THE NEW ERA OF GASOLINE FUEL INSTALLATIONS - ABYC H-24 & H-25

New EPA Regulations Have Made Significant Changes to Gasoline Fuel Systems on Boats. Here's What You Need to Know

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After several years of discussion, investigation and review, the U.S. Environmental Protection Agency (EPA) has introduced completely new regulations governing fuel installations on boats with gasoline engines or equipment. Most of these new regulations have been implemented starting in 2009 and through 2011. (A few final aspects are scheduled for implementation in 2012.) New regulations and requirements mean added cost and complexity, but they are the law and must be followed fully.

In fact, the new requirements could well have been still more onerous, but various boating industry organizations (such as NMMA) helped to explain industry concerns and work out acceptable solutions. No organization was more instrumental in assuring that the new regulations were as sensible and reasonable as possible than the Technical Department of ABYC. Under the direction of ABYC vice president and Tech Department director, John Adey, ABYC not only worked with the EPA regulators, but assisted in research and in conducting tests to demonstrate that—where possible—simpler and more cost-effective solutions would be acceptable.

We'll review here what the new EPA regulations are and explain some of the practical approaches for implementing them. These regulations are now law under the Code of Federal Regulations, specifically 40 CFR Part 1060. They will affect the way you design, build, repair or inspect gasoline boats from now on.

The new rules cover three ways that the EPA identified in which hydrocarbons can enter the atmosphere from a gasoline boat's fuel system:

1) Evaporative Emissions
2) Diurnal Emissions
3) Fueling Spitback

Evaporative emissions are fuel that escapes from the fuel system through permeation through the walls of hoses or of plastic tanks or, as a result of ventilation. On small gasoline fuel systems, the primer bulb can also be a source of evaporative emissions.

Diurnal Emissions are the daily emissions of fuel that escape through the vent. They are daily or diurnal as the cycles in temperature from day to night (during a 24-hour period) cause regular expansion and contraction of the fuel. This results in gasoline vapor and droplets escaping through the vent. (Diurnal means recurring every day, or having a daily cycle.)

Fueling spitback or wellback is spitting or splashing of fuel back out of the fill pipe past or around the fill nozzle.

Evaporative Emissions

Fuel-line hoses were identified as one of the ways in which gasoline vapors could escape into the atmosphere. Standard USCG/SAE marine fuel hose was rated A1 or A2 or B1 or B2. The A and B indicate fire rated or not. The 1 and the 2 are USCG permeability ratings. Under SAE (Society of Automotive Engineers) standard J-1527, the 1 equals 100 grams per square meter permeation rate per day, the 2 equals 200 grams per square meter permeation per day. The EPA determined that only 15 grams per square meter per day was acceptable.

USCG A1-15 Fuel Hose
Courtesy Trident Hose

After extensive testing, it was found that most (but not all) standard A1 USCG fuel already in use actually met the 15 g/sq.m per day requirement. New marine fuel hoses must now all meet the 15 g/sq.m. per day standard. These new hoses must be marked:

A or B and 1, plus "-15" for the EPA standard.

New Gasoline Fuel-Installation Requirements

Compliant fuel hose marking is:

USCG TYPE A1-15 J1527 (or ISO 7840)

The A = USCG fire test
The 1 = USCG permeation test rating
The -15 = EPA Permeation requirements.

A "B" instead of an "A" would indicate that the hose did not have a fire resistant cover to pass the 2-1/2-minute burn test.

Carbon Canister

Courtesy Attwood

Traditionally, marine fuel hose with the "1" rating was expected to have fuel in it a good portion of the time, while a "2"-rated hose was not intended to have fuel in it. Hose rated 2 will not meet the -15 EPA requirement, so A2 and B2 hose can now primarily only be used on diesel boats. In fact, you will not find an A2 or B2 hose that had the additional "-15" marking required for use on gasoline systems. The exception is A2 fill hose for fill lines. If it can be demonstrated that the fill hose will not contain or hold fuel itself, A2 can be used. (This brings us to auto fuel-nozzle shut-off, covered below.)

