



lightning & boats

Most thunderstorms happen during the summer boating season, and they can catch boaters unaware. Bolts of lightning hotter than the surface of the sun can cause considerable injury, damage, and death.

Boats and boaters are especially vulnerable to lightning strikes because they are often the highest point in the area and become targets for lightning seeking a path to the ground. The best safeguard a boater has is to get off the water fast.

But there are other precautions that can protect a boat from lightning. The protection system described in this pamphlet is a method that directs lightning strikes safely through the boat with less chance of damage or injury.



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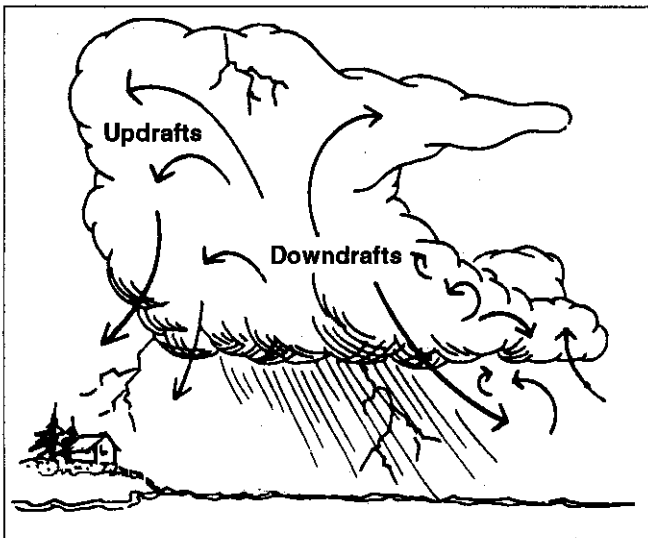
Thunderstorms and Lightning

Thunderstorms are usually formed by air currents rising over locally warmed areas, or by the passage of a cold front that forces warm moist air aloft. Thunderstorms often develop during the heat of the afternoon, winds are generally from the south and west, and the air is warm and humid.

An extreme vertical development of cumulonimbus clouds creates the conditions for an electrical storm. Although they may be obscured by other cloud layers, cumulonimbus clouds can usually be recognized by their characteristic shape. At the top, often over 40,000 feet high, a layer of cirrus clouds shaped like an anvil leans in the direction the wind is blowing and the storm is moving. Below the anvil head is the main body of the storm, very high with "cauliflower" sides. At the front bottom, a roll cloud formed by the strong turbulent winds is at the leading edge of the storm, and underneath is a dark area where hail or rain is falling.

The boater who recognizes this cloud formation should head for shore immediately. Thunderstorms bring strong winds, rough seas, and heavy rain and hail, and lightning can precede a storm by several miles.

Lightning is unpredictable and has immense power. Even with a lightning protection system, your safest precaution is to get off the water when you see thunderclouds.



Commercial AM radio and NOAA's continuous weather broadcast on VHF/FM channels WX1 (162.550 MHz), WX2 (162.400 MHz), and WX3 (162.475 MHz) will provide up-to-date information on weather developments. If you do not have VHF/FM marine radio on your boat, inexpensive portable radios that include the continuous weather broadcast frequencies are available from radio dealers. Marine Weather Service Charts that give weather broadcast frequencies are available at most marinas, or they can be ordered directly from:

National Ocean Survey
Distribution Center (C-4)
Riverdale, MD 20737

Note: Static on the AM frequency is an indicator of thunderstorm activity in the area.

Friction in a thundercloud causes a build-up of electrical charges, positive charges at the top, and negative charges near the bottom. Lightning occurs within, between, and underneath thunderclouds, when accumulated negative charges are attracted to the positive charges, causing a massive rush of electricity. The heat generated by this giant spark rapidly expands the air, and thunder sounds.

Lightning commonly occurs where positive charges build up on a point higher than the ground or water. This makes boats on open water—especially sailboats—vulnerable to lightning strikes.

