Carbon Monoxide Danger In Express Cruisers

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Study Provokes Stern Warning

Chances are, if you operate a gasoline-powered express cruiser with the canvas enclosure in place, dangerously high levels of carbon monoxide (CO) could build up at the stern, the swim platform, and even in the cockpit and cabin.

In nine out of 10 express cruisers evaluated during normal operating conditions in an interagency survey by the National Institute of Occupational Safety and Health (NIOSH) and the U.S. Coast Guard, the "station wagon" effect was found to generate hazardous concentrations of CO in areas where passengers congregate.

NIOSH and the Coast Guard have teamed up before to study CO exposure on houseboats, following a number of highly publicized CO deaths in the late 1990s. The latest study, conducted during 2005 and 2006 at locations in Florida, North Carolina and New Jersey, was designed to help the Coast Guard better understand how CO poisonings may occur on express cruisers, identify the most hazardous conditions and to begin the process of identifying ways to mitigate CO exposures.

Express cruisers generally have a raised bridge deck that houses the helm station, with a windshield and canvas bimini top or hardtop that extends over the bridge and cockpit to provide protection from the elements. They also feature extensive enclosed accommodations below decks.

The boats evaluated in the survey were brand new gas-powered cruisers ranging in size from 30 to 42 feet. and built by several different manufacturers. The report does not identify boat makes and models. All boats had standard factory power, with inboard engines made by Volvo Penta, Crusader or Mercury Marine and most had stern drive units. In addition, all boats were equipped with gasoline-powered generators manufactured by Kohler. Neither the engines nor the generators were found to be faulty.

Tests show that in three cases CO levels in the aft parts of the boats exceeded 1,100 parts per million (ppm). Six others tested out at over 100 ppm to as high as 658 ppm. According to the study report, only one vessel, which was equipped with a combined exhaust system showed "concentrations at the stern consistently below the NIOSH ceiling limit of 200 ppm with the canvas enclosed."

To put this in perspective, the EPA standard for maximum CO exposure is no more than nine ppm during an eight-hour period and 35 ppm for a one-hour average. Data compiled by the Coast Guard, NIOSH, the Dept of Interior and the National Park Service show that CO has caused 113 deaths and 458 reported poisonings on or near recreational boats in the past 20 years.

"The CO levels did not surprise me, I have seen similar (and higher) levels in several of the studies I have participated in and read," American Boat & Yacht Council Technical Director John Adey told BoatU.S.

But, if the CO levels are so high, why aren't more people being adversely affected? "I believe the issue here is exposure length," Adey answered. In the tested boats, CO levels varied with changes in boat speed, wind speed and direction and configuration of the canvas cover. So, in real-life conditions, passengers may experience only momentary exposure, which could result in symptoms similar to sea sickness.

Adey said ABYC technical committees concerned with CO education and boat design and construction are poised to review the study. For years, the CO problem has been the focus of joint efforts by the Coast Guard and ABYC. However, federal regulations administered by the Coast Guard do not address design and construction issues that involve CO in exterior settings.

The NIOSH/Coast Guard tests were conducted at the dock with engines running and while underway at speeds ranging from 5 to 25 miles per hour, with and without the generators running. The boats' canopies were in various configurations — open, partially open, and closed — for every phase of the tests.

According to the express cruisers study, "When the canvas is deployed and the boat is underway, CO concentrations exceeded the 'immediately dangerous to life and health' level near the swim platform for many of the evaluated boats." Travel speed, wind direction, presence or lack of forward-facing ventilation, canvas design, hull shape, exhaust system configuration, and proximity to structures like docks and other boats are some of the factors that influence CO buildup.

CO is produced when fuels such as gasoline, wood and propane are burned. In comparison to gasoline exhaust, the CO component of diesel exhaust is extremely low, so diesel engines and generators are not considered a serious risk. CO is absorbed by the lungs and limits the ability of blood to carry oxygen. Depending on concentrations, exposure time and the health and age of victims, CO can cause unconsciousness, collapse and even death in only a matter of minutes. Low-level exposure can cause symptoms similar to seasickness, so many boaters may not suspect CO is the culprit when a passenger falls ill.