Metal fuel tanks do not suffer from permeation, but plastic gasoline fuel tanks can. ABYC began a working group to identify the challenges of creating a tank that meet the EPA permeation rating while still maintaining the safety and reliability of cross-linked polyethylene. After several meetings, it became clear that technology was becoming available to meet the permeation ratings while passing the current test and maintaining the current properties of plastic tanks. All tanks must now meet the traditional tests as well as the EPA permeation requirements.

One nice aspect of this is that the new permeation rate falls well below the threshold for the ventilation required of spaces containing gasoline equipment. It will no longer be necessary to vent a space containing a plastic gasoline tank once these tanks meet the EPA permeation requirements. As with hoses, many tanks (though not all) met the EPA threshold for years even though there was no requirement to do so.

Diurnal Emissions

Carbon Canisters

In order to reduce the hydrocarbons escaping into the atmosphere as a result of diurnal emissions, it was found that a carbon canister should be added to the gasoline vent line. In fact, this is the same as automotive carbon canisters. Adding a carbon canister to the vent line is an entirely new component—a significant change aboard gasoline boats.

The expansion of the fuel in the tank during the day sends vapor through the vent and thus through the carbon canister and the carbon absorbs much of the hydrocarbons. When the cycle is reversed during cooling at night, air passes back into the vent and through the carbon canister. This purges the carbon of most of the hydrocarbons returning them to the tank.

Carbon canisters are nothing more than a sealed container filled with activated charcoal. It usually most convenient to fabricate them in roughly cylindrical shapes out of pipe or tube, with inlet and exit barbs at each end.

Minimum canister size is calculated as follows :

For boats less than or equal to 26 feet, the canister size in liters = 0.04 x Fuel tank capacity in gallons.

EXAMPLE: An 18-foot boat with a 25-gallon tank would require a canister of 0.04 x 25 = 1.0 liters

For boats greater than 26 feet the canister size in Liters = 0.016 x Fuel tank capacity in gallons.

EXAMPLE: A 30 foot boat with a 250 gallon tank would require a canister of 0.016 x 250 = 4.0 liters

If convenient for some reason, two or more canisters can be strung in series to meet the required minimum volume. Perko and Attwood are two manufacturers producing carbon canisters.

The reason there are different requirements for boats less than and greater than 26 feet is that the EPA determined that boats larger than 26 feet would usually spend more time in the water. The water moderates the cooling and heating effect driving diurnal emissions, so—on average—larger boats can be expected to have proportionally lower diurnal emissions, which can be handled by smaller carbon canisters.

An enormous amount of testing was done by NMMA, simulating the worst-case heating and cooling cycle. The results enabled NMMA to negotiate a more realistic number than

New Gasoline Fuel-Installation Requirements

was originally offered by the EPA.

Installing the required carbon canister creates some new issues of its own. The carbon is very sensitive to liquid immersion—water and fuel. Liquid has to be kept from entering the canister. In fact—on many vessels—typical boaters determine when their tank has been topped off during fueling by watching to see when gasoline starts spilling out of the vent. If this happens with a carbon canister in the vent line, the canister will, obviously, be completely flooded with fuel.

Finally, the canister itself is an interesting component. Does it need to meet the 2-1/2 minute burn test? (Yes if inside the engine compartment, no if outside.) How should it be mounted? Can it handle boat shock and vibration? How about prolonged low (or high) temp winter storage? How do we measure its effectiveness? All of these items are addressed in a new ABYC standard to be published in 2012.

