

1.0 Introduction:

Generator sets installed on watercraft have to be adapted to suit a marine application. Whether the vessel is a work boat or pleasure craft, there are several considerations for safety, operation, and codes for a marine environment that have to be considered.

This Information Sheet discusses how a generator system is configured to operate reliably and within codes in a marine environment.

2.0 Different Marine Markets by Application:

There are two distinct market sectors for marine generators - one for pleasure craft and the other for commercial vessels. Your authorized marine generator distributor will be experienced on both sectors. Work boat and higher end pleasure craft both need on-board power generation to supply various items of electrical equipment.

Marine Engine Cooling System Options

Diagram - 1
Keel Cooling

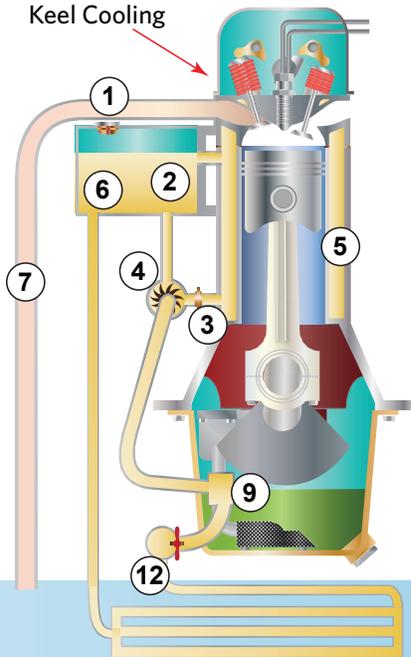
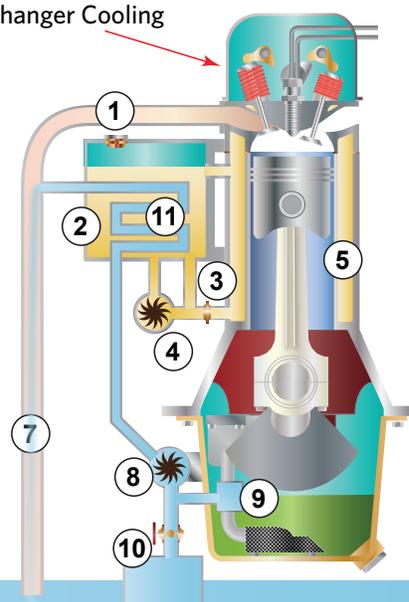


Diagram - 2
Heat Exchanger Cooling



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|---------------------|---------------------------|--|
| 1 - Filler Cap | 5 - Engine Coolant System | 9 - Oil Cooler |
| 2 - Header Tank | 6 - Fresh Water Return | 10 - Sea Chest & Shut-off Valve |
| 3 - Thermostat | 7 - Exhaust | 11 - Heat Exchanger |
| 4 - Freshwater Pump | 8 - Saltwater Pump | 12 - Keel Cooling Pipes & Shut-off Valve |

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2.0 Different Marine Markets by Application (Continued):

The fundamental difference between a work boat and a pleasure craft is the operating environment and duty-cycle of the applied load. The following sections discuss the similarities between work boat and pleasure craft, but also the different factors that have to be taken into account when specifying a marine generator system.

3.0 Key Types of Marine Generator Markets:

The following are the two distinct market sectors for marine generators that require on board electrical power.

3.1 Pleasure Craft -

The pleasure craft market tends to have a less arduous duty-cycle. Most pleasure craft marine generators are supplied pre-packaged by the manufacturer with optional accessories to meet most requirements. These sets are designed for a life cycle of 3,000 to 4,000 hours maximum and are equipped with lighter weight diesels.

As a guide, pleasure craft less than 35 feet utilize diesels running at 1800 rpm for 4-pole generators. Principal requirements are for quiet, compact, lightweight power. Below 10kW there are some spark ignition 3600 rpm 2-pole generators.

