



### ***Setting Standards for Safer Boating***

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ABYC TH-22 July, 2017XX DRAFT

Hull Division Standard Technical  
Information Report

Hull Performance Fuel & Ventilation  
Systems

Project Technical Committee

## **ABYC TH-22**

# **EDUCATIONAL INFORMATION ABOUT CARBON MONOXIDE**

ABYC TH-22

9/20212/2022

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### Origin and Development of TH-22, Educational Information about Carbon Monoxide

ABYC first published this report as T-22, *Educational Information About Carbon Monoxide* in 1992 and revised it in 2000, 2002, 2008, and 2012, and The 2017. In 2017 the designation was changed to TH-22. The 20XX update is the work of the Fuel & Ventilation Systems Project Technical Committee.

#### Fuel & Ventilation Systems Project Technical Committee

~~This list represents the membership of the Fuel & Ventilation Systems Project Technical Committee~~  
~~This list represents the membership of the Fuel & Ventilation Systems Project Technical Committee as of the time the Committee was balloted.~~

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Membership on a committee shall not in and of itself constitute an endorsement of ABYC or any document developed by the committee on which the member serves.

This technical information report, which is the result of extended and careful consideration of available knowledge and experience on the subject, was developed under procedures accredited as meeting the criteria for American National Standards and is intended to provide minimum performance requirements. The Project Technical Committee that approved the technical information report was balanced to ensure that individuals from competent and concerned interests have had an opportunity to participate.

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Upon written request the Fuel & Ventilation Systems PTC will render an interpretation of any recommendation of the report. 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 that might affect it becomes available to the PTC. Persons aggrieved by an interpretation may appeal to the committee for reinterpretation.

### Summary of Revisions

*This list indicates revisions to the report when compared with the previously published version. It is not intended to be used independently of the report. It should be used for informational purposes and as a guide to the official recommendations contained in this report. It is the responsibility of the user to read and understand the complete report.*

The main changes in this revision of TH-22, *Educational Information About Carbon Monoxide* as compared with the previous edition dated 7/17, are:

- Units of Measure section was added
- Time vs concentration figure deleted **UPDATE**

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# TH-22 EDUCATIONAL INFORMATION ABOUT CARBON MONOXIDE

## BACKGROUND

This technical information report provides educational material about carbon monoxide relative to boats and boating.

Carbon monoxide can accumulate in interior spaces and exterior areas. Carbon monoxide accumulation is affected by a multitude of variables (e.g., boat geometry, hatch, window and door openings, ventilation openings, proximity to other structures, swim platforms, canvas enclosures, location of exhaust outlets, vessel attitude, wind direction, boat speed, boat system performance and maintenance, etc.).

This technical information report ~~discusses many of these variables and enables the reader to better understand some of~~ provides clarity information on some of the more predictable effects of carbon monoxide accumulation. However, this ~~Because this report is limited in that it cannot cover all conceivable variables, and the reader is cautioned not to~~ against exclusive reliance exclusively upon it to prevent the accumulation of carbon monoxide. As this report cannot cover all conceivable variables, the reader is cautioned not to rely solely on the recommendations of this report in the prevention of carbon monoxide accumulation.

## INTENT

The information in this technical information report concerns all boats.

## UNITS OF MEASURE

Values stated without parentheses are the recommended. Values in parentheses are explanatory or approximate.

## REFERENCES

The following references form a part of this report. Unless otherwise noted the latest version of referenced standards shall apply.

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-6, Refrigeration and Air Conditioning Equipment

ABYC A-24, Installation of Carbon Monoxide Detectors and Alarms-Systems on Boats

## DEFINITIONS

For the purpose of this technical information report, the following definitions apply.

Carbon ~~monoxide~~ Monoxide (CO) - a gas formed by the combination of one atom of carbon and one atom of oxygen. Chemists refer to it as CO for its chemical formula, C for carbon and O for oxygen.

COHb (carboxyhemoglobin) - the molecule formed when CO, instead of oxygen, combines with blood.

Enclosed Accommodation Compartment - one contiguous space, surrounded by a permanent structure that contains all the following:

1. designated sleeping accommodations,

2. a galley area with sink, and

3. a head compartment.

*NOTE: A cuddy intended for gear storage and open passenger cockpits, with or without canvas enclosures, ~~are-is~~ not considered to be an enclosed accommodation compartment(s).*

PPM - ~~P~~arts per million

52 **PROPERTIES AND CHARACTERISTICS OF CARBON MONOXIDE**

53 Carbon monoxide (CO) is a colorless, odorless, and tasteless gas that weighs about the same as air. This gas is almost  
54 neutrally buoyant and will disperse itself throughout the space. Do not rely on the sense of smell or sight of other gases  
55 to detect CO as it diffuses in the air much more rapidly than easily detectable vapors (i.e., visible and aromatic vapors).

56

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## WHAT MAKES CARBON MONOXIDE?

Carbon monoxide is produced any time a material containing carbon burns, such as gasoline, natural gas, oil, propane, coal, or wood. Common sources of CO are internal combustion engines and open flame appliances such as but not limited to; the following:

- propulsion engines
- auxiliary engines (gensets)
- cooking ranges
- central heating plants
- space heaters
- water heaters
- fireplaces, and
- charcoal grills

The carbon monoxide component of diesel exhaust is extremely low relative to the carbon monoxide level found in gasoline engine exhaust. The use of low CO generators and catalyzed engines may reduce the risk of exposure to CO; however, proper care, maintenance, and operation of these engines should always be followed.

