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by
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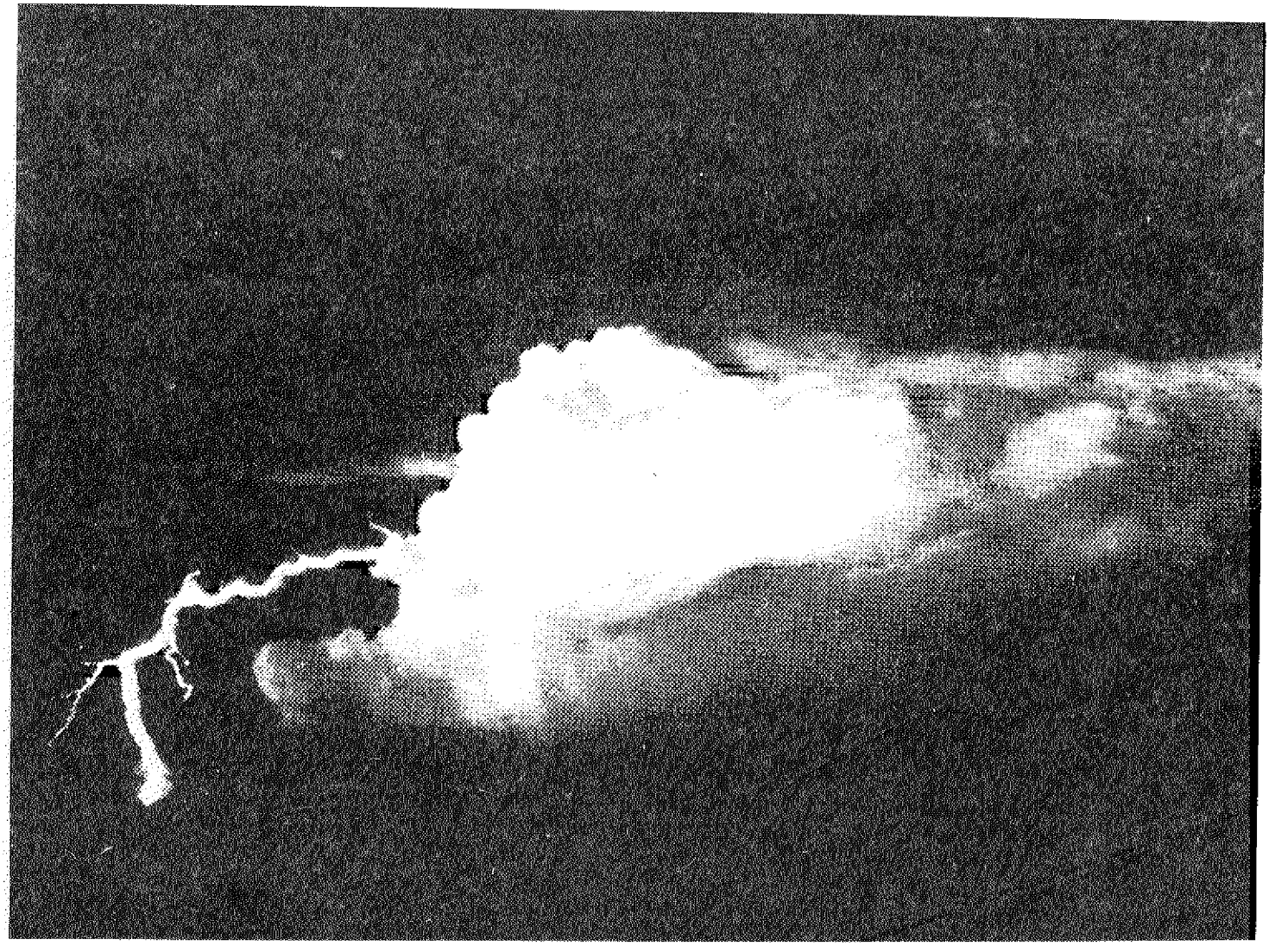

BOATING SAFETY - THUNDERSTORMS

by

Walter A. Sitarz[1]

INTRODUCTION

Safety in boating covers a wide area, including loading, towing, fueling, launching, and lighting of boats, "rules of the road," on board equipment, fire, weather and others. All are important, for failure in any one area can spell disaster.

