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**Equipment Division Standard  
Thermal Appliance Project Technical  
Committee**

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# **ABYC A-22**

## **MARINE COMPRESSED NATURAL GAS (CNG) SYSTEMS**



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This standard was developed under procedures accredited as meeting the criteria for American National Standards. The Project Technical Committee that approved the standard was balanced to ensure that individuals from competent and concerned interests have had an opportunity to participate.

This standard, which is the result of extended and careful consideration of available knowledge and experience on the subject, is intended to provide minimum performance requirements.

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Upon written request, the Thermal Appliance PTC will render an interpretation of any requirement of the Standard. The request for interpretation should be clear and unambiguous. Requests should be presented to the PTC in a manner in which they may be answered in a yes or no fashion.

The committee reserves the right to reconsider any interpretation when or if additional information which might affect it becomes available to the PTC. Persons aggrieved by an interpretation may appeal to the Committee for reinterpretation.

## **A-22 MARINE COMPRESSED NATURAL GAS (CNG) SYSTEMS**

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## A-22 MARINE COMPRESSED NATURAL GAS (CNG) SYSTEMS

*Based on ABYC's assessment of the existing technology, and the problems associated with achieving the goals of this standard, ABYC recommends compliance with this standard for all systems manufactured or installed after July 31, 2013.*

### 22.1 PURPOSE

This standard is a guide for the design, manufacture, installation, and maintenance of compressed natural gas (CNG) systems on boats.

### 22.2 SCOPE

This standard applies to compressed natural gas (CNG) systems used on boats, up to the point of connection with the CNG appliance.

#### NOTES:

**1. The U.S. Coast Guard regulations prohibit the use of compressed natural gas (CNG) on certain vessels and set different standards for small passenger vessels.**

**2. [ABYC A-1, Marine Liquefied Petroleum Gas \(LPG\) Systems](#), covers requirements for liquefied petroleum gas (LPG) systems for boats.**

**3. [ABYC A-3, Galley Stoves](#), covers requirements for CNG galley stoves.**

**4. [ABYC A-26, LPG and CNG Fueled Appliances](#), covers requirements for CNG and LPG fueled appliances other than galley stoves.**

### 22.3 REFERENCES

22.3.1 The following publications form a part of this standard. Unless otherwise noted the latest version of referenced standards shall apply.

22.3.1.1 ABYC - American Boat & Yacht Council, Inc., 613 Third Street, Suite 10, Annapolis, MD 21403  
Phone: (410) 990-4460. Fax: (410) 990-4466. Website: [www.abycinc.org](http://www.abycinc.org)

[ABYC A-1, Marine Liquefied Petroleum Gas Systems \(LPG\)](#)  
[ABYC T-5, Safety Signs and Labels](#)

22.3.1.2 AGA - American Gas Association, 400 N. Capitol Street NW, Washington, DC 20001. Phone: (202) 824-7000. Fax: (202) 824-7115. Website: [www.aga.org](http://www.aga.org)

22.3.1.3 CFR - Code Of Federal Regulations and other government publications. Obtain from the Superintendent of Documents, United States Government Information, POB 371954, Pittsburgh, PA 15250-7954. Phone: (202) 512-1800 or Fax: (202) 512-2250. Website: [www.access.gpo.gov](http://www.access.gpo.gov). An excerpted edition of the CFR is also available from ABYC, Inc.

33 CFR 183.410(a)

22.3.1.4 CGA - Compressed Gas Association, 14501 George Carter Way, Suite 103 Chantilly, VA 20151-2923  
Phone: (703) 788-2700 Fax: (703) 961-1831 Website: [www.cganet.com](http://www.cganet.com)

22.3.1.5 DOT - US Department Of Transportation, 1200 New Jersey Avenue, SE, Washington, DC 20590 Phone: (202) 366-4000. Website: [www.dot.gov](http://www.dot.gov)

22.3.1.6 NFPA - National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02269 Phone: (617) 770-3000. Fax: (617) 770-0700. Website: [www.nfpa.org](http://www.nfpa.org)

NFPA 52 *Compressed Natural Gas (CNG) Vehicular Fuel Systems*

22.3.1.7 SAE - Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096. Phone: (724) 776-4970. Fax: (724) 776-0790. Website: [www.sae.org](http://www.sae.org)

SAE J1171 *External Ignition Protection of Marine Electrical Devices*

22.3.1.8 UL - Underwriters Laboratories Marine Department, POB 13995, 12 Laboratory Drive, Research Triangle Park, NC 27709 (919) 549-1400. Website: [www.ul.com](http://www.ul.com)

UL 1500- *Ignition Protection Test For Marine Products*

## 22.4 DEFINITIONS

For the purposes of this standard, the following definitions apply.