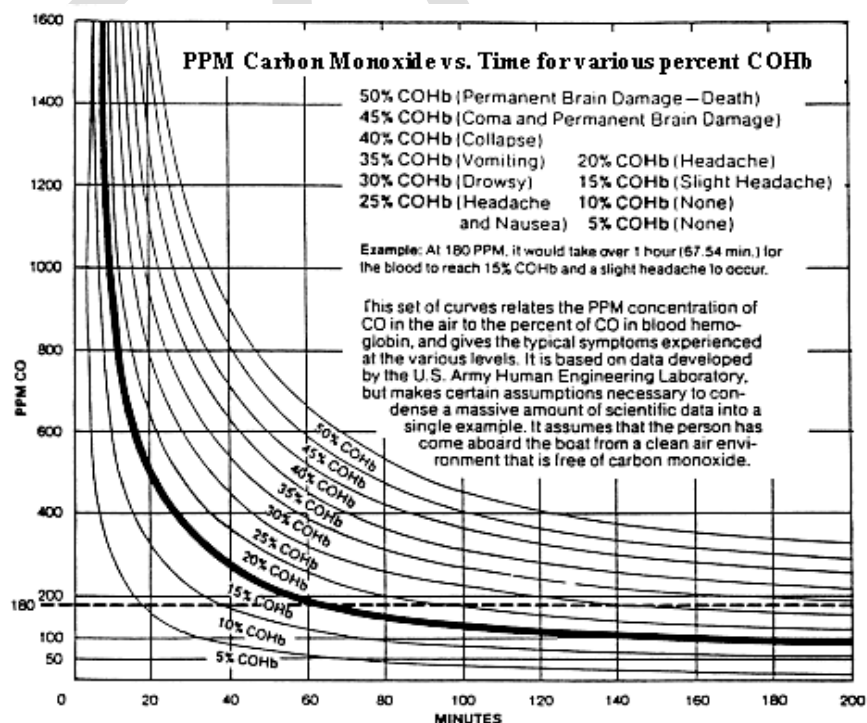
## HOW IS A PERSON AFFECTED BY CARBON MONOXIDE?

Carbon monoxide is absorbed by the lungs and reacts with blood hemoglobin to form carboxyhemoglobin (COHb), which reduces the oxygen carrying capacity of the blood. The result is a lack of oxygen for the tissues with the subsequent tissue death and, if exposure is prolonged, death of the individual. Altitude, heat, certain health related problems, and age will increase the effects of CO. Persons who smoke or are exposed to high concentrations of cigarette smoke, consume alcohol, or have lung disorders or heart problems are particularly susceptible to an increase in the effects from CO. However, all occupants' health should be considered. Physical exertion accelerates the rate at which the blood absorbs CO.

Carbon monoxide in high concentrations can be fatal in a matter of minutes. Lower concentrations must not be ignored because the effects of exposure to CO are cumulative and can be just as lethal (see FIGURE 1).

FIGURE 1 Carbon Monoxide Concentration vs Time

FIGURE 1 Carbon Monoxide Concentration vs Time



~~NOTE: Figure 1 shows the generally accepted curves of a person's absorption rate of CO at various concentrations.~~

### Symptoms of CO Poisoning

The sequence of symptoms listed generally reflects the order of occurrence in most people; however, there are many variables that affect this order of symptom manifestation. One or more of the following symptoms can signal the adverse effect of CO accumulation:

- |                                   |     |                         |                  |
|-----------------------------------|-----|-------------------------|------------------|
| 1. watering and itchy eyes,       | 106 |                         |                  |
| 2. flushed appearance,            | 107 | 7. ringing in the ears, | 122              |
| 3. throbbing temples,             | 108 |                         | 123              |
| 4. inattentiveness,               | 109 | 8. tightness across the | 124              |
| 5. inability to think coherently, | 110 | chest,                  | 125              |
| 6. loss of physical coordination, | 111 |                         | 126              |
|                                   | 112 | 9. headache,            | 127              |
|                                   | 113 |                         | 128              |
|                                   | 114 | 10. drowsiness,         | 129              |
|                                   | 115 |                         | 130              |
|                                   | 116 | 11. incoherence         | 131              |
|                                   | 117 | 11.,                    | 132              |
|                                   | 118 |                         |                  |
|                                   | 119 | 12. slurred speech,     |                  |
|                                   | 120 |                         |                  |
|                                   |     |                         | 13. nausea,      |
|                                   |     |                         | 14. dizziness,   |
|                                   |     |                         | 15. fatigue,     |
|                                   |     |                         | 16. vomiting,    |
|                                   |     |                         | 17. collapse,    |
|                                   |     |                         | 18. convulsions. |

### Emergency Treatment for CO Poisoning

CO toxicity is a life-threatening emergency that requires immediate action. The following ~~is a list of things that~~ should be ~~done-enacted~~ if CO poisoning is suspected. Proceed with caution. The victim may be in an area of high CO concentration.

- Evaluate the situation and ventilate the area if possible.
- Evacuate the area and move affected person(s) to a fresh air environment.
- Observe the victim(s).
- Administer oxygen, if available.
- Contact medical help. If the victim is not breathing, perform rescue breathing or approved cardiopulmonary resuscitation (CPR), as appropriate, until medical help arrives. Prompt action can make the difference between life and death, ~~and~~
- Investigate source of CO and take corrective action.

## MARINE CO DETECTION SYSTEMS

Even with the best of boat design and construction, and scrupulous attention to inspection, operation, and maintenance of boat systems, hazardous levels of CO may, under certain conditions, be present in interior spaces and exterior areas. Vigilant observation of passengers for CO sickness symptoms should be supplemented by a marine CO detection device(s) in the accommodation space(s). Detection device(s) should be marked with "Marine Carbon Monoxide Detector" or equivalent per [A-24, Installation of Carbon Monoxide Detection Systems and Alarms](#).  
Marine CO detection device should be replaced as indicated by the manufacturer's end of life date and/or signal.