But the weather, more than any other factor poses a tragic potential for the boater, especially the small boater and oftentimes weather safety instructions pertaining to this group are limited. The purpose of this report is to provide pertinent weather safety information concerning thunderstorms for boaters in the state of Florida.

GENERAL

A pilot would not attempt to fly somewhere without first checking the weather. The same caution should be practiced by the boater because adverse weather conditions have been a major contributing factor in many small boat accidents. The ironic part is that some people are aware of unfavorable forecast conditions but still follow through with their original plans.

The present philosophy of the National Weather Service (NWS) is to provide services to the public via the mass oriented VHF/FM continuous weather broadcast. Every sailor, whether it be the 8 foot, car top sailor, or master mariner should have this valuable service available. Many radios being sold today contain bands on which this weather forecast service is available. Practically all vessels which have VHF radiotelephones aboard have provisions to include a separate channel for weather broadcast monitoring.

When setting out on a voyage the boater should understand what the weather broadcast can really mean to him. If weather conditions are going to deteriorate sometime during mid-day, he can still safely enjoy the better part of the morning without danger, but it is important to recognize these factors when preparing for a day on the water.

For example, if planning to fish in the ocean area east of Miami Beach, he should be interested in the weather forecast and the actual conditions observed. Usually the weather forecast is representative of conditions which are forecast to occur within 12 to 18 hours. In some cases, this still leaves some time before conditions are expected to deteriorate.

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One way to determine conditions at the present time is to listen for the actual observations on scene, usually provided with the same broadcast as the routine weather forecast. The Miami Beach wind conditions are broadcast frequently by the NOAA Weather Radio station at Miami. These reports are updated hourly and are supplemented with reports from the Biscayne Bay pilots and Florida Marine Patrol who give a sea condition report twice daily. Using this information, along with the forecast can help prudent mariners to take advantage of the best parts of each day. If conditions offshore are poor, there are still always other sheltered areas to pursue recreational activities in coastal waterways which afford adequate protection.

THUNDERSTORMS

During the spring, summer and fall in Florida waters thunderstorms pose an additional hazard to the boater. These thunderstorms are frequently accompanied by strong gusty winds, heavy rain reducing visibility, rough seas and particularly lightning. According to the National Climatic Center in Asheville, N. C. Florida has more lightning storms than any other state in the nation.

The National Hurricane Center in Miami, Florida, reports that the state has 90 to 100 thunderstorm days a year, compared to 20 or 30 in New York, with the most dangerous place during a lightning storm being under a tree or in the water.

Some of the historical evidence pertaining to lightning and its effects on boats has been described by Peter E. Viemeister in "The Lightning Book" as follows:

> "Storms have plagued sailors since man floated his first raft. Whether he is an ocean-going professional or one of the millions of weekend pleasure boatmen, today's sailor is usually more concerned with winds and squalls than he is with lightning. Nevertheless, through history, lightning has taken a heavy toll of ships and sailors alike. Even now, we often read in our newspapers of cabin cruisers or sailboats that have been damaged or set on fire by lightning.
>
> "There is no record of the total damages incurred by sailing vessels through the ages because of lightning. But the Royal Navy had a particularly difficult time. The greatest sea power for several centuries, the English probably lost more ships than any other nation. There are many reports of ships being hit in the 1700's. Sometimes lightning traveled down the masts and punched holes in the hull, causing the ships to sink. When Franklin revealed the secret of the lightning rod to the world, nautical men were quick to use his principles to protect their ships. The obvious need was for some conducting route from the high point of the ship to the water....
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> "No less than 35 ships of the line, 13 frigates, and 10 sloops were disabled or greatly damaged by lightning in the years 1810-1815.....

