ELECTRONIC FUEL INJECTION

Section 3D – Emissions

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Exhaust Emissions Standards

Through the Environmental Protection Agency (EPA), the federal government has established exhaust emissions standards for all new marine engines sold in the U.S.

What Are Emissions?

Emissions are what comes out of the exhaust system in the exhaust gas when the engine is running. They are formed as a result of the process of combustion or incomplete combustion. To understand exhaust gas emissions, remember that both air and fuel are made of several elements. Air contains oxygen and nitrogen among other elements; gasolene contains mainly hydrogen and carbon. These four elements combine chemically during combustion. If combustion were complete, the mixture of air and gasoline would result in these emissions: water, carbon dioxide and nitrogen, which are not harmful to the environment. But combustion is not usually complete. Also, potentially harmful gases can be formed during and after combustion.

All marine engines must reduce the emission of certain pollutants, or potentially harmful gases, in the exhaust to conform with levels legislated by the EPA. Emissions standards become more stringent each year. Standards are set primarily with regard to three emissions: hydrocarbons (HC), carbon monoxide (CO) and oxides of nitrogen (NOx).

Hydrocarbons – HC

Gasoline is a hydrocarbon fuel. The two elements of hydrogen and carbon are burned during combustion in combination with oxygen. But they are not totally consumed. Some pass through the combustion chamber and exit the exhaust system as unburned gases known as hydrocarbons.

Carbon Monoxide – CO

Carbon is one of the elements that make up the fuel burned in the engine along with oxygen during the combustion process. If the carbon in the gasoline could combine with enough oxygen (one carbon atom with two oxygen atoms), it would come out of the engine in the form of carbon dioxide (CO_2). CO_2 is a harmless gas. But carbon often combines with insufficient oxygen (one carbon atom with one oxygen atom). This forms carbon monoxide, CO. Carbon monoxide is the product of incomplete combustion and is a dangerous, potentially lethal gas.

Oxides of Nitrogen - NOx

NOx is a slightly different byproduct of combustion. Nitrogen is one of the elements that makes up the air going into the engine. Under extremely high temperatures it combines with oxygen to form oxides of nitrogen (NOx). This happens in the engine's combustion chambers when temperatures are too high. NOx itself is not harmful, but when exposed to sunlight it combines with unburned hydrocarbons to create the visible air pollutant known as smog. Smog is a serious problem in California as well as many other heavily populated areas of the United States.

