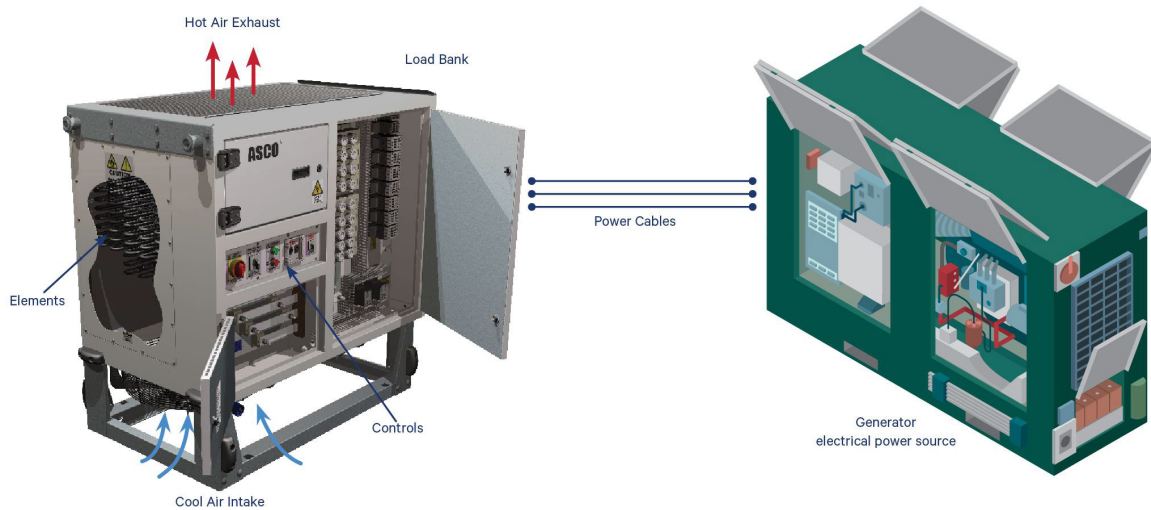


White Paper

Load Bank Rating Factors

# Load Bank Rating Factors

Load banks are specified according to the characteristics of a power source that requires testing. Voltage, power, frequency, and application requirements must be satisfied to provide the correct solution. In certain situations, load banks are utilized to test specifications that differ from the nameplate ratings. This paper describes how load banks are rated and provides guidance for adjusting rating information to meet application specifications.



A load bank testing a diesel generating set

## VOLTAGE

Load banks are designed to provide load at a specific capacity, rated in kilowatts (kW), at a specific voltage. A load bank cannot be operated at a voltage exceeding its voltage rating. Doing so could result in overheating, overloads, damage to the internal components, and failure of fuses and circuit breakers. However, load banks can operate at voltages below their nameplate ratings, provided that capacity is de-rated by a corresponding amount. This will result in a reduction of the overall capacity.

The amount of power that a load bank can dissipate is directly proportional to the square of the applied voltage. To ascertain the load capacity when operated at a lower voltage, the unit must be de-rated according to the following formula:

$$\frac{(\text{Applied Voltage})^2}{(\text{Rated Voltage})^2} \times \text{Rated Capacity} = \text{Reduced Rating}$$

For example, a 400 kW load bank can operate at either 240 or 480 volts. In order to determine the kW capacity at 208 VAC, 3 Phase, 60 Hz, the Applied and Rated Voltages must be used to calculate the load bank's de-rated capacity:

$$\frac{208V^2}{240V^2} \times 400kW = \frac{43,264}{57,600} \times 400kW = 300kW$$

The resulting capacity at 208 volts is thus three-quarters (0.75) of the capacity at the nameplate voltage rating.

Individual load step increments also de-rate by the same 0.75 factor. If 5 kW load steps would be used at the rated 240 voltage, then de-rated load steps of 3.75 kW would be used for a 208-volt load. This de-rating technique can also be used to create very fine test step resolution by utilizing the higher voltage setting on the load bank. To test a 240-volt load bank using small load steps, the load bank could operate in 480-volt mode while the 240-volt load is applied. The resulting load step increments would be 1.25 kW.

## SINGLE-PHASE LOAD TESTING

A three-phase, delta-configured load bank can be used to test single-phase power sources. To do so, two of the three phases would be connected together, such as Phase B and Phase C, to allow for a two-thirds rating. One lead from the power source would be connected to Phase A of the load bank and the other lead would be connected to the Phase B and C connection points. In this configuration, the single-phase capacity of the load bank would be reduced to two-thirds of its three-phase capacity. Whenever a power source operates at a different voltage than a load bank, the load bank voltage must be de-rated accordingly.