"Sir William Snow Harris, formerly a doctor in Plymouth who had given up his successful medical practice to concentrate on electricity, believed that the best protection for a wooden ship was to make the masts themselves conductors by nailing copper plates on the bottom of the hull and keel.

"In 1847, Sir William published the results of his study of 220 ships of the Royal Navy that had been hit by lightning. He noted that of these 220 ships, 87 were first line ships, 55 were frigates, and 78 were sloops. Almost invariably they were struck high on the mast, with two-thirds of the strikes hitting the highest point of the ship. A few bolts struck lower points along the mast and four hit the ship hull itself. One ship was struck five times in a single hour. In nearly fifty cases the ships were set on fire. All told, ninety seamen were killed and almost two hundred were wounded.

"The introduction of metal ships in the 1860's helped relieve the lightning problem at sea. An all metal ship with a metal mast acts in its entirety as a lightning rod. Modern steel ships are rarely damaged by lightning. For example, U.S. Navy files for 1954-1957 show that there wasn't a single report of material damage nor crew casualty attributed to lightning"

But small boats remain prone to the same circumstances which were prevalent prior to the introduction of metal ships. Most small boats, being constructed of wood or fiberglass do not afford the automatic grounding protection offered by steel or aluminum hulled craft. Damage to small craft is common and usually expensive. Small power boats with radio antennas are frequent targets of lightning, and sailboat masts are frequently struck, even though there are higher objects in the vicinity.

Exact records of small boat damage incurred by lightning related incidents are not generally available, but it would be safe to assume that damage to pleasure boats over the years is quite considerable.

Reliable statistics on lightning related injuries and deaths were not available until several years ago and may not be complete even today. One source of information of this type, Storm Data, available from the National Oceanic and Atmospheric Administration has revealed the following:

Reported lightning incidents in Florida

	Injured	Killed
1973	19	11
1974	39	17
1975	73	13
1976* (through Sept.)	29	14

At least 9 of the persons killed in 1973 and 1974 were killed in marine related incidents. Of the 1975 statistics, three were killed in marine related incidents. Of the 14 killed so far in 1976, at least four were in marine related accidents. In the above figures, marine related includes those people involved in activities related to boats, fishing, beach fronts or piers. Considering the number of people exposed in non-marine areas, it is apparent that lightning in marine areas is particularly dangerous.

Today's fiberglass constructed small boats, especially sailboats are particularly vulnerable to lightning strikes, since any projection above the flat surface of the water acts as a potential lightning rod. In many cases, the small boat operator, or casual weekend sailor is not aware of this added vulnerability to the hazards of lightning. Boats can be protected from lightning strikes by properly designed and connected systems of lightning protection, but a large majority of boats are not so equipped.

Many accounts of lightning casualties have revealed that no rain was occurring at the time of the lightning strike. In frequent cases these strikes occurred just prior to the onset of a thunderstorm. Boaters should be particularly aware of the phenomena because they usually can see the approaching storm very well. In many areas, NOAA Weather Radio will give movements of major cloud areas and thunderstorm activity in the frequently updated radar summaries. Boaters could use this service along with "eyeball" evaluations to allow for an alternative course of action.

The National Fire Protection Association, Lightning Protection Code of 1968 suggests a number of ways in which the boater can protect his boat and minimize any damage if the boat is struck or is in the vicinity of a lightning strike. (See Appendix attached)

On a large power or sailboat, if the antenna is properly grounded and designed, it will offer a cone of protection. If it is not properly grounded, it may and can kill. Lightning strikes upon radio antennas have destroyed boats, caused fires or destroyed radio instruments.

