White Paper

Application of Resistive/Reactive Load Banks for kVA Testing

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Resistive load banks are the most commonly used load banks for the testing of generator sets and power systems. They provide full kW loading to the power source and help evaluate the generator sets engine cooling, exhaust, and fuel systems. However, due to its design a resistive load bank will not load to full nameplate kVA capacity. To achieve full kVA load testing a reactive load bank will be required.

Resistive Load Banks

The kW of a resistive load bank is "real" power in electrical terms. When a resistive load bank is used to test an engine generator set the engine will produce its full horsepower rating, dissipate engine exhaust gases, and produce thermal energy into the engine cooling system. The resistive load bank in fact, will completely test the engine and its various systems.

It is important to understand that the generator or power system will not be loaded to its full kVA rating. Resistive load banks utilize resistors, which only provide kW loading at 1.0 (unity) power factor.

Reactive Load Banks

Reactive load banks are designed to simulate either an inductive, or a capacitive load depending on the type of load expected on the power system.

Reactive/Inductive Load

Measured in kVAR (Kilo Volt Amperes Reactive), a reactive/inductive load converts current into a magnetic field. Inductive reactance resists the change to current, causing the circuit current to ***lag*** voltage. The inductive power factor is the most common reactive load. Examples of devices producing reactive/inductive loads include motors, transformers and chokes.

Reactive/inductive load bank testing is routinely required in OEM Test Cells, Acceptance Testing, Health Care Facilities, Federal & State Agencies and off-shore maritime applications.

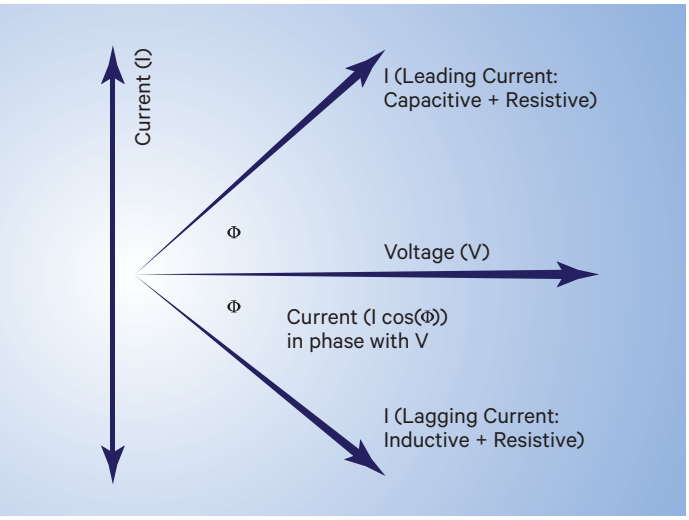

Figure 1: Power Factor Chart

Reactive/Capacitive Load

Measured in kVARc (capacitor kVAR rating at the system voltage), a capacitive load charges and releases energy. Capacitive reactance resists the change to voltage, causing the circuit current to ***lead*** voltage.

A reactive/capacitive load bank is similar to a reactive/inductive load bank in rating and purpose. However, with leading power factor loads reactive power is applied to the system which results in an improvement in overall power factor. The electronic and non-linear loads

Photo courtesy of ASCO Power Technologies

simulated by capacitive load banks are typical of the Telecommunications, Computer or Uninterruptible Power Supply (UPS) Industries.

Reactive/capacitive load testing is also used in applications requiring heavy inductive loads and/or power factor correction, such as in the Manufacturing and Mining industries.

Resistive/Reactive Load Banks

Typically, facilities require motor-driven devices, transformers and capacitors. If this is the case, then the load banks used for testing require reactive power compensation.

The ideal solution is a combination of both resistive and reactive elements in one load bank package. Resistive/reactive loads are able to mimic motor loads and electromagnetic devices within a power system, as well as provide purely resistive loads.