## WHAT TO DO WHEN THE ALARM GOES OFF

Actuation of a CO alarm indicates the presence of carbon monoxide (CO). If alarm sounds, take the following actions as appropriate:

- If safe to do so, Sshut off sources of CO, such as engines ~~(if safe to do so)~~, generators, and open flame stoves.
- Look for sources of CO that may be from other boats, and take appropriate steps, which may include moving your boat to a safe area.
- Provide fresh air through actions such as, opening port lights, hatches, and doors.
- If anyone is exhibiting signs of CO poisoning, move them to fresh air and seek medical assistance.

## BOAT OPERATION

Do not run engine(s) or auxiliary generator(s) on boats with enclosed accommodation compartments unless the boat is equipped with a functioning marine carbon monoxide detector that complies with [ABYC A-24, Installation of Carbon Monoxide Detection Systems on Boats and Alarms](#).

## STATIONARY OPERATION

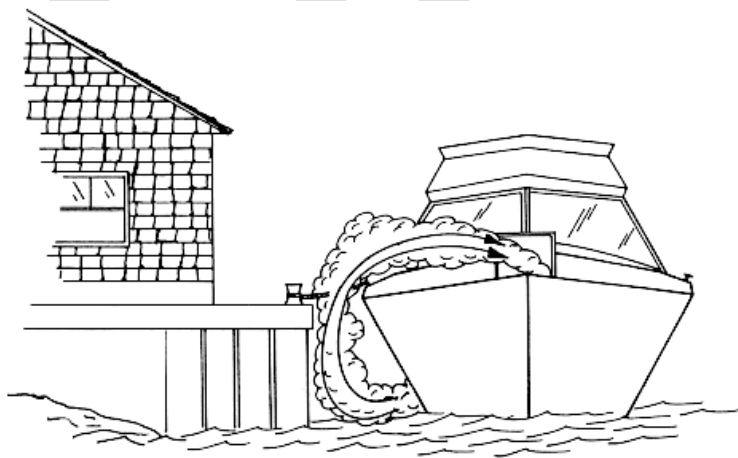
FIGURE 2 FIGURE 1 illustrates the effects of running engine or auxiliary generator in confined areas.

A boat operator should be aware that dangerous concentrations of CO can accumulate when propulsion engines and/or an auxiliary generator are operated while the boat is stationary, especially when rafted or moored in a confined area such as boathouses, proximity to seawalls, or proximity to other boats (see [FIGURE 2](#) FIGURE 1).

*NOTE: The risk from CO is greatly increased when there is little or no wind present.*

FIGURE 2 The Effect of Sea Walls and Other Confined Spaces

This figure illustrates the effects of running engine or auxiliary generator in confined areas.



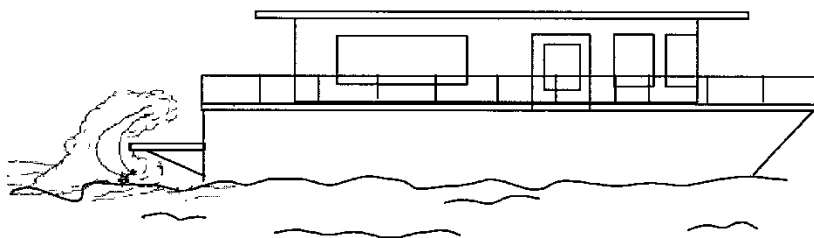
Keep engine room hatches and doors closed when operating engines, including the generator set. Before running generator set, consult boat owner's manual or boat manufacturer to determine if the blowers should be operated continuously.

Pay attention to prevailing conditions and provide for ventilation to induce fresh air and minimize exhaust re-entry. Orient the boat to enable the maximum dissipation of CO. Be aware that cockpit and deck drains can be a source of CO ingress into boats, especially boats with cockpit or decks enclosed with canvas or permanent boat structures.

When the propulsion engine or generator is running, CO is produced and may remain in the vicinity of the exhaust outlet (including underwater exhaust outlets such as sterndrives and outboards). CO accumulation may remain entrapped for some time after the engine or generator is turned off (~~see see~~ FIGURE 3FIGURE 2).

- Do not occupy aft lounging area(s) or swim platform.
- Do not swim under or around swim platform.
- Do not swim in the vicinity of exhaust outlet(s).

**FIGURE 3** ~~Accumulation of Exhaust Gases at the Swim Platform~~

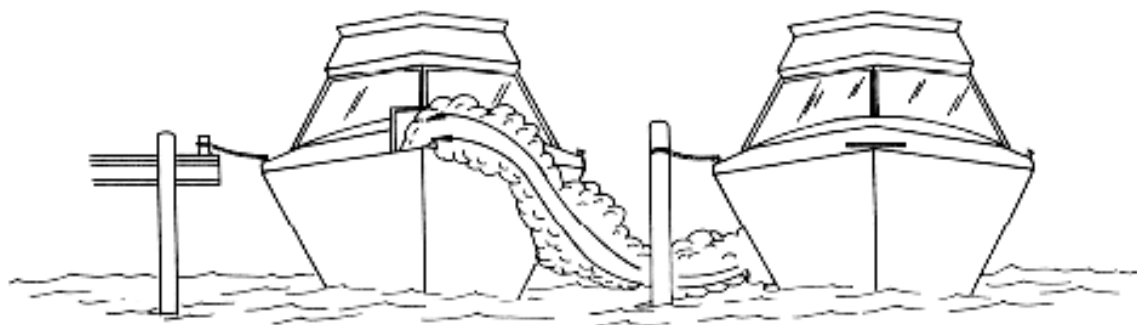


In order to minimize CO buildup, do not warm up or run propulsion engine(s) for extended periods while the vessel is stationary. Carbon monoxide production is greater when engines are cold versus when they are warm.