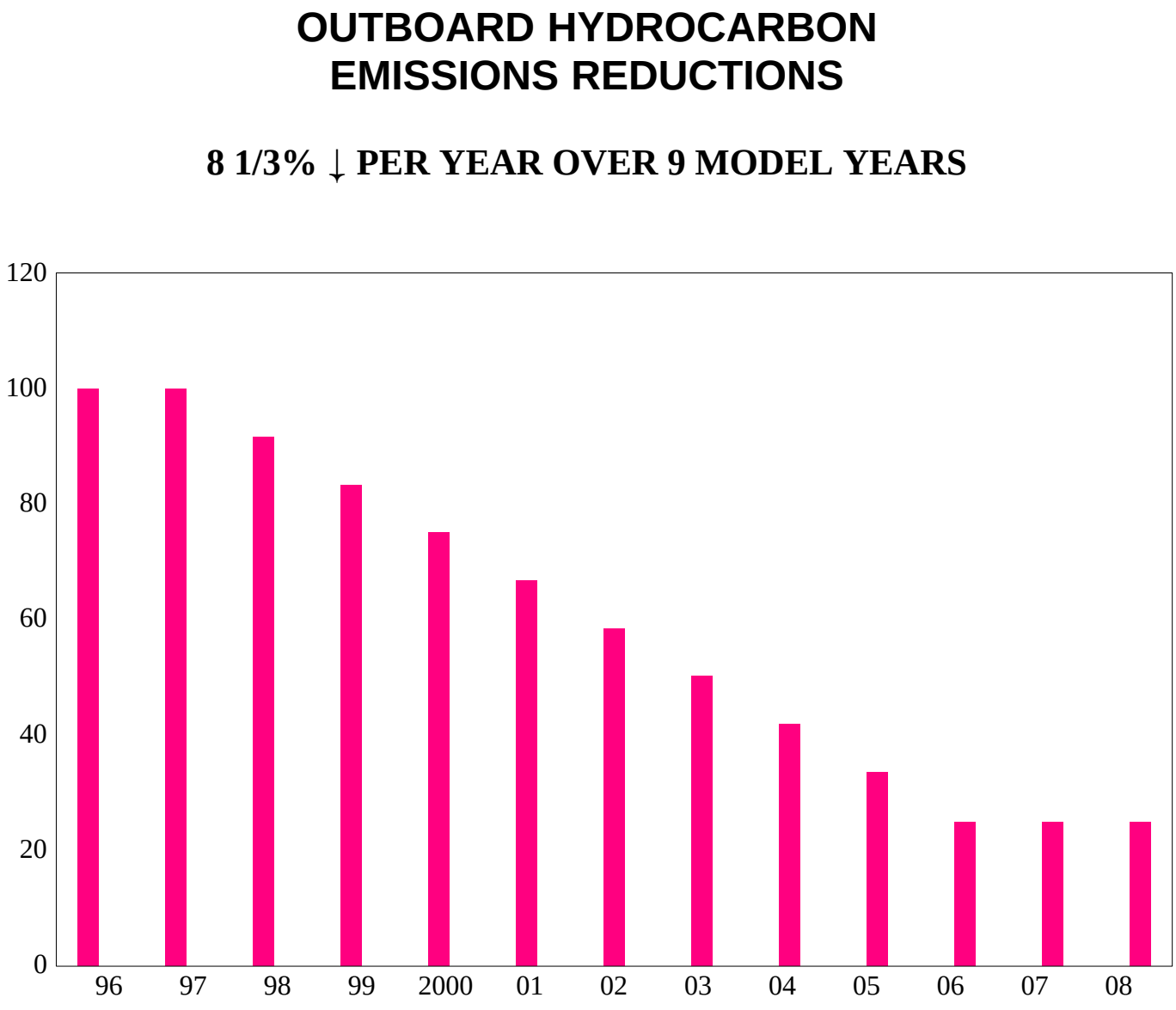
Controlling Emissions

There are two principle methods of reducing emissions from a two-stroke-cycle marine engine. The first method is to control the air/fuel ratio that goes into the combustion chamber. The second is to control the time when this air/fuel mixture enters the combustion chamber. Timing is important, to prevent any unburned mixture from escaping out of the exhaust port.

Stoichiometric (14.7:1) Air/Fuel Ratio

In the search to control pollutants and reduce exhaust emissions, engineers have discovered that they can be reduced effectively if a gasoline engine operates at an air/fuel ratio of 14.7:1. The technical term for this ideal ratio is stoichiometric. An air/fuel ratio of 14.7:1 provides the best control of all three elements in the exhaust under almost all conditions. The HC and CO content of the exhaust gas is influenced significantly by the air/fuel ratio. At an air/fuel ratio leaner than 14.7:1, HC and CO levels are low, but with a ratio richer than 14.7:1 they rise rapidly. It would seem that controlling HC and CO by themselves might not be such a difficult task; the air/fuel ratio only needs to be kept leaner than 14.7:1. However, there is also NOx to consider.

As the air/fuel ratio becomes leaner, combustion temperatures increase. Higher combustion temperatures raise the NOx content of the exhaust. But, enrichening the air/fuel ratio to decrease combustion temperatures and reduce NOx also increases HC and CO, as well as lowering fuel economy. So the solution to controlling NOx - as well as HC and CO - is to keep the air/fuel ratio as close to 14.7:1 as possible.

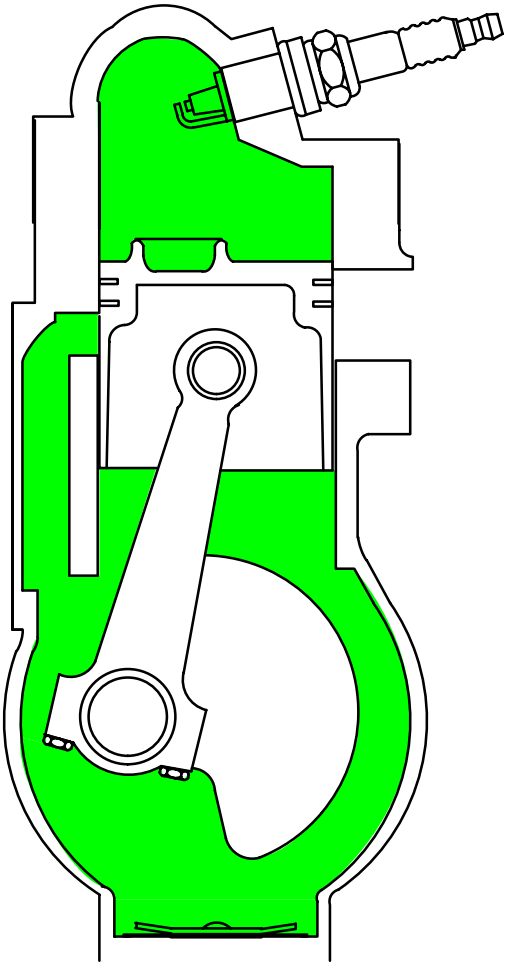


STRATIFIED VS HOMOGENIZED CHARGE

DFI engines use a stratified charge inside the combustion chamber to aid in reducing emissions. All other models use a homogenized charge. The difference between the two is:

Homogenized Charge

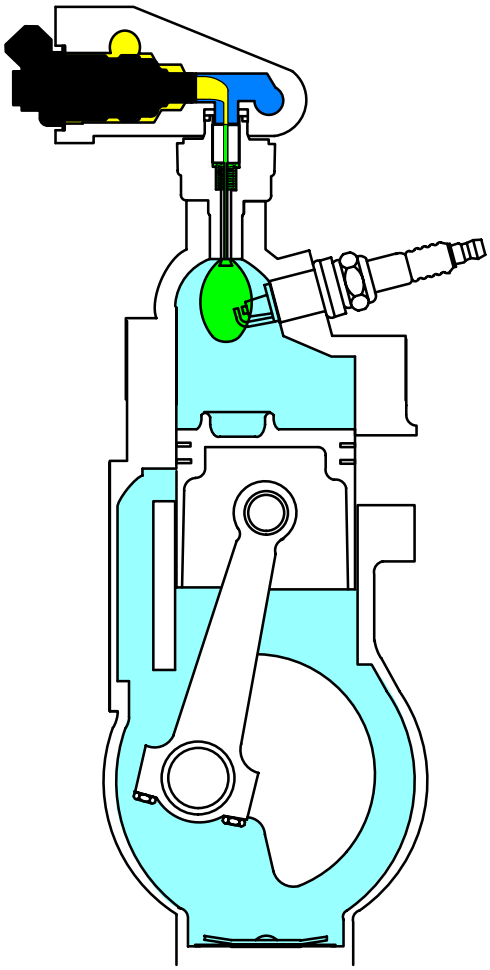
A homogenized charge has the fuel/air particles mixed evenly throughout the cylinder. This mixing occurs inside the carburetor venturi, reed blocks and crankcase. Additional mixing occurs as the fuel is forced through the transfer system into the cylinder. The homogenized charge is easy to ignite as the air/fuel ratio is approximately 14.7:1.



Stratified Charge

A stratified charge engine only pulls air through the transfer system. The fuel required for combustion is forced into the cylinder through an injector placed in the top of the cylinder (head). The injector sprays a fuel/air mixture in the form of a bubble into the cylinder. Surrounding this bubble is air supplied by the transfer system. As the bubble is ignited and burns, the surrounding air provides almost complete combustion before the exhaust port opens.

A stratified charge is hard to ignite, the fuel/air bubble is not evenly mixed at 14.7:1 and not easily ignited.



Emissions Information

Manufacturer's Responsibility:

Beginning with 1998 model year engines, manufacturers of all marine propulsion engines must determine the exhaust emission levels for each engine horsepower family and certify these engines with the United States Environmental Protection Agency (EPA). A certification decal/emissions control information label, showing emission levels and engine specifications directly related to emissions, **must** be placed on each engine at the time of manufacture.

Dealer Responsibility:

When performing service on all 1998 and later outboards that carry a certification, attention must be given to any adjustments that are made that affect emission levels.

Adjustments must be kept within published factory specifications.

Replacement or repair of any emission related component must be executed in a manner that maintains emission levels within the prescribed certification standards.

Dealers are **not** to modify the engine in any manner that would alter the horsepower or allow emission levels to exceed their predetermined factory specifications.

Exceptions include manufacturers prescribed changes, such as that for altitude adjustments.

Owner Responsibility:

The owner/operator is required to have engine maintenance performed to maintain emission levels within prescribed certification standards.

The owner/operator is **not** to modify the engine in any manner that would alter the horsepower or allow emissions levels to exceed their predetermined factory specifications.

Exceptions:

- Carburetor jets may be changed for high altitude use in accordance with factory recommendations.
- Single engine exceptions may be allowed with permission from the EPA for racing and testing.

EPA Emission Regulations:

All new 1998 and later outboards manufactured by Mercury Marine are certified to the United States Environmental Protection Agency as conforming to the requirements of the regulations for the control of air pollution from new outboard motors. This certification is contingent on certain adjustments being set to factory standards. For this reason, the factory procedure for servicing the product must be strictly followed and, whenever practicable, returned to the original intent of the design.