Sailboats with portable masts, or those with the mast stepped on the cabin roof are particularly vulnerable as they are usually the least protected as far as grounding or bonding is concerned. Grounding precautions are definitely recommended to Florida boaters. An effective ground plate should be installed on the outside of all boats when the hulls are constructed. This ground plate would also help manufacturers design safe antennas that would function as excellent lightning conductors.

Even with a properly grounded boat, boaters should recognize the lightning potential and take the necessary safety precautions as follows:

1. Remain in the center of the cabin of a closed boat when possible.

2. Don't go in the water or swim until the storm passes.

3. Keep away from any metal fittings aboard the boat, and particularly those which are connected to the lightning conductive system.

4. Disconnect the major electronic equipment not being used.

5. Don't touch the radio equipment or wiring.

6. On small power boats, lower the radio antenna, and keep a low profile below the freeboard.

7. Ground small sailboats without sophisticated electronic systems by using a length of battery cable which is clamped to the wire stays of the mast and allowed to hang over the side into the water.

8. If the boat is near shore, seek refuge under a bridge.

9. After any lightning storm passes, check the electrical system, and compass. Lightning strikes have been known to alter the magnetic characteristics of a boat.

10. Learn to use and interpret weather broadcasts properly as a means of protecting property and saving lives.

11. If struck by lightning, inform the local weather office of the incident. The report could help to identify hazards, and will be recorded as significant input. A brief account might identify areas where improvements are necessary or satisfactory.

CONCLUSIONS

To reduce boating accidents, protect property, and save lives, it is the responsibility of all boaters to practice the basic rules of boating safety.

Learning to use and interpret the NWS continuous weather broadcast on VHF/FM radio and checking the weather before beginning any boat trip are basic to any weather safety program. Remembering the precautions pointed out in this bulletin, and the principles as set forth in the National Fire Protection Association, Lightning Protection Code of 1968, will reduce the chance of a boater being killed or injured as a result of a thunderstorm.

APPENDIX

THE NATIONAL FIRE PROTECTION ASSOCIATION LIGHTNING PROTECTION CODE OF 1968

Section 26. Sailboats, Power Boats, Small Boats, and Ships.

2600. General Principles.

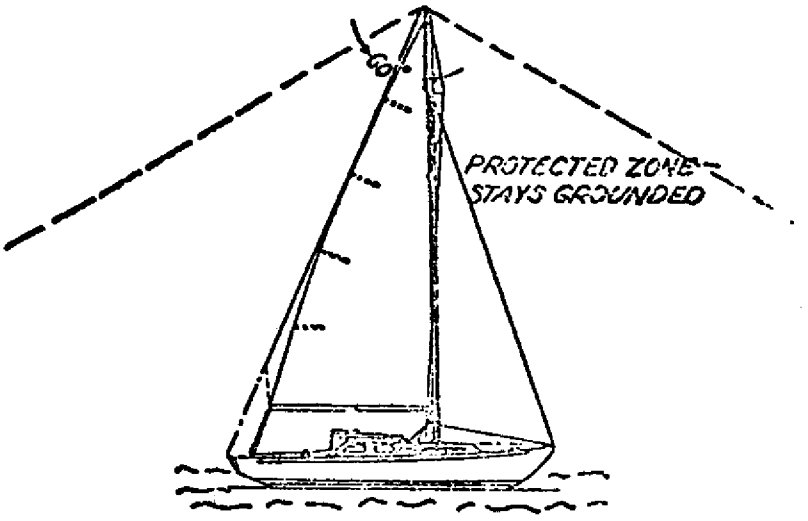
Successful protection of persons from lightning is dependent upon a combination of proper design, personal behavior, and maintenance of equipment. Proper design is covered in this and following sections. Personal behavior and maintenance of equipment are covered in paragraph 2600. In view of the wide variation in structural design of boats, the following basic guides should be considered and used in designing and installing a lightning protection system for any given craft.

