

10th July 2013

Considerations for Lightning Protection

PART TWO – CONSIDERATIONS FOR LIGHTNING PROTECTION

Updates on strikes can be found at the end of this article, highlighted in yellow.



[<http://3.bp.blogspot.com/-E0tTjz44NgE/Ud2oBa0J-TI/AAAAAAAAANqM/2O4avnyUEkU/s1600/lightning11.jpg>]

DOMINO's original 16' VHF antenna: well above the air terminal - A big mistake!

This is neither an exhaustive nor an authoritative article about lightning protection. I certainly do not have the proper credentials for that. Rather, it is—I hope—an eye-opener about the importance and feasibility of installing the right lightning protection system on a cruising yacht. As demonstrated in the previous blog, cruisers get hit, especially those who cruise in higher-risk areas. As well, yachts that stay at marinas in high-activity areas are at highest risk. But my focus is on cruisers, since not only their yachts are at risks, but also their own lives.

From all I've read, and I agree with the [Peterson Owner's Group](http://www.kp44.org/LightningProtection.php) (<http://www.kp44.org/LightningProtection.php>) (1), you cannot prevent lightning from striking your yacht. There is no such thing as a "lightning-proof" yacht. But there is plenty that you can do to limit the damages from a lightning strike. Since yacht builders are under no obligation to fit their products with any kind of lightning protection or bonding system (17), it behooves the yacht owners to address the issue and protect their yachts from utter destruction.

But let's go through the decision process. I am a firm believer in statistics and probabilities, much more than in following three of the most common *Boaters Lightning Beliefs (BLBs)*: keeping my fingers

crossed, hiding my head under a pillow, or praying to some Heavenly God to spare my yacht.



[http://2.bp.blogspot.com/-h89NHlq0-0Q/UeVVD3pUcal/AAAAAAAAANvE/B7_aFGIUMQY/s1600/supercell.jpg]

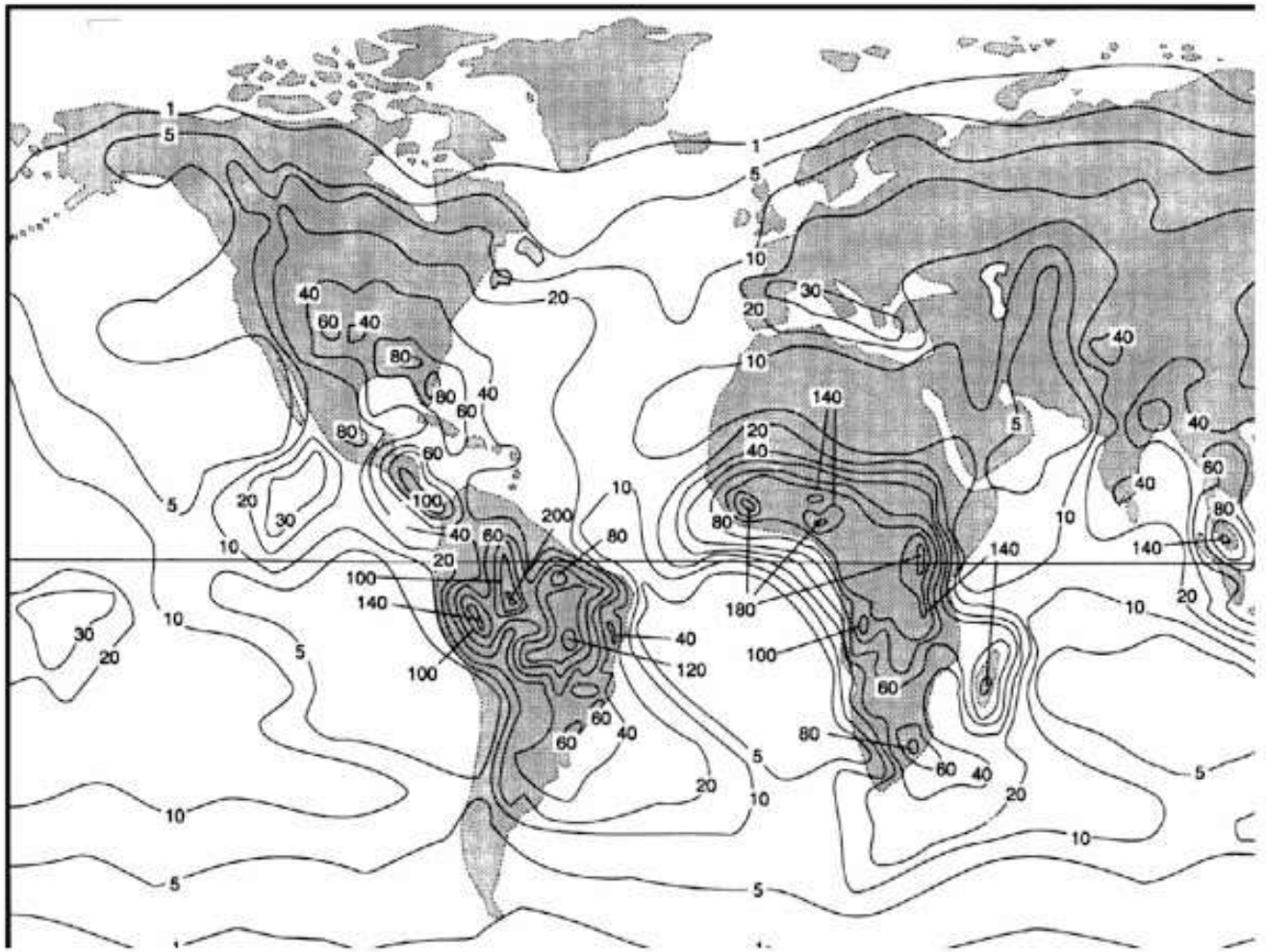
Supercell over Nebraska
(Jeremy Holmes Photography)