22.4.1 Accessible - capable of being reached for inspection, removal, or maintenance without removal of permanent boat structure.

22.4.2 Readily Accessible - capable of being reached quickly and safely for effective use under emergency conditions without the use of tools.

22.4.3 Accommodation Spaces - spaces designed for living purposes for persons aboard a boat. Examples of specific uses of accommodation spaces include: staterooms, heads (bathrooms), galley, pilothouse, navigation, workshop, and other similar people-oriented spaces. These uses contrast with engine and fuel tank compartments.

22.4.4 Attended Appliance - an appliance that is installed in the cabin of a boat and used when the occupants are in the cabin. An attended appliance requires action and attention by an operator, including operator initiated ignition.

22.4.5 Compressed Natural Gas (CNG) - a gas that consists principally of methane in gaseous form and includes naturally occurring mixtures of hydrocarbon gases. CNG is a natural gas that is normally supplied as a fuel by a gas utility and is stored under pressure in portable cylinders.

22.4.6 Cylinder - any vessel or container used to transport or store CNG.

22.4.7 Locker - an enclosure intended for storage of one or more CNG cylinders.

22.4.8 System - the arrangement of cylinders, safety devices, regulators, connections, valves, piping, tubing, hose, fittings, and devices intended to store, supply, monitor, or control the flow of fuel gas up to, but not including, the appliance.

## 22.5 REQUIREMENTS – IN GENERAL

22.5.1 Comprehensive printed instructions and a labeled diagram(s) covering details of proper installation, maintenance, and operation shall be provided with each CNG system installed in a boat. These instructions shall include the requirements for a system test every time the cylinder supply valve is opened for use.

22.5.2 Components of this system that are subject to cylinder pressure shall have a working pressure that is at least 133 percent of the maximum fill pressure of the cylinder.

**NOTE: CNG Cylinder maximum fill pressure is approximately 2,600 psi (17,926 kPa)**

22.5.3 The system and all its components, as installed, shall be capable of operation within an ambient temperature range of 0°F (-18°C) to 140°F (60°C).

22.5.4 All devices and appliances using CNG shall be secured so as to prevent upset or displacement that will place strain on the fuel distribution system or appliance connections.

**NOTE: In some applications, the CNG cylinder, system components, and appliances could be subjected to repeated impact loads. When designing and installing a CNG system, the impact loads should be considered with regard to amplitude and direction depending on the type of vessel and its anticipated use.**

## 22.6 **IGNITION PROTECTION**

22.6.1 All electrical sources of ignition located in a compartment containing CNG appliances, cylinders, fittings, valves, or regulators shall be ignition protected, and

22.6.1.1 have all potential electrical sources of ignition located in the compartment ignition protected and so marked (for example "SAE J1171 Marine", "UL 1500 Ignition Protected", or "Ignition Protected"), when located within 40 inches (one meter) of, or located above the level of any CNG appliance, storage cylinder, fittings, valves or the regulator. If the potential leakage source is high pressure (the storage cylinder or associated fittings) the potential ignition source shall not be within 40 inches (one meter) in any direction, and

22.6.1.2 have no open flame devices, or devices or equipment capable of emitting sparks, and

22.6.1.3 have no exhaust pipes or heat producing devices capable of producing a temperature in excess of 300°F (149°C).

### **EXCEPTIONS:**

**1. Accommodation spaces.**

**2. Open compartments having at least 15 in<sup>2</sup> (97 cm<sup>2</sup>) of open area per cubic foot (0.028 m<sup>3</sup>) of compartment volume exposed to the open atmosphere outside of the boat.**

## 22.7 **FUEL CYLINDERS, VALVES, AND SAFETY DEVICES**

22.7.1 Cylinders used in CNG systems shall meet the applicable DOT regulations and AGA standards.

22.7.2 Pressure Regulator

22.7.2.1 Each CNG system shall be provided with a two stage pressure regulator specifically designed for use with CNG, and

22.7.2.1.1 the pressure regulator shall be made of materials that are compatible with CNG.