A boat operator should be aware that ~~carbon monoxide~~CO is emitted from any boat's exhaust. Operation, mooring, and anchoring in an area where other boats' engines or generators are running may put your boat in an atmosphere containing CO, even if your boat's engine(s) ~~is~~(are) not running. Boat operators need to be aware of the effect of their boat on other boats in the area. Of prime concern is the operation of an auxiliary generator where boats are moored along side each other. Be aware of the effect your exhaust may have on other boats and be aware that the operation of other boats' equipment may affect the carbon monoxide concentration on your boat (see [FIGURE 43](#)).

**FIGURE 4** ~~The Effect of Boats Moored Along Side~~

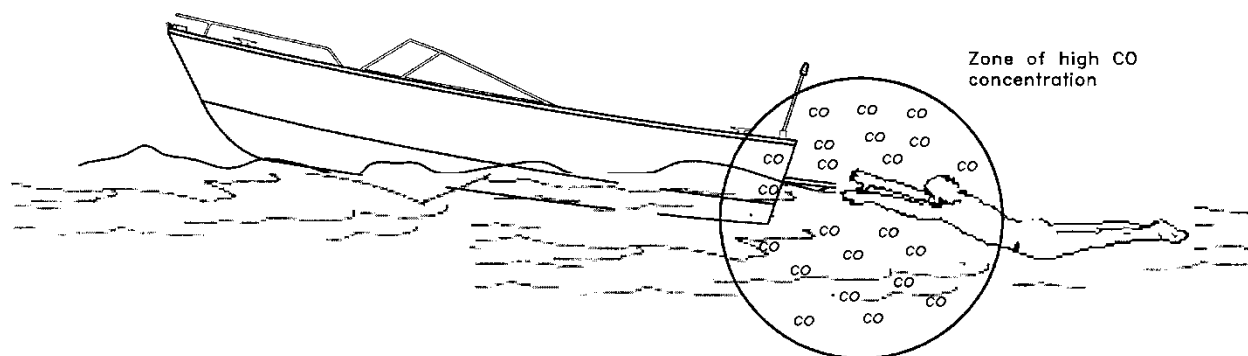
~~Boats moored close together can affect each other.~~



## **UNDERWAY OPERATION**

Do not sit on, occupy, or hang on any stern appendages (e.g., swim platforms, boarding ladders, etc.) while underway. Do not body surf, commonly known as "teak surfing" or "platform dragging," etc. in the wake of the boat. Do not tow persons in close proximity to the stern of the boat (see [FIGURE 54](#)).

**FIGURE 5** ~~Dangerous Activity When Engine is Running~~

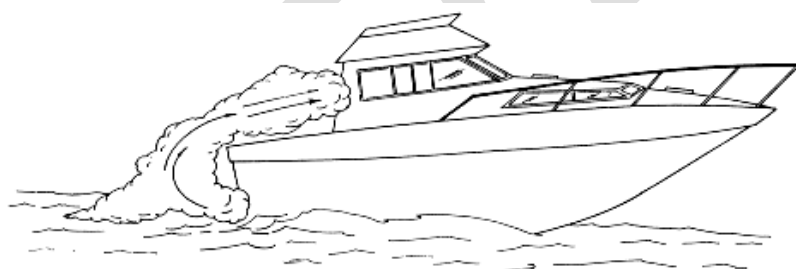


### **Backdrafting (Station Wagon Effect)**

Backdrafting is caused by air movement over or around a boat creating a low pressure or suction area around the stern that can increase CO level on the boat. Backdrafting can be affected by relative wind direction, boat speed, and boat trim angle. See [FIGURE 65](#) for an illustration of airflow over a boat and behind its transom. Under certain speed and operating conditions, the low pressure area may form in other regions and permit ~~carbon monoxide~~ [CO](#) to enter the hull through openings that are not on the back of the boat.

**FIGURE 6** ~~Backdrafting (Station Wagon Effect)~~

~~This figure illustrates airflow over boat and behind the transom.~~



### **Other Factors ~~during boat operation which~~ [That](#) May Affect Carbon Monoxide Concentration ~~include:~~**

- Adding or removing canvas may raise or lower CO levels (see [FIGURE 76](#)).
- Intentional or unintentional excessive trim angle (e.g., high bow angle or excessive unequally distributed weight) may raise the CO level and should be avoided (see [FIGURE 87](#)).
- Opening and closing ports, hatches, doors, and windows may raise or lower CO levels on board a boat. When airflow is moving forward inside the boat, CO may be entering the boat.
- Operating a boat at slow speeds with a following wind should be avoided. Consider changing direction, adjusting speed, or both (see [FIGURE 9](#)[FIGURE 8](#)).
- ~~Be aware that e~~Cockpit and deck drains can be a source of CO ingress into boats, especially boats with cockpit or decks enclosed with canvas or permanent boat structures.

FIGURE 7 — THE EFFECT OF CANVAS/HATCH CONFIGURATIONS

THIS FIGURE ILLUSTRATES DESIRED AIRFLOW THROUGH THE BOAT.



AS SHOWN IN THIS FIGURE, CERTAIN CANVAS CONFIGURATIONS, SUCH AS SIDE CURTAINS, AND POSITION OF HATCHES CAN INCREASE BACKDRAFTING.