Many backup generators and turbines need to be commissioned at nameplate capacity using a combination of resistive and reactive load to fully qualify their operating capability. Using a resistive/reactive load bank enables comprehensive testing from a single unit. A range of resistive/reactive load banks are available to simulate these types of loads on a power source and the transformers, relays and switches which will distribute the power throughout the facility.

Resistive/reactive load banks are great choices for testing turbines, switchgear, rotary UPS, generators and UPS systems. They can also be used for integrated system testing of utility substation protection systems, particularly for more complex relays like distance, directional overcurrent, power directional and others. A resistive/reactive inductive and/or capacitive load is often required to test solar inverters to ensure solar panels can be stopped from producing electricity in the event of a power outage.

The resistive/reactive combination load banks are used to test the engine generator set at its rated power factor. In most cases this is 0.8 power factor.

Using Resistive/Inductive Load Banks to Test to ISO 8528 (BS7698) Part 6.

ISO 8528 (BS7698) part 6 is the standard for testing engine-driven generating sets. It sets out general test requirements and defines a functional and an acceptance load bank test. Functional tests must always be performed and usually occur at the manufacturer's test cell.

Acceptance tests are optional, they may be done on site and are often witnessed by the customer or a representative.

ISO 8528 (BS7698) part 6 defines three performance classes - G1, G2, and G3. A further class, G4, is reserved for performance criteria which are agreed upon between the supplier and the buyer. Each performance class has different criteria for a range of characteristics of the generating set.

- G1 is the least stringent and generally applies to small, simple generating sets, intended to supply unsophisticated loads.
- G2 is broadly equivalent to commercially available power.
- G3 is intended for sets which are powering strategically critical loads or those which particularly require a stable and accurate power supply.

Typically resistive/reactive load banks are used in the manufacturer's facility to class a gen-set to G1, G2, or G3 rating and to ensure 0.8pf kVA nameplate ratings are met. Power testing and maintenance companies use resistive/reactive load banks on site to ensure ISO 8528 standards are met in gen-sets during operation. The resistive/reactive load ensures full gen-set testing takes place and allow ISO 8528 standard to be met.

Load Control and Monitoring

Resistive/Reactive load banks require sophisticated load control and monitoring so operator is aware of the various responses in testing. Controls should allow for individual resistive, reactive, or combined (kVA) loading along with ability to preset loads on a percentage basis.

The ideal platform is software control where operator can set up and store load profiles, capture transient responses, and data log, so test results can be analyzed. Besides the standard Volt, Amp, Frequency and kW monitoring, combined units need to monitor Power Factor and kVA.

Automatic testing ensures the same load test parameters are met every time a test is performed. ISO 8528 standards (as mentioned earlier in this paper) are provided in market leading load bank controls, and present a pass or fail report. Original manufacturers classes (G1, G2, or G3) are able to be referred back to ensure the health of the gen-set over time and kVA ratings are met.

Today most reputable load bank manufacturers offer sophisticated control software. If not, there are many third party software packages that could facilitate load control.

This is a screen shot of software showing power factor rating. (Photo courtesy of ASCO Power Technologies.)

Parallel Systems

When testing installations with multiple generator sets operating in parallel the use of resistive/reactive load banks is justified. Having the ability to fully load the generator with the reactive component is usually required to calibrate the load sharing and voltage regulating systems of parallel generator systems. The load bank system can be connected to the common paralleling bus and be used for testing individual engine generators or any combination of engine generators operating in parallel. A 3000 kW load bank could be used to test a single 1500 kW generator set at full kW or two 1500 kW generators in parallel at full nameplate kW load. If the 1500 kW generator sets were on line in parallel, the operator could load them to two-thirds of their combined or individual kVA rating.

Summary

The correct selection and installation of a load bank is important to effectively determine the operating capability of the power source. The use of a combined Resistive/Reactive Load Bank is an essential tool for power source verification where leading or lagging power factors are required. ASCO Power Technologies has the product depth and breadth to provide practical solutions along with the support to assure your power system will provide many years of safe operation.

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