The responsibilities listed above are general and in no way a complete listing of the rules and regulations pertaining to the EPA laws on exhaust emissions for marine products. For more detailed information on this subject, you may contact the following locations:

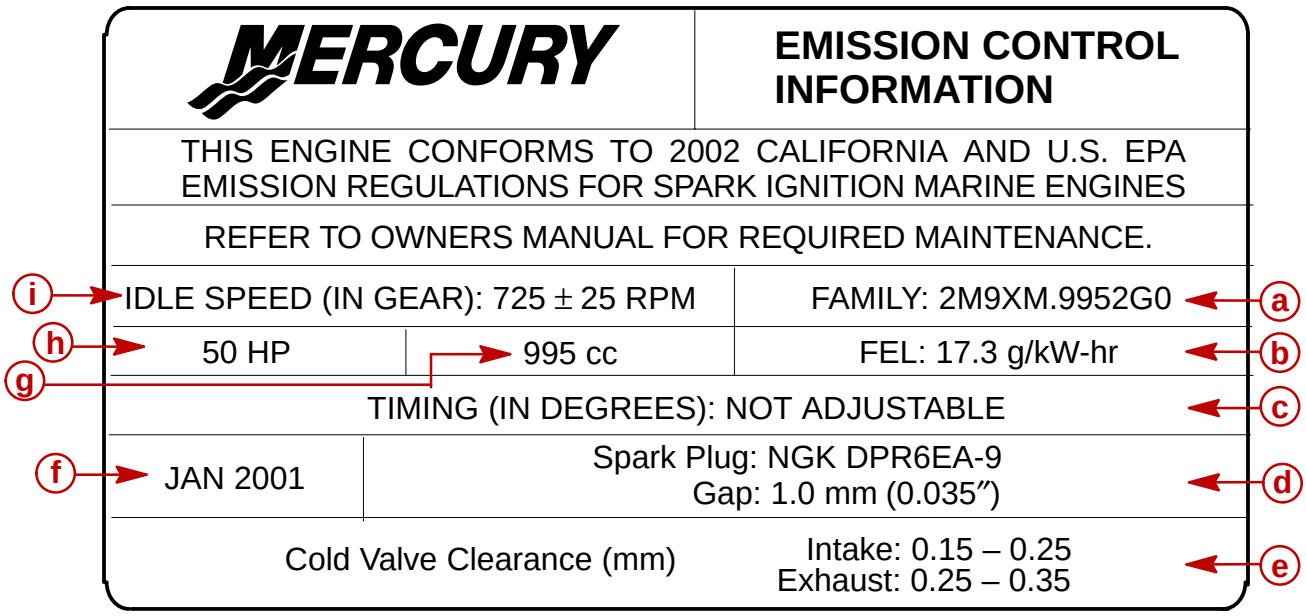
VIA U.S. POSTAL SERVICE:
Office of Mobile Sources
Engine Programs and Compliance Division
Engine Compliance Programs Group (6403J)
401 M St. NW
Washington, DC 20460

VIA EXPRESS or COURIER MAIL:
Office of Mobile Sources
Engine Programs and Compliance Division
Engine Compliance Programs Group (6403J)
501 3rd St. NW
Washington, DC 20001

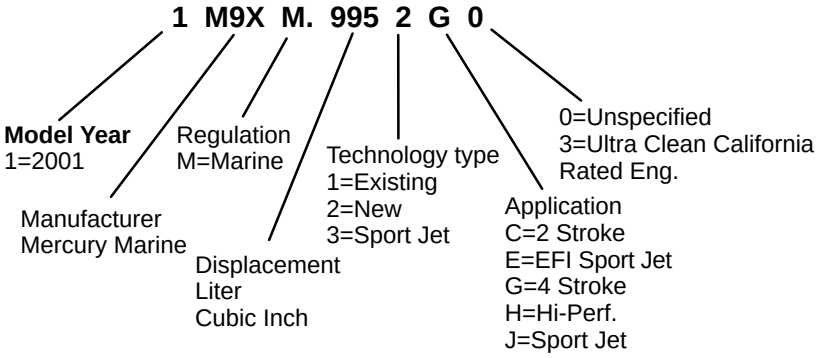
EPA INTERNET WEB SITE:
http:/www.epa.gov/omswww

CERTIFICATION LABEL:

The certification label must be placed on each engine at the time of manufacture and must be replaced in the same location if damaged or removed. Shown below is a typical certification label and is not representative of any one model. Label shown below is not to scale; (shown at twice the normal size).