I - RISK ASSESSMENT

1 – Where do you cruise?

BLB #1 - “If you don’t want to be hit by lightning, stay away from an area where there is a lot of lightning.”

For boaters whose crafts spend most of the year at a marina, the issue of lightning protection may not be important. But for bluewater cruisers whose life depends on the integrity of the yacht, lightning protection becomes much more vital. Even more important is the area in which they cruise.



[http://3.bp.blogspot.com/-f_2TduukcZY/Ud2md8p50MI/AAAAAAAAANp8/p1wrN4v5AFc/s1600/lightningzones.jpg]

The lightning index chart above gives an idea of the risk of lightning for any given region. It seems logical that the higher the index, the more desirable a marine lightning protection system (MLPS.) Yet lightning does strike in low-index areas too. A survey respondent was hit in Nova Scotia, another one in Maine, and another one in Spain, with damage up to \$5,000. The [Gowrie](http://www.gowrie.com/) Insurance group reports the average claim to hover around \$20,000.

2) Salt or fresh water? Consider the story of [WINGS hit by lightning](http://www.glcclub.com/wings-hit-lightening-lake-st-clair) (2) on Lake St Clair, a low-index area. Not only did the yacht lose its electronics, but also it was taking on water by blown through-hulls. Consider the fact that damage from lightning on fresh water bodies can be much more extensive than on saltwater, due to the lower conductivity of fresh water. Read the story of [ECLIPSE](http://www.sailingcatamarans.com/lightningarticle.htm) (3) hit in the Pilmico Sound.



[http://2.bp.blogspot.com/-6SMxRrTvLto/Ud2s-SfM6_I/AAAAAAAAANqY/jrxOE8dHaJE/s1600/lightning21.jpg]

This catamaran suffered an indirect strike, lost its navigation suite

3) What kind of boat? A boat with a 50-ft mast is likely to be struck once in an 11.2-year period (4)

- According to the 2000-2005 Boats US insurance claim data, the overall odds of any boat being struck by lightning in any given year are about 1.2 in 1000. But, the odds are much greater for boats in higher activity index, such as Florida, with a strike rate of 3.3 in 1000. A close second to Florida is the Chesapeake Bay.

- The majority of strikes are on sailboats (4 per 1000), but powerboats get struck also (5 per 10,000) with trawlers topping the list (2 per 1000) ahead of miscellaneous houseboats, bass boats, and PWCs. (5)

These numbers are astonishing and yet I suspect that the number of yachts involved in a lightning event is much higher than reported by the insurance industry. According to the survey I published earlier, 50% of the respondents either had no insurance coverage or did not report to their insurance company.



[http://4.bp.blogspot.com/-FKKtykdL_c/Ud2tAs8IC5I/AAAAAAAAANqw/ukLSXli5S3U/s1600/lightning51.jpg]

"Witching Hour" in Panama City... lightning is coming!

a) Cat vs/ monohull - Multihull sailboats are struck more than twice as often as monohulls. (7)

Compared to a monohull of identical length, a catamaran has twice the water length, which certainly makes strike management more desirable. But the length on the water may not be the reason why cats get hit twice as often.