The Lightning Protection System

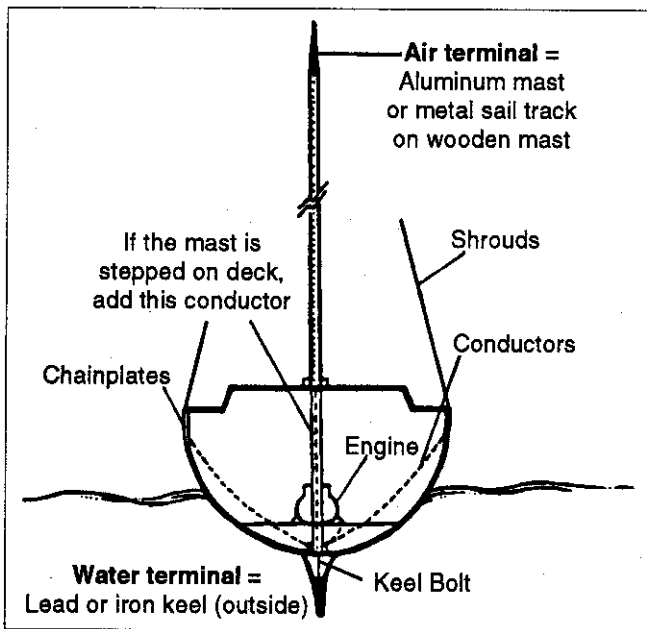
There are NO guaranteed safeguards against lightning. However, you can minimize damage from a lightning strike by installing a grounding system on your boat similar to those found on buildings and other structures. In the case of a lightning strike, the electrical current is directed through the boat with less likelihood of damage or injury. *A lightning protection system does not prevent a strike.*

What kind of boats need protection?

Since metal conducts electricity, metal boats should carry the electrical charge to ground (water), but boats made of wood or fiberglass need a lightning protection system. Saltwater dissipates an electrical charge better than freshwater, therefore boats in freshwater may need the additional protection of a larger ground plate.

Most boats are not constructed with a permanent grounding system to protect against lightning. If you are handy with tools and have a basic understanding of electricity, you can install one yourself with hand tools and common hardware store items. However, a lightning protection system that is improperly or inadequately installed can be dangerous. Ask the electrical contractor at the local boat yard to either check the system you install or help you do the job.





A complete lightning protection system has four components:

- Air terminal (lightning rod)
- Conductor
- Water terminal (ground plate)
- Bonding system

The AIR TERMINAL functions as a lightning rod, and it should be the highest point on the boat. A metal mast serves as its own conductor; wooden masts can be extended with metal such as aluminum sharpened to a point. (Note: objects on or near the top of a metal mast receive no protection, however. To protect the mast-head instruments, install an aluminum rod that extends six to 12 inches above the mast.)

The CONDUCTOR can be a combination of the mast and copper wiring to conduct a lightning current from the air terminal to the water terminal. It must have enough capacity to carry a tremendous amount of electricity through the boat without allowing any to

escape. Copper is the best material to use, although any metal mast or metallic sail track will make a good conductor when used with copper wiring. Copper stranded wire resists metal fatigue better than solid wire. Use the largest gauge wire possible to further reduce heat and resistance, and do not use wire smaller than gauge #4 or 3/8 inch.

The copper wiring should completely connect the air terminal with the water terminal and run without bends, kinks or loops. If a curve in the wire is too sharp, the lightning current, searching for an easier path to the ground, can leave the wire and strike inside the boat. In addition, do not run the wire too near the inside wall of the hull (see illustration). The lightning current is attracted to the positive charge of the water, and it may jump out through the hull rather than continue safely through the wire to the water terminal.

Copper tubing can be used as additional conductors if wall thickness is at least .032 inch. Again, it is best to use the thickest material possible. All electrical connections should be made with corrosion-resistant hardware and be mechanically strong and secure. Crimping AND soldering the connections are recommended. Solder may melt during a lightning strike, but it increases the strength of the connection.

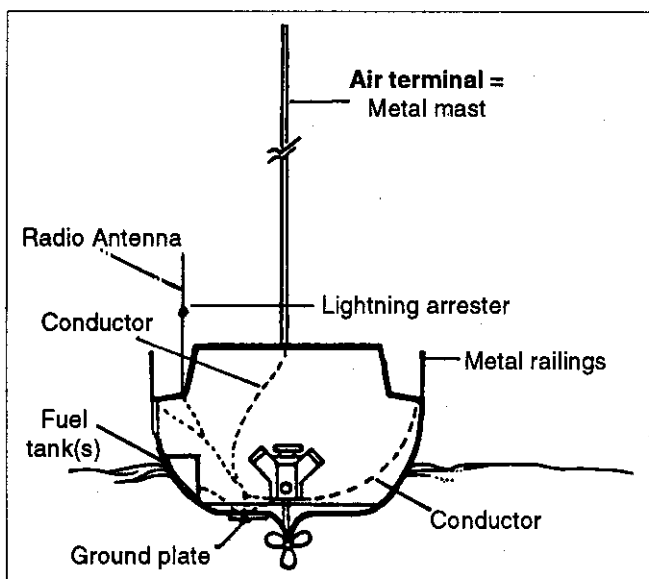
The WATER TERMINAL is the ground plate that directs the lightning current from the conductor safely to the water. A metal keel or rudder works well, but a propeller and shaft may not have enough surface contact with the water. If you are uncertain, add a ground plate or hull fittings. For boats with wood or fiberglass hulls in saltwater, the equivalent of at least one square foot of copper should be attached to the bottom of the boat. Since freshwater resists electrical flow more than saltwater, some sources recommend a larger water terminal on boats in freshwater. All grounding plates should be completely and firmly attached to all conductors by large, strong bolts that extend through the hull.