3.2 Commercial or Work Boat Vessels -

Work boats (eg. fishing vessels under 200 feet) usually have a much more demanding work-cycle requiring a generator life expectancy of up to 60,000 hours. To meet this life cycle 1,800 rpm 4-pole diesel-powered generator sets are utilized.

Many work boat generator set applications require custom built generators built around a specific specification to meet requirements for extensive duty cycle, low fuel consumption, and reliability. However, large ocean-going pleasure craft will also require the continuous long life duty-cycle of work boats.

4.0 Marine Engine Cooling Systems:

Most marine generator sets are installed in tight compartments making traditional land based radiator cooling systems impractical. Over the years, two types of marine engine cooling systems have been developed.

4.1 Keel Cooling -

Commercial/Work Boat applications traditionally incorporate keel cooling, (*See diagram 1*). Instead of a radiator, the marine engine is fitted with a fresh water expansion tank. Water is pumped from the engines cooling system through pipes running along the keel below the water line. Sea water is generally considered to have a maximum temperature of 80°F to enable sufficient cooling. Higher temperatures will require increased cooling capacity and piping.

4.2 Heat Exchanger Cooling -

Many pleasure craft vessels incorporate heat-exchanger cooling, (*See diagram 2*). As with keel cooling, the radiator is replaced by a fresh water expansion tank, but now the engine coolant is pumped through the heat-exchanger with raw water pumped through the exchanger to take away the heat generated by the engine and returned to the sea (or lake, etc).

Heat exchangers are preferred on pleasure craft vessels as they can be more compact and easier to install because they do not have the requirement for cooling pipes to be installed on the outside of the hull below the water-line.

5.0 Marine Engine/Generator Features:

Marine generator sets operate in an environment that is subject to waterborne contaminants, such as salt, and in tight spaces that makes heat rejection more complex. In consideration of these issues, the generator set will have the following features:

5.1 Engine Features -

- **Water-Cooled Exhaust Manifold** - Fitted for safety for tight spaces within engine rooms, and to assist heat rejection.
- **Auxiliary Power Take-off** - To drive hydraulic pumps, bilge pumps, compressors, etc.
- **Water-Cooled Turbochargers** - As for the exhaust manifold, cooled for safety and less heat rejection.
- **Vibration Isolators** - To prevent vibration being transmitted to crew areas and vessel hull.
- **Sacrificial Anodes** - To prevent the corrosive effect of salt.

5.2 Alternator/Electrical Features -

- **Anti-Condensation Heaters** - To prevent water damage to windings in high humidity areas.
- **Marine Grade Winding Insulation** - Necessary to prevent corrosion in a salt water environment, special resistant epoxy insulation Class F or H. ABS regulations require a maximum 95° C alternator winding temperature rise in 50° C ambient conditions.
- **Wiring** - To marine standards to avoid corrosion and grounding for safety where there is no land grounding.
- **Generator Sizing** - Recommendations are the generator is sized to run at 75 to 80% of the continuous (24/7) electrical load. This can be 65 to 70% of the average running load when electric motors are cycling on and off.

6.0 Marine Regulatory Bodies:

Marine generator systems are subject to a different set of regulations and standards than that of land based sets. The following should be considered when specifying a generator system to be used in a marine vessel application:

- **Exhaust Emissions** - EPA standards for marine engines up to 800 hp are Marine Tier 3, and above Marine Tier 2.
- **US Coast Guard (USCG)** - Some regulations with USGA cover the requirement of generators in vessels.
- **American Bureau of Shipping (ABS)** - ABS mandates some vessels cannot leave port without 2 running marine generators.
- **International Maritime Organization (IMO)** - A specialized UN Agency for Safety and Security as well as marine pollution. EPA Marine Tier 3 is higher than IMO standards, therefore US certified marine engines meet IMO export standards.

7.0 Marine Classification Bodies:

There are several marine classification bodies that set marine performance. Manufacturers of vessels and marine equipment have to have witness tests from several including, Lloyd's Register, Det Norske Veritas, and Bureau Veritas.