Air Terminals

General principle An air terminal is intended to intercept the downward-moving stepped leader by launching an upward-going
attachment spark. Once this attachment is made, the bulk of the lightning current follows this ionized path. Hence an air terminal is intended to divert the lightning away from crew and electronics. In the absence of a separate air terminal on a boat mast, the highest point, usually the VHF antenna, is the most likely attachment point. For an informative debate concerning folklore and science of lightning rods read this. Devices that are intended to prevent a lightning strike altogether are also typically mounted on the highest point. However, the effectiveness of these devices has been questioned in several studies, as described in the section on Lightning Dissipators below.

Sharp or blunt?
Almost every lightning air terminal you are likely to see has a sharp point. The theory behind this was that a sharp point causes the largest electric field and hence is more likely to launch the attachment spark. However, recent research indicates that blunt rods are more effective in this task. Following the suggestion of Prof. C. Moore, the next edition of the NFPA code will reflect this change. The full text of his paper is published in GEOPHYSICAL RESEARCH LETTERS
. The most effective air terminal is one with a radius of curvature between 3/16 and 1/2 inch. However, this does not mean that sharp terminals are necessarily avoided: in the absence of a nearby blunt terminal, Prof. Moore found that sharp terminals do intercept the lightning. Also, the top of an aluminum mast is an effective air terminal, but if you want to stand a chance of protecting masthead transducers such as a VHF antenna or anemometer vane, a separate air terminal is a good idea. And in light of the recent research, a simple 3/8" diameter road that is rounded at one end and attached securely (via a flat face) to the mast at the other is all that is needed. Make sure that any transducers are well below the top of the air terminal, and at least within an imaginary cone with 90 degree apex angle.

Lightning dissipators The idea that a device might be able to prevent a lightning strike is very appealing to the average sailor. Devices that attempt to eliminate or reduce the incidence of lightning strikes generally have a bristly appearance caused by multiple conducting points. Under the influence of an electric field under a thunderstorm, it is undisputed that these multiple points release charge into the air in a similar manner to the phenomenon of St. Elmo's fire. How effective these charge flows are at eliminating or reducing lightning has been the subject of investigations by NASA, FAA, the Departments of Army and Air Force, NFPA, and FDOT. None of these agencies consequently supported their use. Scientific papers by scientists in reputable journals have also been negative. In 1994 Donald Zipse, IEEE Fellow, compared the conventional Franklin air terminal with, amongst other systems, multipoint discharge systems and concluded "The claims of being able to dissipate any and all lightning strokes have been shown to be untrue." In a subsequent study that considered only lightning elimination devices employing the point discharge phenomenon, (that is, lightning dissipators) Abdul Mousa, also an IEEE Fellow, documents many instances when lightning struck towers at Kennedy Space Center and Eglin AirForce Base, and one case of a strike to an FAA control tower in Tampa. In his paper Dr. Mousa concludes that "Natural downward lightning flashes cannot be prevented." His comments on the subject are much more candid in a subsequent posting to the LightningSafety listserve. His phraseology "natural downward lightning" is carefully chosen, but does cover the case of a sailboat mast.

References

Zipse, D.W., *Lightning Protection Systems: Advantages and Disadvantages*, IEEE Transactions on Industry Applications, **30**, 1351-1361, 1994

Mousa, A.M., *The Applicability of Lightning Elimination Devices to Substations and Power Lines*, IEEE Transactions on Power Delivery, **13**, 1120-1127, 1998.