltage of the blower circuit is usually specified the same as the load bank (i.e. 480V, 3ph, 60Hz). Most load banks offer the option of blower power to be sourced from an external three phase source, or derived internally from main input bus. The preferred method is from an external source which will allow the load bank blower motors to operate if main voltage supply is lost.

The control power requirement is typically from a single phase voltage source. This voltage can be derived from a separate source, or from an internal control power transformer. Like the blower circuit, a separate control power source is the preferred method.

The exhaust systems of permanent load banks are available with either horizontal or vertical discharge. Horizontal units offer a low profile. By directing exhaust flows downward, their louvers prevent hot air flow from discharging directly towards nearby personnel. Alternatively, vertical load banks direct hot air upward, away from personnel. Vertical load banks typically offer a smaller footprint than comparable horizontal discharge units.

Providing enough distance between load banks and surrounding structures is important for reliable load bank operation. Load banks require a steady supply of ambient air to cool internal components. Manufactures provide intake and exhaust distance specifications for continuous operation. To facilitate service and maintenance, adequate distances must be maintained between load banks and surrounding site features. These features should be specified on the site drawings for the project.

Freestanding load banks are not designed for indoor operation. As detailed above, these units need a constant supply of fresh air for effective cooling. Most major load bank manufactures offer a full line of high capacity portable load banks that are designed specifically for indoor operation.

Figure 3: A freestanding load bank with vertical discharge installed on a concrete pad.

Radiator-Mounted Load Banks

Figure 4: Radiator-mounted load bank with horizontal discharge.

Figure 5: Typical horizonal-mounted load bank.

When compared to equivalent freestanding units, a radiator-mounted load bank typically offers lower cost because it does not use an integral cooling fan. Instead, the load bank is mounted on the genset's radiator and is cooled by air from the engine fan. The depth of radiator-mounted units typically should not exceed 13 inches as this avoids the potential of excessive back pressure that could impact engine cooling performance.

Importantly, radiator-mounted units are designed to apply supplemental load to the gensets. Radiator-mounted units are not designed to apply loads equaling 100 percent generator capacity. Radiator-mounted load banks are typically sized at 50-60% of nameplate kW rating. Units sized at greater than 60%, (or where the amount of load element kW required exceeds the available 13" depth) increase the potential of genset over heating due to increased back pressure. When 100% loading is required, freestanding load banks are the preferred design.

Radiator-mounted load banks operate in the exhaust of a genset radiator and radiate heat during operation. Common galvanized steel is not recommended for radiator-mounted load bank construction because this material can be degraded when temperatures exceed 500°F. For this reason, radiator-mounted units should be constructed of aluminized steel, which can tolerate temperatures of approximately 1250°F.

Photo courtesy of ASCO Power Technologies

When radiator-mounted load banks are specified to be installed inside duct work (or the plenum of a genset exhaust system), indoor NEMA 1 Type enclosures are available. Modern generators fitted with sound-attenuating enclosures offer the opportunity to use radiator-mounted load banks mounted horizontally for rooftop exhaust discharge. See figure 5.

Load Bank Controls

In regards to user control, freestanding units typically use a remote control panel located on a generator or in a switchgear room. The controls can either be manually operated mechanical or digital push buttons, or icon-controlled through a touch-screen interface. Controllers for these units offer Modbus TCP/Ethernet communications to enable interaction with Building Management Systems.

Figure 6: Load Bank remote control panel.

Radiator-mounted units are most often controlled by a panel mounted on or near the generator. Like freestanding units, radiator mounted units can be designed to interface with existing building or switchgear controls.

Controllers for both types offer step-wise load control for precise and repeatable testing. Load bank manufacturers also offer optional control software that can data log and time stamp load testing. This load data can be downloaded into reports that can help streamline commissioning, acceptance, code compliance, equipment maintenance, and troubleshooting.

OTHER CONSIDERATIONS

Both freestanding and radiator-mounted units load banks are available in NEMA 3R Type enclosures for outdoor applications. Freestanding or radiator-mounted load banks provided to the international market should be designed to meet IP55 outdoor type construction.

Seismic requirements for the project site must also be addressed. Load bank manufacturers offer units that meet baseline Uniform Building Code specifications for areas without pronounced seismic risks. Manufacturers may offer enhanced

structural options for freestanding load banks that will be used where seismic risks are higher. However, manufacturers typically do not offer radiator-mounted load banks for these applications because the seismic performance of the load bank will depend, in part, on the seismic performance of the genset on which it is mounted. Specifiers should consult load bank and genset manufacturers whenever elevated seismic risks are present.

Load banks should be designed for continuous duty cycle operation without limitation at ambient temperatures of -20°F to 120°F. For temperatures beyond this range, load bank manufacturers offer special "High Ambient" or "Arctic" designs.

Altitude of the application is also important. Typical outdoor load banks can easily operate at 3300 feet or below. If the installation will be above this, contact the manufacturer. The thinner air at higher altitudes effect the proper cooling of the unit, and kW capacity will be reduced.

SUMMARY

Specifying a load bank for a client's mission-critical emergency power installation is necessary for proper operation of the diesel generator set and to comply with applicable required electrical codes. Radiator-mounted units offer partial genset loading at relatively low cost because they use cooling air discharged from a genset radiator. They are typically used to apply loads equaling 50 to 70 percent of rated genset output. Freestanding units have integral cooling fans, and thus can be specified to provide loads equaling 100 percent of rated genset output.

Environmental and site factors must be considered for proper load bank selection and operations. The temperature range, construction materials, and seismic risks must be addressed to provide safe and reliable service. In addition, clearances around the load bank must be maintained to allow the required air flow and provide access for service and maintenance.

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