FIGURE 8 — INEFFICIENT TRIM ANGLES

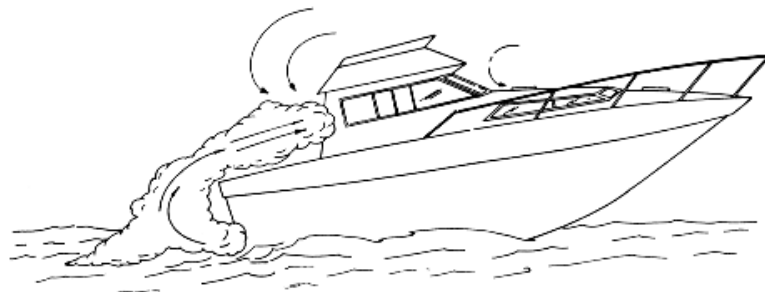


FIGURE 9 — OPERATING AT SLOW SPEED WITH A FOLLOWING WIND



#### CABIN APPLIANCES—

~~boats~~ Boats having fuel-burning appliances in accommodation areas should be provided with adequate ventilation and the appliance should be maintained to function properly.

#### AIR CONDITIONING

~~—If~~ Improper installation or lack of system maintenance may cause the air conditioner to bring CO ~~to be brought~~ into the air-conditioned spaces ~~by the air conditioner~~. Be sure that the air handling ducts and plenums are sealed from the engine room(s). ~~—Aftermarket~~ Aftermarket air conditioning systems should be installed in accordance with [ABYC A-6, Refrigeration and Air Conditioning Equipment](#) and the manufacturer's instructions.

#### VENTILATION OF OCCUPIED SPACES—

Occupied spaces ~~need to~~ should be ventilated to introduce fresh air into the spaces. Ventilation methods (e.g., use of windows, hatches, doors, and blowers) used to accomplish this may, under certain conditions, bring hazardous levels of CO into the occupied spaces. Be aware of all prevailing conditions when using these ventilating methods.

#### ALTITUDE AND SEA CONDITIONS—

Operation at altitudes greater than 5,000 ft contributes to inefficient engine performance and may require adjustments to ignition systems, fuel systems, or changing the propeller's size or gear ratio. Failure to make adjustments to ignition systems and/or fuel systems for altitude conditions may cause an increase in CO. Reduced power resulting from increased altitude may require adjustments to propeller size. Heavy seas or out of trim conditions tend to load engines resulting in reduced performance and increased CO production.

#### PORTABLE GENERATOR SETS—



301 Do not use this equipment on boats. Gasoline powered portable generator sets produce CO. These sets discharge  
302 their exhaust products in locations ~~which~~that can lead to an increase in the accumulation of ~~carbon monoxide~~CO in  
303 ~~the~~occupied spaces.  
304  
305

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## 306 **MAINTENANCE**

### 307 **Engine Performance**

308 ~~–e~~Efficient engine performance is vital to minimizing CO production. The following items are those considered to have  
309 the greatest effect on increased CO production:

- 310 •      Fuel that is contaminated, stale, or incorrect octane number

### 311 CARBURETORS/INJECTORS

- |  |   |
|--|---|
| 312 • Dirty or clogged flame arrester                | 317 • High float level                    |
| 313 • Malfunctioning automatic choke plate or faulty | 318 • Incorrect idle mixture adjustment   |
| 314 adjustment of manual choke plate                 | 319 • <u>    </u> Dirty or worn injectors |
| 315 • Worn float needle valve and seat               |   |
| 316  |   |

### 320 IGNITION SYSTEM

- |  |   |
|--|---|
| 321 • Fouled or worn spark plugs             | 324 • Shorted or opened circuit high tension spark plug |
| 322 • Worn points or incorrect gap on points | 325 cables  |
| 323  | 326 • Incorrect ignition timing                         |

327

### 328 GENERAL

- 329 • Worn piston rings and valves.
- 330 • *Engine temperature* - cold running engines increase CO production. Generally, an engine produces less  
331 CO if it operates at a relatively high temperature within manufacturer's specifications. The correct thermostat  
332 should be selected based on manufacturer's specifications.
- 333 • *Exhaust back-pressure* - certain alterations to the exhaust system may increase engine exhaust back pressure  
334 and CO production.
- 335 • Restricted engine room or compartment ventilation.

### 336 EXTERNAL BOAT CONDITIONS

337 ~~–e~~Conditions that contribute to inefficient engine performance can include:

- 338 • Fouled hull bottom
- 339 • Damaged and fouled running gear (i.e., shaft, strut, propeller, rudder, and trim tabs)
- 340 •      Incorrect selection of propeller size

### 341 EXHAUST SYSTEM INTEGRITY

342 ~~–g~~Gas tight integrity of exhaust systems must be maintained to ~~insure~~ ensure that prevention of leakage of CO within  
343 the boat ~~does not occur~~. Disassembly may be required to carry out a thorough inspection. Repair or replace  
344 components as needed. Inspect the following:

- |   |                                      |
|---|--------------------------------------|
| 345 • Gaskets at cylinder head connection           | 350 • Mufflers and their drain plugs |
| 346 • Castings and pipe fittings in the dry section | 351                                  |
| 347 • All joints                                    | 352 • Thru-hull fittings             |
| 348 • Hoses   | 353                                  |
| 349 • Clamps  | 354 • Hangers and other supports     |
| 355   |                                      |



## 356 VENTILATION SYSTEMS

357 ~~Boats~~ are equipped with ventilation systems to eliminate gasoline vapors. Blowers and fans may also be provided  
358 for ventilation and to mitigate migration of CO into occupied compartments. ~~Attention should be paid to t~~The following  
359 actions should be performed on a regular basis:

- 360
- |   |  |
|---|--|
| 361 • Keep <del>ing</del> ventilation intakes clear of debris       | 369 • Eliminat <del>ing</del> e sags in ducting that can form a water trap |
| 362 • Replac <del>ing</del> e damaged hardware                      | 370  |
| 363 • Maintain <del>ing the</del> integrity of the ducting material | 371 • Check <del>ing</del> hangers and other supports                      |
| 364 and its connections   | 372  |
| 365 • Ensuring <del>e</del> that position of ducting intake is not  | 373 • Ensuring <del>e</del> blower/fan is operational                      |
| 366 obstructed or restricted, collapsed, kinked, or                 | 374  |
| 367 crushed   | 375 • Check <del>ing</del> that airflow is present at discharge            |
| 368   | 376  |
|   | 377 • Inspect <del>ing</del> wiring to equipment                           |

## 378 379 BULKHEAD AND DECK INTEGRITY

- 380 • Seal all visible openings (e.g., cracks, crevices, holes, including openings around wiring and piping runs) in  
381 bulkheads and decks that separate machinery compartments from occupied compartments. These openings can  
382 permit migration of CO vapors.
- 383 • Check gaskets and sealing surfaces on hatches, doors, and access panels.

## 384 CO DETECTION SYSTEMS

385 ~~CO~~ detectors require periodic replacement. ~~C~~Check the system and its installation and maintain and/or replace in  
386 accordance with the manufacturer's instructions.

## 387 AIR ~~CONDITIONING~~ SYSTEMS ~~t~~

388 Air conditioning ~~hese~~ systems can be a source of CO ingress and migration of CO vapors.

- 389 • Keep return air grilles and filters clean.
- 390 • Seal bulkhead voids and openings at wiring and piping runs in return air ducting, plenums, and air handling  
391 equipment enclosures, especially those adjacent to machinery compartment bulkheads.
- 392 • Check that water traps and condensate drains are present and correctly routed. These may be in the form of a  
393 double loop in the drain line or prefabricated p-traps. Any drain that discharges below the waterline when the boat  
394 is underway is sealed, by virtue of its design, against CO intrusion.

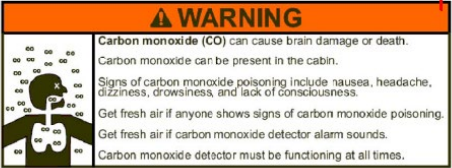
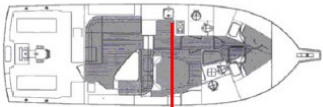
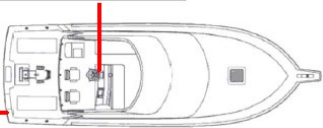
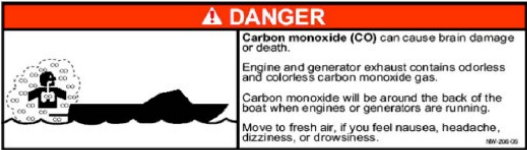
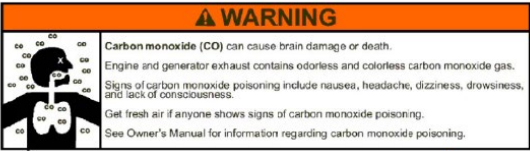
## 395 LIQUID DRAINS~~—~~

396 ~~s~~Sink, shower, and condensate drains can be a source of CO ingress. Ensure that water traps are present and contain  
397 fluid. These traps may be in the form of a double loop in the drain line or prefabricated p-traps. Any drain that terminates  
398 below the waterline is, by virtue of its design, sealed against CO intrusion. The location of drains, relative to the  
399 waterline, can be affected by the dynamics of boat motion (i.e., underway or at rest).

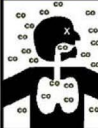
400

401     **SAFETY AND WARNING LABELS**

402     The following labels should be displayed in these specified locations:  
403



404  
405



**⚠ WARNING**

**Carbon monoxide (CO)** can cause brain damage or death.


Engine and generator exhaust contains odorless and colorless carbon monoxide gas.

Signs of carbon monoxide poisoning include nausea, headache, dizziness, drowsiness, and lack of consciousness.

Get fresh air if anyone shows signs of carbon monoxide poisoning.

See Owner's Manual for information regarding carbon monoxide poisoning.

**⚠ DANGER**



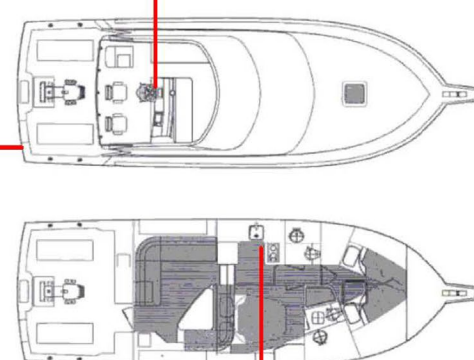
**Carbon monoxide (CO)** can cause brain damage or death.

Engine and generator exhaust contains odorless and colorless carbon monoxide gas.


Carbon monoxide will be around the back of the boat when engines or generators are running.

Move to fresh air, if you feel nausea, headache, dizziness, or drowsiness.

999-200-05



**⚠ WARNING**



**Carbon monoxide (CO)** can cause brain damage or death.

Carbon monoxide can be present in the cabin.

Signs of carbon monoxide poisoning include nausea, headache, dizziness, drowsiness, and lack of consciousness.

Get fresh air if anyone shows signs of carbon monoxide poisoning.