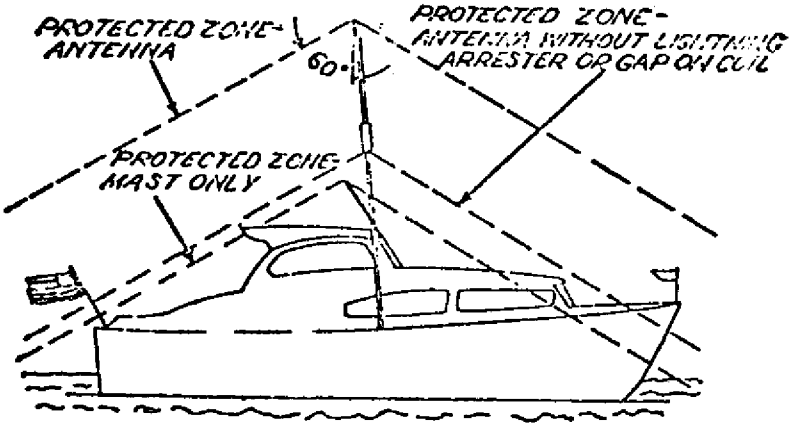
2601. A grounded conductor, or lightning protective mast, will generally divert to itself direct hits which might otherwise fall within a cone-shaped space, the apex of which is the top of the conductor or lightning protective mast and the base is a circle at the surface of the water having a radius of approximately two times the height of the conductor.

2602. To provide an adequately grounded conductor or lightning protective mast, the entire circuit from the top of the mast to the ground should have a conductivity equivalent to a No. 8 Awg. copper conductor and the path to ground followed by the conductor should be essentially straight.

To remove all known risk of melting the conductor when carrying lightning current, conductivity equivalent to No. 6 or No. 4 Awg. copper would be necessary. However, the risk in using No. 8 Awg. is considered adequately small in the applications under consideration, and in many cases will be mitigated by the presence of electrically paralleling stays. This statement should not be interpreted to admit the use of conductivity smaller than that of No. 8 Awg. copper.

2603. If there are metal objects of considerable size within a few feet of the grounding conductor, there will be a strong tendency for sparks or sideflashes to jump from the grounding conductor to the metal object at the closest point. To prevent damage from such sideflashes an interconnecting conductor at least equal to No. 8 Awg. copper should be provided at all places where they are likely to occur. Large metallic objects which are not part of the electrical system of the boat and which are not already grounded due to their own functional or other requirements may be grounded directly to the ground plate (see 2615), provided that it is not practical to interconnect with the lightning conductor or bonding systems.





Diagrams above illustrate the "cone of protection" provided by a grounded mast or antenna. This protective zone is largely immune to direct strokes of lightning. No part of the vessel to be protected should extend outside the cone of protection. Thus in the cabin cruiser illustrated, adequate lightning protection is afforded only by the grounded antenna equipped with a lightning arrester or gap on the coil.

2604. Lightning protection provisions are quite likely to receive scant attention and therefore their composition and assembly should be strong and materials used should be highly resistant to corrosion.

2610. Installation Recommendations.

2611. Lightning Protective Mast.—A lightning protective mast should be of adequate height (paragraph 2601) and should be mechanically strong in order to withstand exposure to use and weather. If the mast is of nonconducting material, the associated lightning or grounding conductor should be essentially straight, securely fastened to the mast, should extend at least 6 inches above the mast, should preferably terminate in a receiving point, should be led as directly as practicable to the grounding connection (paragraph 2615), and should meet the requirements of paragraph 2613.

2612. Radio Antenna.—A radio antenna may serve as a lightning protective mast provided it has adequate conductivity and is equipped with lightning arresters, lightning protective gaps, or means for grounding during electrical storms. The grounding of metal rod type radio antennas constitutes sufficient protection for wooden boats, without masts and spars, provided the following conditions are met:

(1) The antenna and all conductors in the grounding circuit of the antenna have a conductivity equivalent to the No. 8 Awg. copper in accordance with paragraph 2613(1).