Gasoline boats must not only comply, but the boatbuilder must install certified components and affix a label visible from the helm with the company's name and the statement:

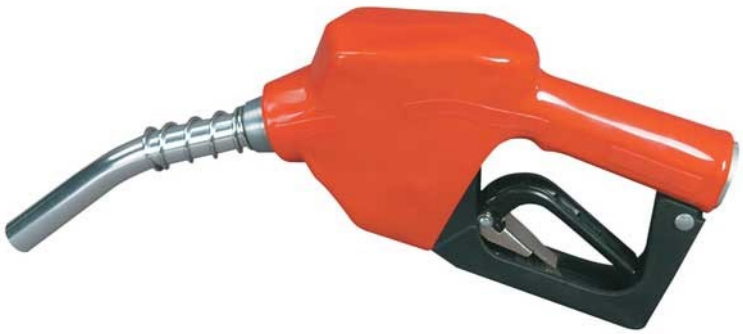
Meets U.S. EPA Evap Standards Using Certified Components

Auto Fill Shutoff

The other really big change is the requirement for auto fill-nozzle shutoff. The fuel-fill nozzle is to shut off in compliance with SAE J 285, *Dispenser Nozzle Spouts for Liquid Fuels Intended for Use with Spark Ignition and Compression Ignition Engines*.

Many have asked why this is included with all of the other changes that boatbuilders will be facing, and the reasons are as follows:

a) It was determined early on that liquid fuel is detrimental to the canister (and allows fuel in a place we did not intend it to be). Activation of the nozzle auto-shutoff feature was a way to ensure the liquid level in the tank remained where it was supposed to.



b) There has always been a ullage space (air space at the top of the tank) required for expansion, the auto shut-off ensures this. (Ullage is specifically the amount of volume in a tank that is not filled with liquid. Ullage can be quantified as an absolute quantity in gallons or cubic feet or it can be quantified as a percentage of maximum tank capacity.)

c) We needed a way to keep the fill hose free of fuel (in order for it NOT to have to meet the 15 g/m^2/day permeation) so, auto shut-off became the answer. (A1-15 hose is not manufactured in diameters large enough for fuel fills, so standard A2 hose needs to be employed here.)

d) Fuel system manufacturers agreed that this is the time to tackle this problem and not wait for another regulation that would cause this change.

e) This is NOT part of the new EPA regulation but is something that the industry decided to do through ABYC's H-24 and H-25 PTCs (project technical committees), which are a good representation of the industry as a whole through ABYC's ANSI rules.

All gasoline boats now have to be tested to demonstrate that their fuel systems do cause the fill nozzle to shut off when the tank is filled to the proper level or ullage amount. For boats 26 feet and under, the testing is done at the following angles of heel and trim:

4 degrees list to starboard
4 degrees list to port
4 degrees down by the bow
4 degrees down by the stern

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For boats over 26 feet, the fuel shutoff test is conducted only for the normal static floating position.

Testing the Emissions Components

When the nozzle-shutoff test is complete—with the tanks filled to their maximum level at nozzle shutoff—the emissions components (the vent and carbon canister) and other portions of the fuel-storage system (such as A2 fuel-fill hose) must be shown not to have accumulated or hold gasoline. This is after fuel a temperature rise of 60° F (33° C) over the ambient temperature. (This can be from actual temperature increase or maintaining temperature and simulating volumetric thermal expansion.)

For boats under 26 feet long the test should be conducted at:

7 degree list to starboard
7 degree list to port
17 degree down by the bow
17 degree down by the stern

With nozzle flow rates of 4 and 10 GPM.

New Gasoline Fuel-Installation Requirements

The Kind of Grades Trailer Boats May End Up On
Courtesy John Adey/ABYC

These large angles simulate a trailerable boat parked on land in on a driveway or storage lot with a significant grade.

For boats 26 feet and over, the test angles are:

2 degree list to starboard
2 degree list to port
4 degrees down by the bow
4 degrees down by the stern

With nozzle flow rates of 4, 10 and 18 GPM.

The lower nozzle flow rates for smaller boats are because it is expected they will frequently be refilled on their trailer at automotive filling stations, which are limited to a maximum of 9 GPM fill rate.