Analysis of the NIOSH/Coast Guard test results shows the following:

• When the canvas was in place, CO concentrations on the test boats immediately reached levels deemed by NIOSH to be "immediately dangerous to life and health." Peak CO concentrations "often exceeded 1,100 ppm, while average CO concentrations were well over 100 ppm in the stern." On at least one boat, however, CO levels remained at about 1,000 with or without the canvas in place.

• Canvas configuration significantly affected CO concentrations in the cockpit area.

• The combination of travel at low speeds, into the wind with the canvas fully deployed and no forward hatches opened maximized the station wagon effect, pulling significant amounts of CO into the cockpit.

• Two test boats equipped with a combined exhaust system exiting at the sides and underwater exhibited about 40% lower CO concentrations than vessels equipped with exhaust systems that were at or above the water line. The system is engineered to release all the exhaust at the surface through the sides of the vessel when the engine is idling or the rpm level is below 1500. At levels over 1500 rpm, a pressure release mechanism on the lower part of the hull is activated that releases most of the exhaust underwater. Researchers found that exhaust gases released underwater take longer to reach the surface and are broken up by prop turbulence, reducing CO concentrations close to the boats.

• Contrary to popular wisdom, operating the boat at higher speeds was no guarantee of adequate ventilation when the canvas was in place. Researchers found the CO was still present.

• The bulkheads between engine compartments and living spaces were adequately sealed on all boats tested. Seepage of exhaust through bulkhead seams was eliminated as a source for CO that migrated into cabins.

• Current CO warning labels do not contain adequate information to properly warn about potential hazards and preventive or corrective measures to prevent CO poisonings.

• If cabin doors were closed while test boats were underway, the cabins were under negative pressure when air conditioners were running. This can lead to CO intrusion if cabin doors or bulkheads do not seal properly.

• In a number of the boats tested, openings in the hull for generator exhaust lines were located adjacent to engine compartment air intake ports, in effect, allowing the intake to "inhale" the generator's fumes.

• The report points out that, unlike automobile engines, which are equipped with catalytic converters that remove many air pollutants and substantially reduce CO emissions, catalytic converters for marine engines are still cutting edge. Indmar Products Co., Inc., recently introduced the first production catalytic converter system, EXT/CAT, which will be standard equipment on 2007 Indmar 5.7L EFI inboards. An Indmar spokesman told BoatU.S. the company is not planning to sell DOT/CAT technology to other engine makers.

While the current study provides insight into how CO poisonings may occur on express cruisers, more research is needed to "evaluate different options to reduce onboard CO exposures," according to NIOSH engineer Alberto Garcia.

"We conducted some additional tests to evaluate the effects of blowers and fans to ventilate cockpits and cabins on these vessels," said Garcia. "However, the data is nonconclusive and we are still looking into other options to reduce or mitigate onboard CO concentrations."

"It is very difficult to draw conclusions from a single test, for one boat, under the evaluated conditions," Garcia said.

Phil Cappel, chief of the Coast Guard's recreational boating product assurance branch, agreed. "The preliminary results from the follow-on testing showed that the [preventive] measures taken were not 100% effective. The data collected need to be analyzed to determine just how effective they were.

Boater awareness is crucial. "Initial symptoms of CO intoxication can be easily confused by what is commonly known as 'sea sickness," Garcia pointed out. There is a lack of education and lack of reporting that makes it hard to identify the extent of the problem. Education, training and symptom recognition are important in identifying and preventing CO intoxications."

Boat owners need to be proactive in minimizing the CO dangers on board. The first line of defense is to install functional carbon monoxide detectors in all enclosed living spaces. And, know where engine and generator exhaust outlets are located and keep everyone away from these areas. Always maintain adequate forward-facing ventilation when the engine or generator is running and the canvas enclosure is in place. As an added precaution, leave the canvas slightly open to increase air flow. Finally, never let anyone sit, teak surf, or hang on the back deck or swim platform while the engines and generators are running. Teak surfing is NEVER a safe activity.

To learn more about the CO threat, visit the Coast Guard Web site, uscgboating.org, or call 800-368-5647 to obtain a copy of the Coast Guard's brochure, "Carbon Monoxide Poisoning: What You Can't See..."

Additional CO information is available at the BoatU.S. Foundation Web site, www.boatus.com/foundation/grants/carbon_monoxide.htm.

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