a-Family Example
b-FEL: Represents (Mercury Marine) statement of the maximum emissions output for the engine family
c-Timing specifications when adjustable
d-Recommended spark plug for best engine performance
e-Valve Clearance (Four Stroke engines only)
f-Date of Manufacture
g-Cubic Centimeter
h-Engine Horsepower rating
i-Idle Speed (In Gear)



Decal Location

Model	Service Part No.	Location on Engine
2001 Merc/Mar 995 cc	37-804655AO1	Flywheel/Rewind Cover
2002 Merc/Mar 995 cc	37-804655AO2	Flywheel/Rewind Cover

Service Replacement Certification Label

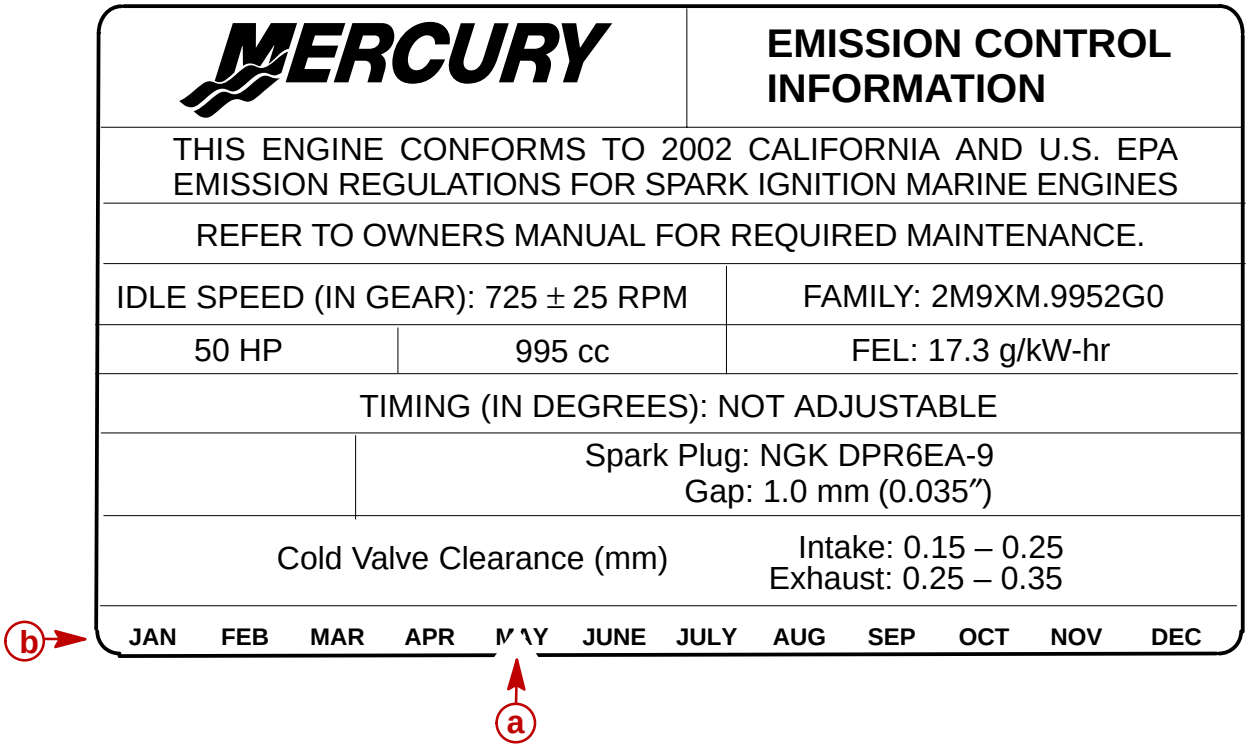
IMPORTANT: By federal law, it is required that all 1998 and newer Mercury Marine outboards have a visible and legible emission certification label. If this label is missing or damaged, contact Mercury Marine Service for replacement if appropriate.

Removal

Remove all remaining pieces of the damaged or illegible label. Do not install new label over the old label. Use a suitable solvent to remove any traces of the old label adhesive from the display location.

Date Code Identification

Cut and remove a “V” notch through the month of engine manufacture before installing the new label. The month of manufacture can be found on the old label. If the label is missing or the date code illegible, contact Mercury Marine Technical Service for assistance.



a-“V” Notch
b-Month of Manufacture

Installation

Install the label on a clean surface in the original factory location.

Decal Location:

Model	Service Part No.	Location on Engine
2001 Merc/Mar 995 cc	37-804655AO1	Flywheel/Rewind Cover
2001 Merc/Mar 995 cc	37-804655AO2	Flywheel/Rewind Cover