Watertight Vent Fitting
Because the carbon canister cannot be allowed to get wet (either from fuel or water), the vent fitting exiting the hull must be watertight. It must resist a direct nozzle spray for at least 15 minutes at at least 2 inches per hour at 5 psi, with no measurable water anywhere in the fuel system after the spraying.

It must also resist a stream of direct water from a one-inch nozzle, at a pressure of 15 psi at the nozzle, with the nozzle 10 feet away, for a period of 5 minutes. Again, there must be no measurable water anywhere in the fuel system after this test.

One method of meeting these requirements is with a P-Trap vent fitting available from manufacturers such as Perko and Attwood. Where the distance from the tank to the vent outlet is short, you may want to install a P-Trap with a built-in surge chamber, which is available from Attwood and others.

Prior versions of ABYC H-24 specified a minimum 7/16-inch diameter vent line. Because of the requirements for a watertight vent fitting this requirement has been changed to read that the vent system must prevent the pressure in the tank from exceeding 80% of the tank test pressure. This actually returns to the wording of the original 33 CFR.

Methods of Compliance
Several companies already offer gasoline-fuel-system components to meet the new EPA regulations. Other companies are offering entire fuel systems.

The illustration shows the system offered by one manufacturer:

The P-trap meets the vent water tightness requirement.

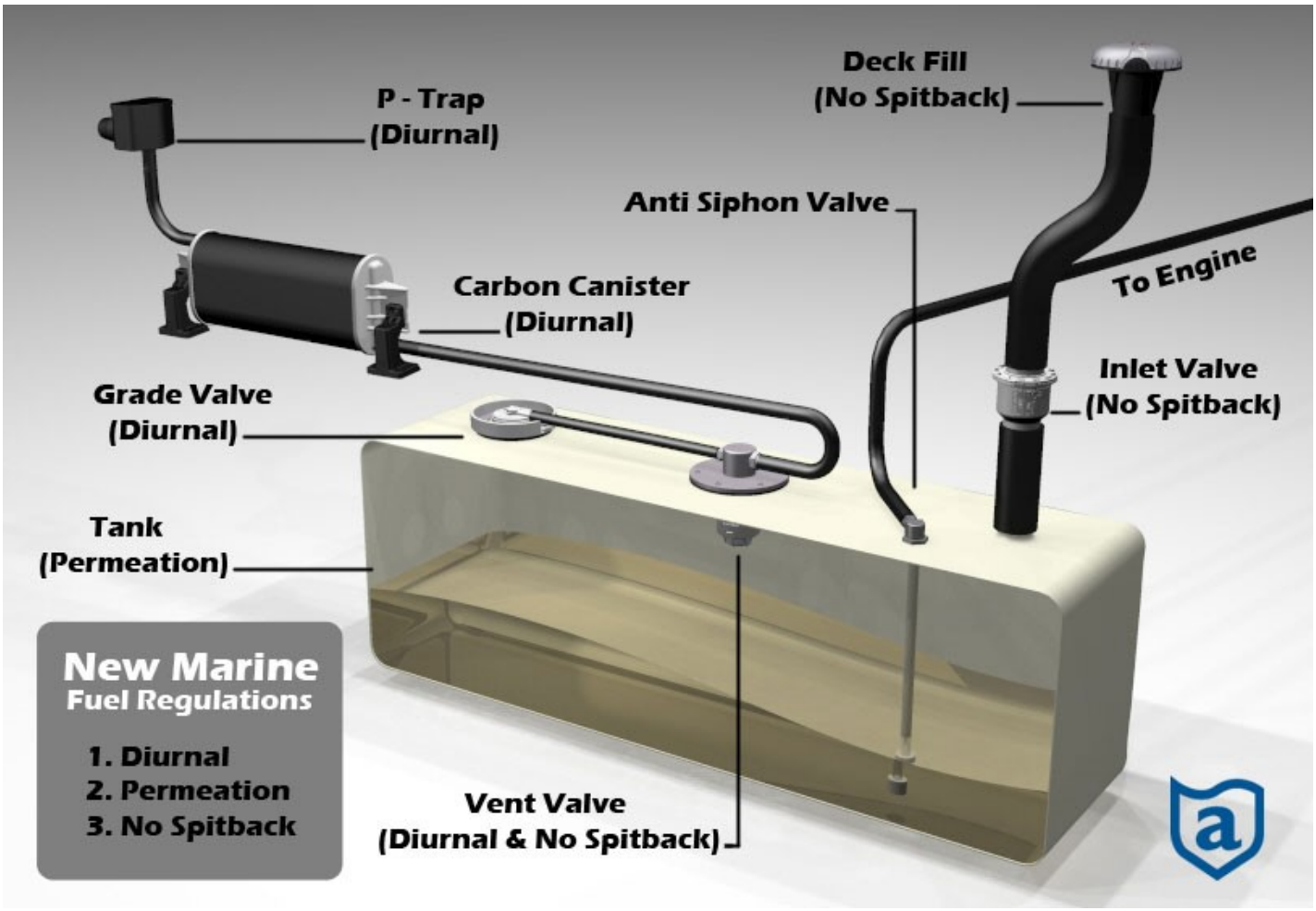
The grade and vent valves ensure that the fuel rises up in the fill line and shut off the nozzle at all the various angles of heel, with the correct ullage in the tank.