Many boaters encounter corrosion problems when a metal different from their rudder or propeller is used as a water terminal. Be sure to inspect these metal parts periodically.

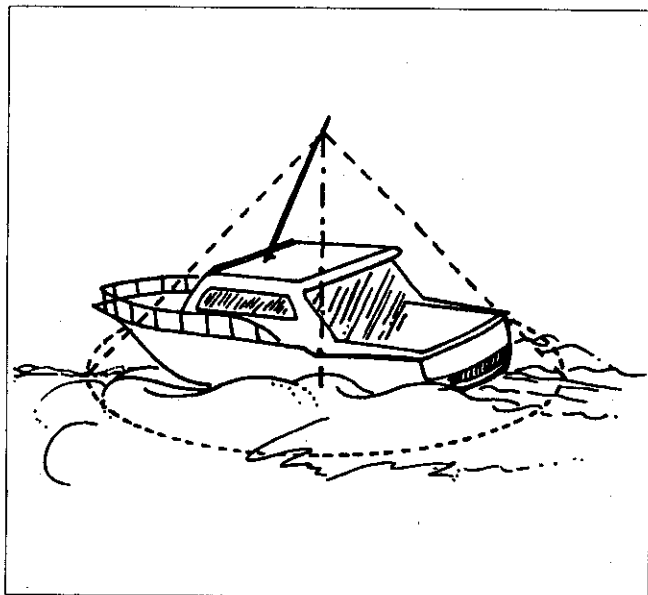
The BONDING SYSTEM can be the most important part of your lightning protection system. It is the interconnection of all the parts of your boat attractive to lightning flow. Linking these parts to the lightning protection system helps prevent secondary electrical discharges inside the boat called "side flashes," which are responsible for most human casualties and many fires on closed boats.

Connect all exterior and interior metal parts to the protection system with no less than #4 gauge copper wire. Large metal objects such as the engine or fuel tank should be connected straight to the water terminal. Hand railings, antennas, shrouds, and stays can be connected to the main conductor.

Imagine a skeleton of your grounding system. Generally, the closer the path is to a straight line, the better. If another route could be attractive to lightning, this route should also be interconnected and attached to a ground plate.



Do not use a radio antenna as an air terminal or attempt to take an antenna down during a thunderstorm. Instead equip all antennas with a lightning arrester in the lead-in cable. The lightning arrester allows normal operation of the radio, but in the event of a lightning strike to the antenna, the high voltage jumps a small gap within the arrester and is shunted to ground. It not only provides protection for the vessel, but reduces the chance of damage to the radio equipment.



Cone of Protection

To adequately protect a wood or fiberglass boat from lightning, imagine the entire vessel enclosed in a cone extending from the tip of the air terminal, the highest point of the vessel, to the surface of the water. The bottom of this cone is a circle with a radius equal to the height of the mast. If the air terminal is too low in relation to the length of the boat, the extremities of the vessel may not be protected. Extend the air terminal until all parts of the boat lie within the "cone of protection." Any point which lies outside this cone should have additional air terminals connected to the grounding plate. The bowsprit, bow staff, stern staff, or secondary masts on multi-masted sailboats, for example, should have additional protection. Keep in mind also that boats usually heel during storms, and the cone of protection will change in proportion to the dip of the mast.

IMPORTANT: Only grounded objects up to about 50 feet high have this protection. TV towers and other very tall objects are sometimes struck from the side, indicating that no protection exists at certain heights, and boats with masts over 50 feet high will probably need additional air terminals.

If You Are Caught in a Storm...