**NOTE: The very high pressure of the CNG cylinder requires the use of a two stage pressure regulator that reduces the pressure to a working pressure suitable for further reduction to the required appliance supply pressure.**

22.7.2.2 The CNG pressure regulator system, as installed, shall deliver gas to all appliances, under varying appliance loads, at a pressure not in excess of 0.23 psig (16 mbar).

22.7.2.3 The CNG pressure regulator shall be connected directly to the cylinder shut-off valve, using one CGA series 350 connection.

22.7.2.4 Each regulating system shall include a pressure gauge. The gauge shall read the cylinder pressure side of the pressure regulator.

**NOTE: The twofold purpose of this gauge is to monitor the amount of CNG fuel remaining in the storage cylinder, and to provide a quick and easy way to test the system for leakage. See [A-22.9.3.1](#)**

22.7.2.5 The pressure regulation system shall include a high flow restrictor located on the cylinder pressure side of the regulator that shall actuate and control gas flow through the vent system to the open atmosphere in the event of regulator malfunction.

22.7.2.6 The vent system shall be designed to contain the gas flow at the pressure present when the high flow restrictor is activated.

22.7.2.7 The high flow restrictor vent system shall be designed to contain the gas flow at the pressure that actuates the high flow restrictor.

22.7.2.8 The relief vent outlet(s) shall not discharge to the interior of the boat.

22.7.2.9 The vent discharge system shall be located and designed to prevent water from entering the regulation system.

22.7.2.10 The vent opening shall be protected against entry of other foreign material.

22.7.3 A readily accessible manual or electrically operated, (e.g., solenoid) shut-off valve(s) shall be installed in the low pressure line to all appliance(s), and

22.7.3.1 the valve or its control shall be operable from the vicinity of the attended appliance(s) in the event of a fire at the appliance(s).

22.7.3.2 The valve or its control shall be operable without reaching over the top of any open flame appliance, e.g., cooking appliance burners.

**EXCEPTION: If the cylinder valve(s) is readily accessible from the vicinity of the attended appliance(s), the shut-off valve(s) required in [A-22.7.3](#) is not required.**

22.7.4 Cylinders and Connected Devices - Location and Installation

**NOTE: Horizontal or vertical orientation of the cylinder position is not critical.**

22.7.4.1 CNG cylinders, cylinder valves, regulation equipment, and safety devices shall be readily accessible, secured for sea conditions, and protected from the weather and against mechanical damage.

22.7.4.2 CNG cylinder location shall be readily accessible so that the cylinder valve can be conveniently and quickly operated, and the system pressure gauge dial is fully visible.

22.7.4.3 CNG cylinders shall not be installed in compartments containing an internal combustion engine(s).

22.7.4.4 CNG cylinder storage compartments shall not have openings that communicate with the engine compartment above the level of the pressure regulator.

22.7.4.5 Storage provisions for unconnected reserve cylinders, filled or empty, shall be the same as the provisions for the cylinder in use.

22.7.4.6 For CNG installations that include cylinders with an attached combined capacity of 100 cubic feet (2.8 cubic meters) or less, cylinders, cylinder valves, regulating equipment, and safety devices shall be:

22.7.4.6.1 readily accessible, secured for sea conditions, and protected from the weather and against mechanical damage, or

22.7.4.6.2 in a vented dedicated location where escaping gases can flow into the atmosphere, or

22.7.4.6.3 in a dedicated compartment or locker that shall have a vent opening located above the cylinder.

22.7.4.6.3.1 The vent opening shall provide a path to the open atmosphere outside the boat for escaping vapors.

22.7.4.7 For CNG installations that include an attached combined capacity of greater than 100 cubic feet (2.8 cubic meters), the cylinders, and connected valves, regulating equipment, and safety devices shall be located on the exterior of the boat where escaping gases can flow directly into the atmosphere outside the boat, or

22.7.4.7.1 the cylinders and connected devices shall be installed in a dedicated locker.

22.7.4.7.1.1 Dedicated lockers shall be vapor tight to the hull interior, and

22.7.4.7.1.1.1 vented to the open atmosphere outside the boat, and

22.7.4.7.1.1.2 constructed of or lined with corrosion resistant materials, and

22.7.4.7.1.1.3 equipped with a means to discharge incidental accumulated water.