Keep in mind that the “new” valves aren’t new. They have been used in automotive applications for over thirty years.

P-Trap Vent Fitting
Courtesy Attwood

Inspection and Maintenance
Don’t forget that all the fuel-system components must be accessible for inspection, maintenance and repair. This may mean installing additional access ports or panels to access

New Gasoline Fuel-Installation Requirements



some of the new required items.

Portable Tanks and Primer Bulbs
Under the new EPA regulations portable gasoline tanks must have vents that remain closed until at least 5 psi internal pressure. This creates enormous pressure in a tank, resulting in both fuel leaking through the hose and overflowing a connected engine and creating surging fuel (a geyser) when the cap is loosened under pressure.

ABYC's new H-25 standard addresses the venting options for portable tanks. A manual relief or automatic relief of pressure is allowed and accepted by the EPA. The EPA has indicated that they will reference ABYC H-25 regarding portable tanks.

Primer bulbs used on smaller gasoline engines, are subject to the same emissions requirements as hoses and plastic tanks and any other fuel-system component. Final details on primer bulbs are due out in 2012.

Meeting the Standards on Custom Boats?
What do you do if you're a custom builder and you're building a gasoline boat? You can purchase a complete gasoline fuel system (such as those from Perko or Attwood). This may be the simplest way to comply.

Alternately, for most installations, creating a 5% to 8% ullage at the top of the tank will ensure that fuel will not remain in the fill hose. A "forced" ullage will thus be created by extending the vent pipe (and the fill) down into the tank below the tank top to the height of the desired ullage. When the fuel reaches the level of the extended vent pipe, pressure will build and the fill nozzle will auto shutoff. If the vent pipe is located at the geometric center of the tank top, it should cause proper shut-off and proper venting at the required angles, particularly for boats over 26 feet.

A carbon canister can then be added to the vent line, to meet diurnal emissions requirements, and a P-Trap vent fitting to ensure water doesn't enter.

All these new requirements are *performance* based. Accordingly, you can try simple approaches as above, but remember the word "performance." You can't just build a fuel system like this and assume it will work. You MUST test it to demonstrate it actually complies with all the requirements.

Home-built boats must meet these criteria as well, with the home builder as the builder of record on the compliance label at the helm.

New Gasoline Fuel-Installation Requirements

Not Applicable to Older Boats

New tanks and fuel lines are not subject to the new EPA requirements when installed in older boat built prior to the implementation of the standard.

