

White Paper

Load Bank Utilization in
Marine Environments

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One of the toughest and most technically demanding load bank testing environments is also one of the most common. This paper describes typical marine applications for load banks and the types of load tests that are used. It also explains how load bank testing ensures reliable and efficient power in harsh marine applications.

TYPES of LOAD TESTS for MARINE APPLICATIONS

Diesel Generator Maintenance

Shipyards, oil rigs, and marine vessels often use diesel generating sets for either primary or back-up power. In these applications, load banks are used to exercise and test gen-sets to verify efficient and reliable operation. Load banks are used to test gen-sets for the following reasons:

Avoiding “Wet Stacking”: Wet stacking occurs when diesel engines operate for extended periods without minimum load, which is typically 30% of rated capacity. When loads are insufficient, an engine’s internal operating temperatures do not reach optimal levels, resulting in deposits of unburned fuel and carbon in the engine and its exhaust system. Load banks prevent wet stacking by loading gen-sets to obtain operating temperatures that will avoid depositions of fuel and carbon residues.

Diesel Particulate Filter (DPF) Burn-Off: A diesel particulate filter (DPF) removes soot and other particulates from diesel exhaust gases. DPFs are either provided with new gen-sets, or fitted to the exhaust systems of existing engine-generators. During periods of light load operation, soot and carbon can deposit on a DPF, reducing its subsequent effectiveness. Load banks apply loads that raise exhaust temperatures to reduce filter deposits. When the filter is free of soot, the engine can operate more efficiently with reduced emissions.

Commissioning and Verification of Gen-Sets

ISO 8528 (BS7698) Part 6 sets four general test requirements for engine-generators, and defines load bank tests for function and acceptance. During commissioning and verification, functional tests must be completed, and usually occur at a manufacturer’s test facility. These tests are also completed when mission-critical power equipment is commissioned on oil rigs and in marine vessels. Part 6 defines four performance classes as follows:

- G1 is the least stringent, and generally applies to small, simple generating sets that supply unsophisticated loads
- G2 is broadly equivalent to commercial power
- G3 designates gen-sets that power critical loads or loads that particularly require a stable and accurate power supply
- G4 is reserved for performance criteria established between a manufacturer and a customer



Engine governing functions are measured by frequency response and alternator voltage regulation is measured directly. Frequency specifications include steady-state variation, where frequency decreases when maximum load is applied; and frequency rise, when 100% load is removed. Voltage characteristics include the permissible voltage decrease, when maximum load is applied; and the voltage rise, when 100% load is removed.

ISO8528 PERFORMANCE CLASS CRITERIA

Chart 1: Generator Set Performance Criteria.

Performance Class	G1	G2	G3
Steady-state frequency band	2.5%	1.5%	0.5%
Maximum frequency dip	-15%	-10%	-7%
Maximum frequency rise	+18%	+12%	+10%
Frequency recovery time	10 sec	5 sec	3 sec
Steady state voltage deviation	5%	2.5%	1%
Maximum voltage dip	-25%	-20%	-15%
Maximum voltage rise	+35%	+25%	+20%
Voltage recovery time	10 sec	6 sec	4 sec

The maximum load increase for these tests, expressed as a percentage of the rated power of the gen-set, is determined by the characteristics of the engine and its alternator. Traditionally, naturally-aspirated engines were tested with 100% load acceptance, whereas turbo-charged engines were tested with a 60% power increase. However, the standard defines a more complex formula based on engine parameters. In practice, the value is now usually determined by the manufacturer.

Market-leading, PC-based, load bank software can automatically test marine diesel gen-sets to ISO 8528 G1, G2, or G3 standards. The tests can be performed and recorded automatically. Thereafter, the programs produce reports indicating whether the results pass or fail test criteria. Non-compliant systems must be evaluated and serviced, as appropriate, then retested to document compliance.



Oil Rig Gas Turbine Engine Testing

Offshore oil rigs require a stable, reliable, and compact power source to supply machinery and ancillary equipment. Gas turbines are typically selected as a primary power source because they produce a high power output while occupying comparatively little space. Furthermore, an oil rig's drilling activities may produce surplus combustible gas that can be used as fuel. In these instances there may be a strong economic case for using a turbine instead of a diesel engine.

Load banks are used to commission oil rig power infrastructure. Gas turbine generators are typically medium or high-voltage units, so a matched load bank with a step-down transformer or direct connect high-voltage load bank is required. These provide both resistive and reactive load to facilitate total power system testing at a lagging power factor of 0.8.

Turbines are precisely engineered and have very fine operational parameters. Load banks verify performance by stressing turbines to reveal potential issues before and after installation. Typically, a turbine is tested in a 'heat run' at full load between 6 and 24 hours. During the test, operators monitor the functional efficiency of the turbine, and note any issues with alternator operation, blade movement, and vibration. The test results are used to document that the turbine-generator can produce stable and reliable power for the oil rig in a controlled environment.

Motor Start Simulation Testing

Motor Start (M Load) testing originated in naval dockyards. It is used to simulate start-up of the largest motor on a vessel by applying short-duration load to a gen-set at a very low lagging power factor. When a motor starts on an already-loaded gen-set, it produces a short period of very high inductive current that stresses the alternator. An M load test simulates the high-induction load to verify gen-set performance under this stress. An M Load test is important in ensuring that a marine gen-set is fit for its intended purpose.

A typical M Load test requires a gen-set to run at 25%, 50%, 75%, and 94% nameplate rating at a power factor of 0.8. At each step, the M Load (50% of nameplate rating at a power factor of 0.4) is applied for a few seconds to test whether the gen-set trips or presents other electrical issues. If the gen-set trips, it is in a controlled environment without the risk of damage to the vessel power infrastructure.

Many tests require the gen-set to be loaded to 85% or 94% at a 0.8 power factor before an M Load is applied and rejected. Data captured during this test is analyzed to verify voltage and frequency transient response performance. A typical load bank, operated at a power factor of 0.8, may not be able to supply the inductive load necessary to complete the test. M Load requires technical support and pre-calculated parameters and settings from the load bank manufacturer as well as software that can only be provided by market-leading load bank suppliers.

Specifying Load Banks for a Marine Environment

Marine environments expose load banks to saline conditions that corrode exposed metals at a faster rate than non-saline conditions. Load banks used at commercial shipyards, naval bases, and oil rigs must be built to withstand heavy abuse.

Due to their high power output and integral isolation from environment conditions, containerized load banks are often specified for marine applications. An unprotected, non-containerized load bank may be susceptible to corrosion of its enclosure and internal components. Prominent manufacturers offer special marine paint to protect an enclosure from spray and salt. For even harsher environments, the container, internal enclosures, hardware, and ducts can be obtained in stainless steel. Protective measures allow load banks to operate reliably in coastal and marine environments.



A containerized load bank solution testing a diesel gen-set on a naval vessel.

For marine settings, it is important to understand the requirements of the load test application, and then match a suitable load bank to an appropriate control system. Leading manufacturers offer a range of load bank configurations and control solutions to ensure power system efficiency.

SUMMARY

Understanding how and why load banks are utilized in critical marine environments is vital to ensuring effective power generation. Marine environments continue to be one of the most common load bank applications. Only the highest quality units should be specified to endure the environmental and technical demands of abusive marine environments.

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