(2) A line drawn from the top of the antenna downward toward the water at an angle of 60° to the vertical does not intercept any part of the boat (paragraph 2601).

(3) Antennas with loading coils are considered to end at a point immediately below the loading coil unless this coil is provided with a suitable gap for by-passing the lightning current. Such a gap is recommended.

(4) Nonconducting antenna masts with *spirally* wrapped conductors are not considered suitable for lightning protection purposes.

2613. Materials.—The materials used in the making of a protective system should be resistant to corrosion. The use of combinations of metals that form galvanic or electrolytic couples, if of such a nature as to accelerate corrosion in the presence of moisture or direct submersion, should be avoided.

In those cases where it is impractical to avoid a junction of dissimilar metals, the corrosion effects can be reduced by the use of suitable platings or special connectors, available for such purposes. Except for the use of conducting materials which are otherwise part of the structure of the boat, only copper should be used as the conductor. Where copper is used, it should be of the grade ordinarily required for commercial electrical work, generally designated as being of 98 per cent conductivity when annealed.

(1) COPPER CONDUCTOR.--Copper conductor should weigh at least 50 lbs. per thousand feet. Copper cable conductors should be of a diameter not less than No. 8 Awg. The size of any strand of a cable should be not less than No. 17 Awg. The thickness of any copper ribbon or strip should be not less than No. 20 Awg. (0.032 inch).

Where other materials are used the gage should be such as to give conductivity equal to or greater than No. 8 Awg. copper cable.

(2) JOINTS.—Joints should be mechanically strong and should be so made that they have an electrical resistance not in excess of that of 2 feet of conductor.

2614. Interconnection of Metallic Masses.—Metallic masses aboard boats which are a permanent part of the boat, or are permanently installed within or about it and whose function would not be seriously affected by grounding should, with the exception of those of comparatively small size, be made a part of the lightning-conductor system by interconnection with it. [See paragraph 2303 as more fully described in paragraphs 2614(2), (3) and (4).]

The object of interconnecting the metal parts of a boat with the conductor is to prevent damage from sideflashes especially in the case of rather extensive metal objects that are nearby. The main principle to be observed in the prevention of such damage is to pick out on a boat the places where sideflashes are most likely to occur and provide metallic paths for them.

To minimize flow of lightning discharge current through engine bearings, it may be preferable to bond engine blocks directly to the ground plate rather than to an intermediate point on the lightning conductor.

(1) EXTERIOR BODIES OF METAL.--Metal situated wholly on the exterior of boats should be electrically connected to the grounding conductor at its upper or its nearest end, and, if of considerable length, should be also grounded or electrically connected to the conductor at its lower or its farthest end.

Exterior metal bodies on boats include any large masses such as horizontal handrails on cabin tops, smokestacks from galley stoves, davits or metal signal masts.

(2) INTERIOR BODIES OF METAL.—Metal situated wholly in the interior of boats which at any point comes within 6 feet of a lightning conductor should be electrically interconnected with it.

Interior bodies of metal include engines, water and gasoline tanks, control rods for steering gear or reversing gear. It is not intended that small metal objects such as compasses, clocks, galley stoves, medicine chests, and other parts of the boat's hardware should be grounded.

(3) METAL WHICH PROJECTS THROUGH CABIN TOPS, DECKS OR SIDES OF BOATS ABOVE THE SHEER should be bonded to the nearest lightning conductor at the point where the metal emerges from the boat and should be grounded at its lower or extreme end within the boat.

(4) RADIO TRANSMITTER ANTENNA should be (1) equipped with means for grounding during electrical storms or (2) the transmitter and antenna should be protected by lightning arresters or lightning protective gaps.