- Make sure everyone is out of the water.
- Bring in all protruding objects such as fishing lines that can attract lightning.
- Head for shore.
- Keep people low and separate from each other in the center of the cabin or boat. Use cushions to protect and insulate. Remove all metal jewelry, eyeglasses, and clothing containing metal.
- Keep everyone away from all parts of the lightning protection system. Do not touch any wet objects, metal, or electronic equipment such as the radio. Do not "bridge" any metal objects, such as having one hand on a gear lever and the other hand on a control knob.
- Know cardio-pulmonary resuscitation (CPR). A lightning strike, or even a near miss, can interrupt a person's heartbeat or affect respiration.

To protect all marine electronics from extremely high voltage, install transient protectors available from most electronic stores. After a lightning strike, however, check your electronic systems. Your compass, in particular, may need adjustment.

Temporary Open Boat Protection

A storm is approaching and you're caught on a small, open boat with no mast? Some protection would be provided by a metal boathook (the air terminal) that can be attached upright to some metal ground immersed in the water, such as a copper plating, tube, or outboard motor. A boathook shorter than 10 feet should be extended with hollow aluminum tubing.

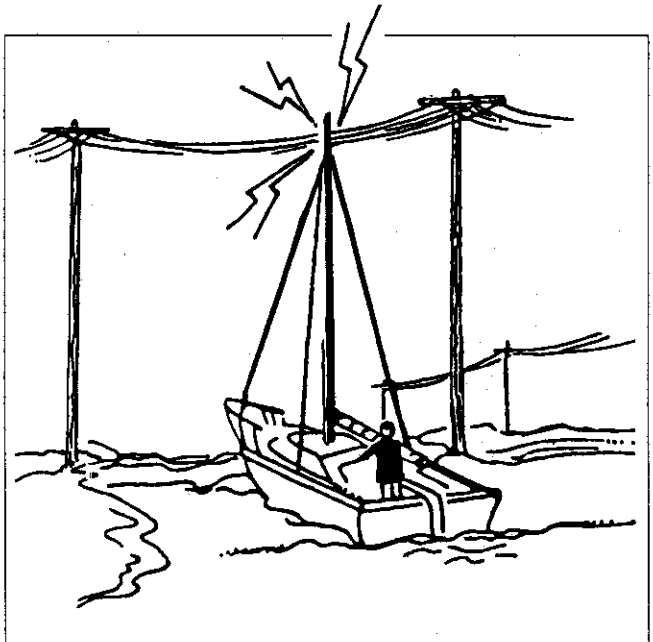
No boathook? Lie down in the boat, as low as possible.

CAUTION: *Never attempt to raise a temporary protection system during a storm.*

Other Electrical Hazards

Power lines at launch ramps are also a hazard to boaters, especially sailors. To expedite launching, many sailors step the mast while the boat is still on the trailer. Before stepping the mast, it is important to check for overhead wires nearby or between the boat and the launching ramp. Sailors have been electrocuted when their metal spars or standing rigging contacted uninsulated wiring.

High tension transmission lines crossing reservoirs and other boating areas are dangerous too. If the tip of the mast should come close to one of these lines, the current may be strong enough to bridge the gap and strike the boat. The fact that you have gone under the lines at other times may not mean that they are safe. The reservoir level may change and, on hot days, the lines may expand and sag from the heat. A watchful eye upwards as well as in other directions is needed.



Related Water Safety Materials

Please contact the Sea Grant programs listed below for ordering information.

Safety and Survival Publications and Videos

This brochure lists more than 20 publications and videos on marine safety and outdoor survival in northern climates.

Examples:

Hypothermia

How to prevent, recognize, and treat.

Family Boating: Preparing for the Emergency

Listing of safety equipment and discussions on emergency plans and safety drills.

Alaska Sea Grant College Program

University of Alaska Fairbanks

P.O. Box 755040

Fairbanks, AK 99775-5040

Phone (907) 474-6707

Beach Safety: Protect Yourself from Lightning

This flyer provides a variety of guidelines, from tips on how to tell if a storm is approaching to first aid for lightning victims.

University of Delaware

Sea Grant College Program

Marine Communications Office

Newark, DE 19716-3530

Phone (302) 831-8083

Sailboats and Lightning

A look at the effects of lightning on sailboats and the installation of grounding systems to reduce lightning damage. 23-minute video and a 24-page booklet.

Please send \$15.00 to the University of Florida at:

Florida Sea Grant

University of Florida

Box 110409

Gainesville, FL 32611

Phone (904) 392-2801