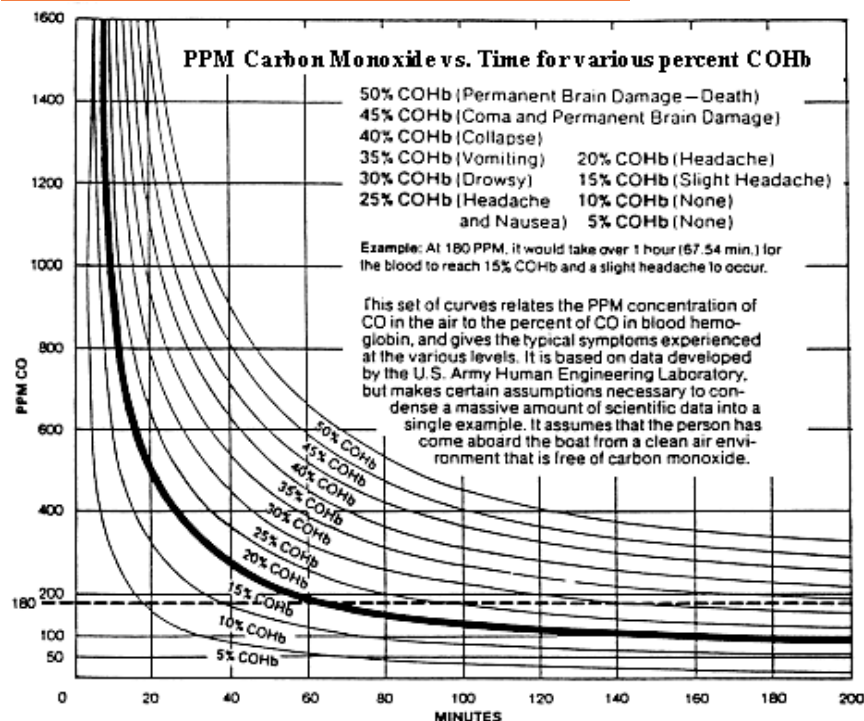
Get fresh air if carbon monoxide detector alarm sounds.

Carbon monoxide detector must be functioning at all times.

DRAFT

**FIGURE 1— Carbon Monoxide Concentration vs Time ALBERT WILL GIVE US SOMETHING!**

**FIGURE 1— Carbon Monoxide Concentration vs Time**

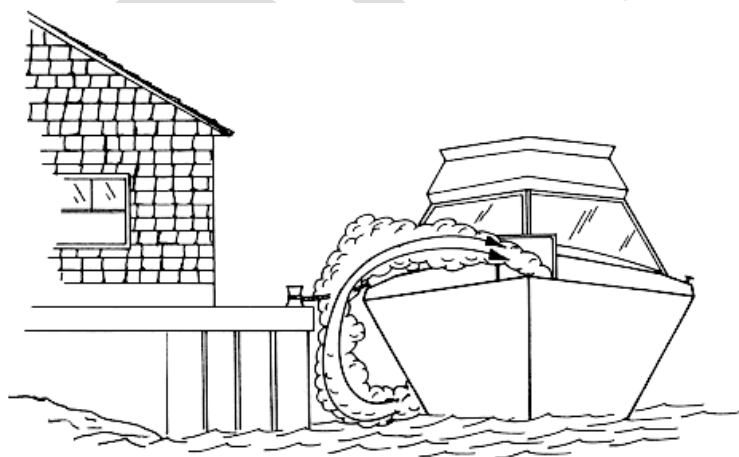


**NOTE: FIGURE 1 shows the generally accepted curves of a person's absorption rate of CO at various concentrations.**

\* \* \* \* \*

**FIGURE 12— The Effect of Sea Walls and Other Confined Spaces**

**This figure illustrates the effects of running engine or auxiliary generator in confined areas.**



**This figure illustrates the effects of running engine or auxiliary generator in confined areas.**

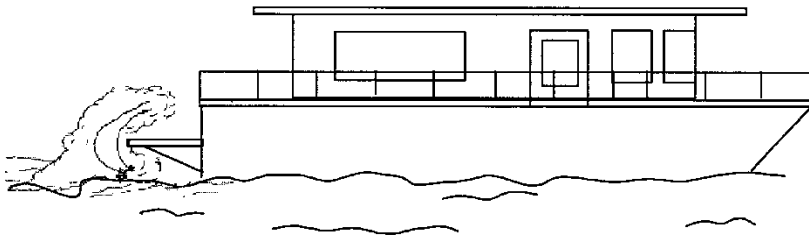
**Origin and Development of TH-22, Educational Information about Carbon Monoxide**



425 ~~ABYC first published this report as T-22 in 1992 and revised it in 2000, 2002, 2008 and 2012. The 2017 update is the~~  
426 ~~work of the Fuel & Ventilation Project Technical Committee.~~  
427  
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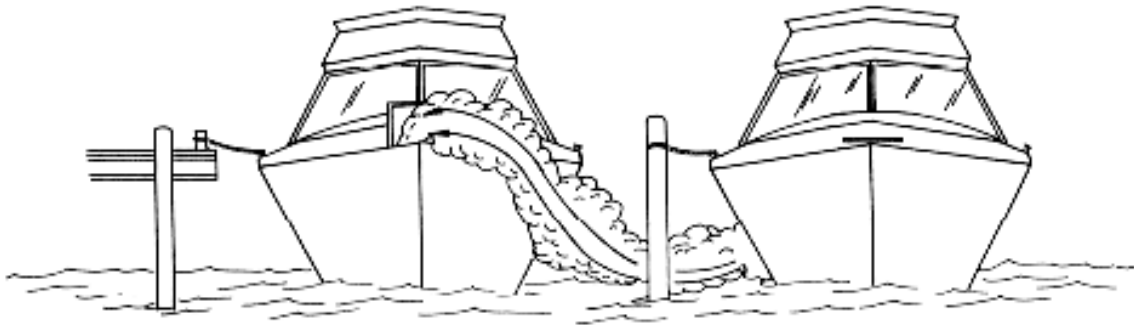
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**FIGURE 23**— - Accumulation of Exhaust Gases at the Swim Platform