22.7.4.7.1.2 Dedicated lockers shall be equipped with a cover that

22.7.4.7.1.2.1 opens directly to the atmosphere, and

22.7.4.7.1.2.2 latches tightly, and

22.7.4.7.1.2.3 is capable of being quickly and conveniently opened without tools, and for operating the cylinder valves, testing the system for leakage, and viewing the pressure gauge.

## 22.8 **FUEL SUPPLY LINES**

22.8.1 Each appliance shall be served by a separate supply line.

22.8.2 CNG fuel supply lines shall not be used for an electrical ground.

22.8.3 Fuel supply lines shall be continuous lengths of tubing, or hose from the regulating device, solenoid valve, or leak detector, to the appliance, or to the flexible section at the appliance.

22.8.4 The fuel supply line system and its components, as installed, shall be compatible with CNG and,

22.8.4.1 shall withstand the stresses of, and exposure to, the marine environment.

22.8.5 Copper tubing is prohibited.

**Note: CNG, which is primarily methane, is corrosive to copper.**

22.8.6 Flexible CNG supply line shall meet the applicable requirements of NFPA 52 *Compressed Natural Gas (CNG) Vehicular Fuel Systems*.

**Note: Due to chemical composition differences, CNG and LPG supply lines are not interchangeable.**

### 22.8.7 Fuel Line Location and Installation

22.8.7.1 Fuel supply lines shall be protected from physical damage and shall be accessible for inspection.

22.8.7.2 A flexible fuel line section shall be used to allow for the free swing of gimbaled stoves.

22.8.7.3 Fuel supply lines shall be supported by clips or straps or other suitable means such as conduit or a tray to prevent vibration damage, and

22.8.7.3.1 the clips or straps or other devices shall be corrosion resistant, and

22.8.7.3.2 shall be designed to prevent cutting, abrading, or damage to the lines, and

22.8.7.3.3 shall be galvanically compatible with fuel supply line material.

22.8.7.4 Fuel supply lines shall be protected by close fitting grommets, sleeves, or sealants of non-abrasive material wherever they pass through decks and bulkheads.

22.8.7.5 Fuel supply lines passing through bulkheads that need not be watertight shall be installed so that the bulkheads will not cut, abrade, or damage the line.

## 22.9 **TESTING**

22.9.1 The system fuel supply line and fittings shall be tested to a pressure of not less than 5 psig (34.5 kPa). This test shall be after installation, but prior to its connection to the regulator and appliance(s).

22.9.2 The cylinder valve shall be checked for leakage at its connection to the cylinder by application of a leak detection fluid prior to connection to the system.



22.9.3 Following the tests prescribed in A-22.9.1 and A-22.9.2, the complete system shall be connected and shall be tested as follows:

22.9.3.1 With the appliance valves off, open the solenoid shut-off valve, if installed, and open the cylinder supply valve. Close the cylinder supply valve. Observe the pressure gauge reading. The pressure indicated should remain constant for not less than three minutes. If any leakage is indicated by a drop in pressure, check the entire system with a leak detection fluid or detergent solution to locate the leak. Test solutions shall be non-corrosive and non-toxic. Repairs shall be made before operating the system.

**NOTES:**

**1. Never use flame to check for leaks.**

**2. Never use solutions containing ammonia to test for leaks. Ammonia, which is present in some soaps and detergents, attacks brass fittings. In a matter of months, these fittings may develop cracks and leaks that may be initially undetectable.**

**22.10 SAFETY SIGNS AND LABELS**

22.10.1 Warnings and safety labels shall comply with [ABYC T-5, Safety Signs and Labels](#), and shall contain at least the following informational elements:

22.10.1.1 the hazard intensity signal word;

22.10.1.2 the nature of the hazard;

22.10.1.3 consequences that can result if the instructions to avoid the hazard are not followed; and

22.10.1.4 instructions on how to avoid the hazard.


22.10.2 All boats with CNG systems shall be provided with a plainly visible warning label and associated operating procedures located in the immediate vicinity of the cylinder, and

22.10.2.1 the sign shall withstand the effects of exposure to water, oil, salt spray, direct sunlight, heat, cold and wear expected in normal operation of a boat without loss of legibility, and

22.10.2.2 the sign shall convey the information shown in the following example.