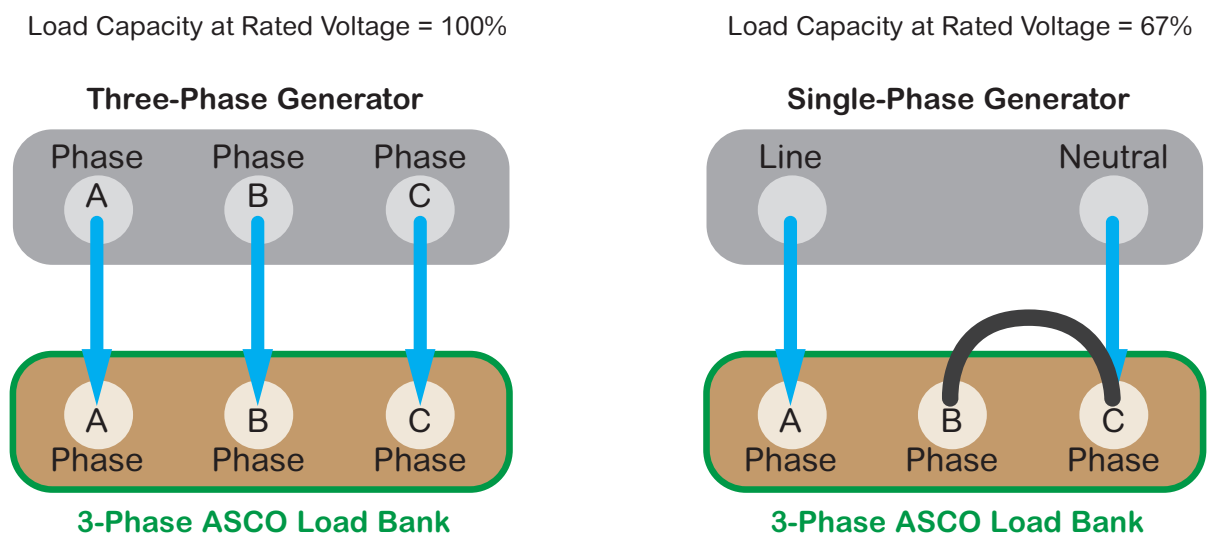


Figure 1: Typical load connections

## FREQUENCY

In general, resistive load banks are not affected by the difference between 50 and 60 Hz test sources because inductance on the load bank elements is insufficient to produce a significantly different result. However, frequency differences will impact the speed of a load bank's cooling air blower. Because the blower will run slower on a 50 Hz source than on a 60 Hz source, the load bank's cooling capacity will also be reduced ( $50 \text{ Hz} / 60 \text{ Hz} = 83\%$ ). 400 Hz sources require special consideration, and will typically have an external connection for a 60 Hz voltage supply.

Reactive load banks are affected by differences in source frequency. Both voltage and frequency must be considered when reactive load banks are to be used in tests that differ from their design ratings, according to the following formula:

$$\frac{(\text{Applied Voltage})^2}{(\text{Rated Voltage})^2} \times \frac{\text{Applied Frequency}}{\text{Rated Frequency}} \times \text{Rated kVAR}^* = \text{De-Rated kVAR}$$

\* kVAR = kilo Volts Ampere Reactive

A 500 kVAR reactive load bank for 480 volts at 60 Hz and used to test 380 volts at 50 Hz would be rated:

$$\frac{380V^2}{480V^2} \times \frac{50\text{Hz}}{60\text{Hz}} \times 500\text{kVAR} = \text{De-Rated kVAR}$$

$$0.626 \times 0.83 \times 500\text{kVAR} = 260\text{kVAR}$$

## ALTITUDE

Load banks used at altitudes of less than 3,000 feet above sea level typically do not require rating adjustments. When used above 3,000 feet, the cooling and load capabilities of a load bank may be affected due to lower air density. Before operating load banks at high altitude, consult the manufacturer to obtain operating parameters for the application.

## ENVIRONMENTAL

The environment in which a load bank will operate must be considered when reviewing a load bank application. In the U.S., most manufacturers offer load banks in NEMA Type 1 and NEMA Type 3R enclosures for indoor and outdoor applications, respectively. Likewise, these manufacturers may offer IP-rated enclosures for deployment in indoor and outdoor locations in other regions. Indoor load banks are typically portable units equipped with casters for mobility. These load banks are used for multiple testing applications, and should include dual voltage and digital monitoring capabilities. Portable load banks are designed to be moved to a test location, connect to a power source, log the resulting test data, and then be wheeled to the next test location. Portable load banks may not be designed for continuous outdoor use or storage. Specifying the conditions in which the load bank will be used is essential to providing the correct solution.



Load testing two diesel generating sets in parallel

Load banks are often rated 120°F/50°C. Outdoor load banks must be positioned in shade to minimize the effects of solar gains. Excessive solar gains may cause over-heating of components, causing equipment to trip offline.

Permanent load banks typically service a single power source. Consequently, they most often employ single-voltage designs, and can be interfaced and controlled by a building management system. Permanent load banks are characterized by weatherproof construction that allows permanent installation and continuous operation in outdoor settings.

## **SEISMIC**

Load bank manufacturers often offer load banks that are certified (using calculations) to meet International Building Code (IBC) seismic requirements. These calculations evaluate the seismic forces that load bank equipment can withstand, and show whether the equipment can be used in specific seismic zones. The seismic design calculations include an evaluation of the forces and stresses at mounting interfaces based on IBC anchorage and equipment codes.

The mechanical anchorage for the load bank is usually specified, supplied, and installed on site by others (per instructions provided with the anchors). If your application is subject to a IBC seismic requirement, contact the manufacturer of the anchorage equipment to obtain detailed information regarding their ratings.

## **SUMMARY**

The proper application of a load bank is critical to evaluating the operating capability of a power system and to maintaining and extending its useful life. Specifying a load bank requires more than knowing the amount of load. Load bank suppliers must consider many factors to provide a solution suited to the application. Knowing how, when, and why a load bank will be used is the first step to selecting a model that will provide adequate performance for its designed service life. Market-leading load bank suppliers provide solutions ranging from compact and portable units to complex containerized systems to meet the demands of any application.

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