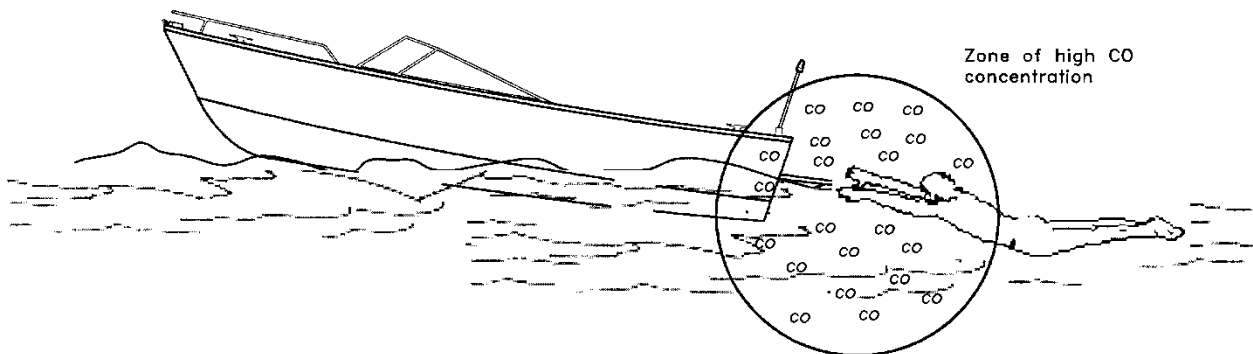
**FIGURE 34**— - The Effect of Boats Moored Along Side

*Boats moored close together can affect each other.*



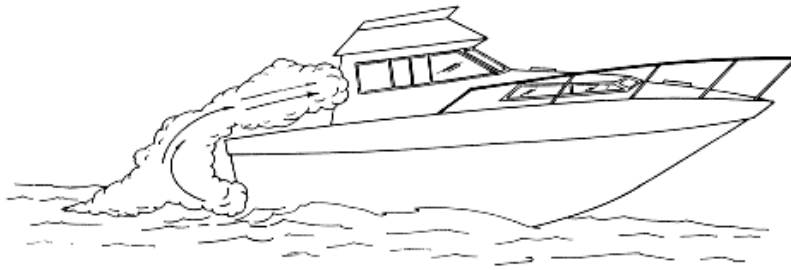
*Boats moored close together can affect each other.*

**FIGURE 45**— - Dangerous Activity When Engine is Running



**FIGURE 56** — - Backdrafting (Station Wagon Effect)

This figure illustrates airflow over boat and behind the transom.



This figure illustrates airflow over boat and behind the transom.

**FIGURE 67** — - The Effect of Canvas/Hatch Configurations

This figure illustrates desired airflow through the boat.



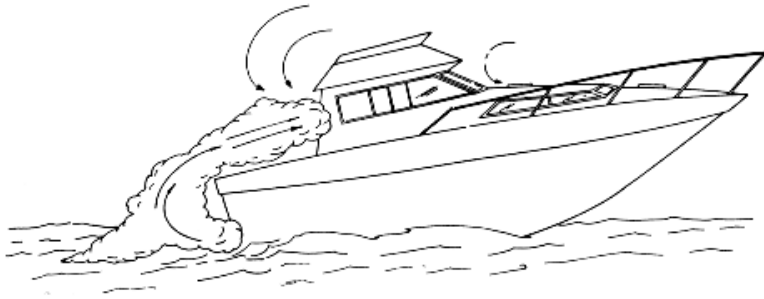
This figure illustrates desired airflow through the boat.

As shown in this figure, certain canvas configurations, such as side curtains, and position of hatches can increase backdrafting.

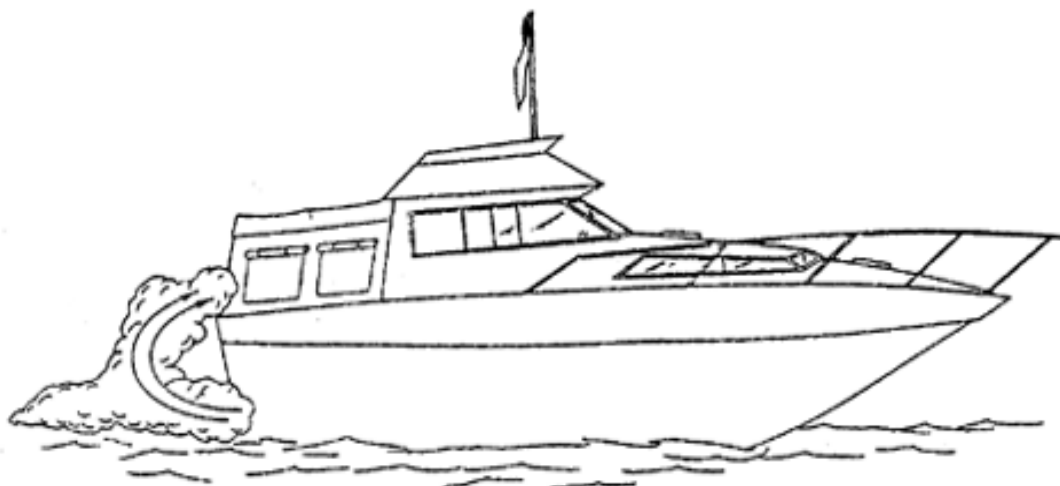


As shown in this figure, certain canvas configurations, such as side curtains, and position of hatches can increase backdrafting.

**FIGURE 78** — - Inefficient Trim Angles



**FIGURE 89** - Operating at Slow Speed with a Following Wind



\* \* \* \* \*

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