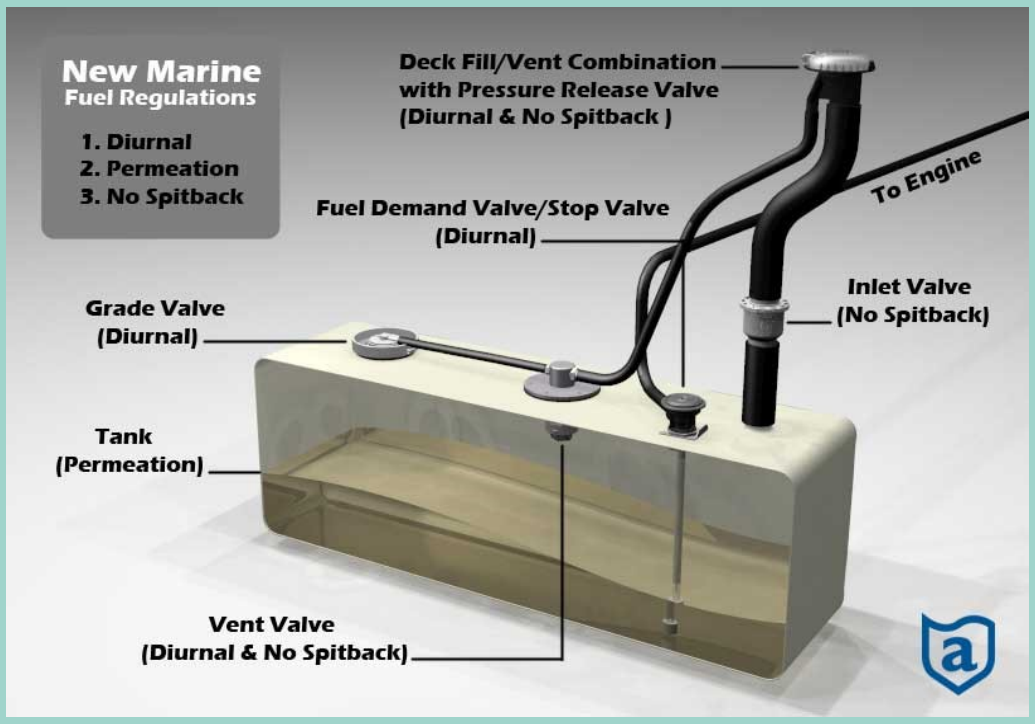
The Last Word

ABYC's standards H-24 and H-25 cover all the requirements for a installed or portable gasoline fuel system. ABYC's publication, *EPA Regulations for Recreational Boats*, covers the full range of EPA regulations applicable to pleasure boats.

This article was made possible by information provided by ABYC president , John Adey, by the ABYC Tech Department and by the work of the ABYC PTC committees, which, in coordination with industry and the EPA, produced the latest versions of H-24 and H-25 — www.abycinc.org

The Pressure-Relief System Option

There is an option in 40 CFR to seal the fuel system to 1 psi instead of a using a carbon canister. This method has been employed in the PWC industry for years. It is an option that builders are currently exploring. H-24 does not give details; however, it does not preclude using this method. Companies are moving closer and closer to this option for certain types of boats. ABYC is investigating several issues surrounding this method and will be adding more detailed testing and information as the results dictate.



Courtesy Attwood

Solaris
The First 100% Solar-Powered Passenger Boat Approved for Use in the United States

Designed by Gerr Marine, to a concept by Capt. David Borton PhD, and owned and operated by the Hudson River Maritime Museum, in Kingston New York, the 44-ft. *Solaris* cruises all day and well into the night entirely powered by her 5-kw solar-panel array. Approved for 28 passengers, *Solaris* is the first commercial passenger vessel in U.S. history to be granted a certificate of inspection (COI) by the Coast Guard.

No fuel tanks on *Solaris!*