2615. Ground Connection.—A ground connection for a boat may consist of any metal surface which is normally submerged in the water and which has an area of at least one square foot. Propellers and metallic rudder surfaces may be used for this purpose. The ground plate as required by FCC for radio transmitters should be considered adequate. A steel hull itself constitutes an adequate ground.

2616. Vessels with Metal Hulls.—If there is an electrical contact between metal hulls and metal masts or other metallic superstructure of adequate height to meet the requirements of paragraph 2601, no further protection against lightning is necessary. Boats with ungrounded or nonconducting objects projecting above the metal masts or superstructure should have these objects grounded or protected with a grounded conductor, respectively, in order to protect them.

2620. Protection of Sailboats.

2621. Sailboats.—Sailboats with metallic standing rigging will be adequately protected provided that all rigging is grounded, so that the mast and rigging meet the requirements of paragraphs 2611 and 2613.

2622. Open Day-Sailers.—Open sailboats will be adequately protected if any shrouds, back stays or preventers, and any continuous metallic track on the mast and boom are grounded. These should be electrically connected at the lower or forward end and grounded to a copper plate on the hull or to a metal rudder, center board or keel.

2623. Cruising Sailboats.—All stays and all sail tracks should be grounded on cruising sailboats since it is assumed that persons will be in proximity of fore-stays as well as after-stays. Grounding of other objects on cruising boats should be in accordance with the foregoing paragraphs.

2630. Protection of Power Boats.

Power boats may be adequately protected by a grounded radio antenna or other suitable grounded lightning protective mast as specified in paragraphs 2611, 2612, and 2613, provided the height of the mast meets the requirements for the cone of protection specified in paragraph 2601. Interconnection and grounding of metallic masses should be in accordance with paragraph 2614.

2631. Where the size of the boat is such as to render the use of a single mast impractical, additional lightning protective masts should be erected to form overlapping cones of protection.

2640. Protection of Small Boats.

Small boats may be protected by means of a temporary lightning protective mast which may be erected when lightning conditions are observed in the distance. Grounding provisions may be made by means of flexible copper wire and a submerged ground plate of approximately one square foot in area.

2650. Protection of Ships.

Ships almost invariably are constructed with steel masts, spars, superstructures, hulls, smokestacks and shrouds, and the array of masts, stacks and radio antennas usually provide the cones of protection called for in paragraph 2601. Therefore, ships and personnel aboard them are usually inherently protected against the effects of lightning. In those cases where adequate cones of protection are lacking, they should be corrected in accordance with paragraph 2601, i

accomplished by changes in number or height of masts, or in accordance with paragraph 3120 if by shielding wires suspended between masts.

In the cases of wooden-hulled sailing ships with wooden masts, protection should be in accordance with paragraphs 2600 and 2620, except that grounding and bonding conductors should have conductivity not less than that of No. 4 Awg. copper wire, and the copper grounding plate below the light water line should have an area not less than 36 square feet (3.3 sq. m.).

2660. Precautions for Personnel and Maintenance Suggestions.

Inasmuch as the basic purpose of protection against lightning is to insure the safety of personnel, it is appropriate that the following precautions and suggestions be listed in addition to all applicable recommendations in paragraph 103:

2661. One should remain inside a closed boat, as far as practical during a lightning storm and should not dangle arms or legs in the water.

2662. To the extent consistent with safe handling and navigation of the boat during a lightning storm, one should avoid making contact with any items connected to a lightning conductive system and especially in such a way as to bridge between these items. For example, it is undesirable that an operator be in contact with reversing gear levers and spotlight control handle at the same time unless necessary to avert collision or shipwreck.

2663. No one should be in the water during a lightning storm.

2664. One should not have a "whip" type radio antenna tied down during a lightning storm if it has been designed as a part of the lightning protective system.

2665. If a boat has been struck by lightning, compasses and electrical gear should be checked to determine that no damage or change in calibration has taken place.

2666. Since the components of the lightning protective system are in a corrosive atmosphere, it is advisable to check all cables and joints at frequent intervals.