**NOTE: The following is an example of such a safety sign.**



 <b>WARNING</b>
<p>Avoid injury or death from fire or explosion. Follow instructions for using and testing the CNG system.</p>
<p style="text-align: center;"><b>IMPORTANT OPERATING INSTRUCTIONS</b></p> <ul style="list-style-type: none"> <li>• This system is designed for use with compressed natural gas (CNG) only. Do not connect liquefied petroleum gas (LPG) to this system.</li> <li>• Keep cylinder valve(s) and/or solenoid valve(s) closed when boat is unattended, and when appliances are not in use.</li> <li>• Close cylinder valves immediately in any emergency.</li> <li>• Keep empty cylinders tightly closed.</li> <li>• Close all appliance valves before opening cylinder valve.</li> <li>• Test system for leakage each time the cylinder supply valve is opened for appliance use. Never use flame to check for leaks! To test system: <ul style="list-style-type: none"> <li>• close all appliance valves;</li> <li>• open solenoid shut-off valve, if installed;</li> <li>• open, then close cylinder supply valve</li> <li>• observe pressure gauge at the regulating device;</li> <li>• see that it remains constant for not less than three minutes before any appliance is used.</li> </ul> </li> <li>• If any leakage is evidenced by a pressure drop, check system with a leak detection fluid or detergent solution that does not contain ammonia.</li> <li>• Repair leaks before operating system.</li> </ul>

22.10.3 On boats with a gasoline engine, the label required in [A-22.10.2](#) shall also contain at least the following supplemental warning about the hazards associated with the presence of explosive vapors.

**NOTE: The following is an example of such a safety label.**

 <b>WARNING</b>
<p>Avoid injury or death from gasoline fire or explosion. Turn off all open flame appliances when fueling.</p>

## APPENDIX - COMPRESSED NATURAL GAS SYSTEMS (CNG)

This appendix provides information about and properties of compressed natural gas (CNG). For similar information about and properties of liquefied petroleum gas (LPG) see [ABYC A-1, Marine Liquefied Petroleum Gas Systems \(LPG\)](#), Appendix.

TABLE I - PROPERTIES OF CNG

PROPERTIES	COMPONENTS OF CNG (methane)
Formula	CH <sub>4</sub>
Specific gravity of gas (Air = 1.0)	0.55
Flammable limits in air (explosive range), percent by volume. lower upper	5.0 15.0
Calorific value - net BTU per cubic foot @ 14.7 psig (100 kPa)	1000
Ignition temperature	1300°F (704°C )
Flame propagation rate	750 ft/s (229 m/s )
Normal cylinder storage pressure @ 140°F (60°C) @ 100°F (38°C) @ 70°F (20°C)	2634 psi (18.2 MPa ) 2423 psi (16.7 MPa ) 2250 psi (15.5 MPa )

**NOTE: In the interest of safety, it is important that the properties of compressed natural gas (CNG) be understood, and that safe practices for its use be followed. It is also important that the differences in properties between compressed natural gas (CNG), and liquefied petroleum gas (LPG), as covered in [ABYC A-1, Marine Liquefied Petroleum Gas Systems \(LPG\)](#), be compared to distinguish between these two types of fuels and their respective hazards.**

Ap.1 CNG - compressed natural gas, being always in the vapor phase, and having a lower calorific value (heating value) than LPG, must be stored at higher pressures than LPG fuels to provide a fuel supply.

Ap.2 CNG, in a natural state, is non-toxic and invisible, but can displace the air necessary to sustain life.

Ap.3 Commercially available CNG, by law, has an odorant added to facilitate leak detection. CNG is always in the vapor phase and has an odor concentration that will not change.

Ap.4 CNG, if unignited and released, will diffuse and mix with air at a comparatively rapid rate, and will tend to rise to the top of an enclosed compartment into which it is released. CNG is readily dispelled by overhead ventilation. Mixed with air in certain proportions and confined, CNG will explode if ignited. In its gaseous state, CNG presents a fire and explosion hazard.

Ap.5 The cylinder shall be refilled only at an authorized fuel distributor.

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*Origin and Development of ABYC A-22 Marine Compressed Natural Gas (CNG) Systems*

A-22 was first published in 1978 and was revised in 1993 and 2006. The 2012 version is the work of the Thermal Appliance Project Technical Committee.

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