- The "Lollipop" factor - Ewen Thomson has an [interesting theory](http://www.marinelightning.com/catamaran/index.html) [http://www.marinelightning.com/catamaran/index.html] on strike probability. I call this the "Lollipop" factor and it has to do with yacht proximity. In a crowded anchorage, yachts close to each other will compete for attraction and have approximately identical electrical potential ("Pick Me" factor); the outlying yachts will only have half the competition; and the larger yachts (wide catamarans and large cruising yachts) who anchor away from the fleet have no competition at all. Remember when you were a kid in the candy store, picking out a lollipop from the counter? Which lollipop did you pick? The one in the middle of the bunch? The one on the outer edge? The one that was standing alone on the side? The outliers were much easier to pick. Ah! Of course, there is always the vicious kid who'll make a point of picking the lollipop from the center of the bunch. Well, lightning can be vicious too. There is no hard rule; just probabilities. However, do keep that 'Lollipop' picture in mind and read Thomson's [theory](http://www.marinelightning.com/catamaran/index.html). [http://www.marinelightning.com/catamaran/index.html] (7)

b)- **Metal vs/ FG** - *'All-metal ships are rarely damaged, and injuries or deaths are uncommon. (6) Their hulls themselves act as grounding and dissipate the charge through salt water. But a wooden or fiberglass yacht does not present that advantage, and they are natural targets for a lightning strike.'* (6) One of our survey respondents, a steel trawler, was hit by a ["Bolt out of the Blue"](http://www.lightningsafety.noaa.gov/bolt_blue.htm) [http://www.lightningsafety.noaa.gov/bolt_blue.htm] that set their engine room and electrical wires on fire.

Had not the yacht been steel, the crew might not have survived.

As one yachtie put it to me, *“The more ground, the better.”* This makes a case for the metal ships, but also may make a case for properly interconnecting the lightning ground to the general ground.



[<http://2.bp.blogspot.com/-06WnxZtv1oY/Ud2s-aNI5aI/AAAAAAAAANqc/YVsGtziv4hk/s1600/lightning22.jpg>]

This yawl lost its electronics, blown TV screen, blown caprails

c)- Mast height – That’s what I call the main “Pick Me” factor.

BLB #2 - *“We always try to anchor next to someone with a taller mast.”*

Lightning coming down from a cloud (“Leader”) will look for the easiest way to hook up with an upward-travelling charge (“Streamer”) emanating from a yacht. Popular thinking has it that the tallest mast will be the easiest pick. But, as we’ve seen above, it’s not the only decisive factor. Reports of small trawlers getting hit while nestled between taller sailboats illustrate the imperfection of the “cone of protection” concept.



[<http://4.bp.blogspot.com/-exbMHwi56TU/Ud3Ne0NHell/AAAAAAAAANrI/AevuF1I7z7g/s1600/tower1.jpg>]

The communication tower at Saboga: we try to anchor close to it

4) - Cone of Protection – Yachties seem to count on each-other for protection. The “Lollipop factor” leads the smaller yachts to anchor close to the tallest ones, or at the foot of a communication tower, or at the base of a hill, hoping to benefit from their cone of protection. But this cone seems to be rather leaky. Lately, I have heard the term being re-coined as “Sieve of Protection.” The [National Lightning Safety Institute](http://www.lightningsafety.com/nlsi_pls/cone-of-protection-myth.html) [http://www.lightningsafety.com/nlsi_pls/cone-of-protection-myth.html] warns that lightning can penetrate the cone of protection. (9) Even Prof. Ewen Thomson admits that there is no absolute guarantee that lightning will not enter the cone of protection afforded by a properly installed system. *“The zone of protection is a region of relative (not absolute) safety in a boat that has a lightning protection system installed. In this region a direct strike, that is, lightning attachment, is very unlikely.”* (10)

5) - “I don’t ground my boat.” Some yachties refuse to ground their boat, not to “*elevate the level of the water*” to the top of their mast. Others are of the opinion that if they have a grounding plate below water, lightning spill-over can enter their boat via the grounding plate. I wonder if they also remove from below water all other metallic part, such as prop and shaft. Freeman [<https://docs.google.com/document/d/1RI5B5FibiYUUqjVgqa43MsdjBRvd2s8gfNmf3eVcKsA/edit>] reminds us that “*lightning is RF and it wants to travel on the surface, not deep in the water.*”⁽¹¹⁾

These particular cruisers, admittedly, have never suffered a strike. But what if they do, one day? Without grounding or any other path for discharge, a strike is likely to create much more damage, fire, and injury to the crew. John Payne has a particular warning for non-grounded vessels: “*Ungrounded Vessels actually promote strikes to the vessel due to [static electricity build-up on deck].*”⁽⁸⁾



[<http://3.bp.blogspot.com/-39NIVsdFg2Q/Ud2tAye3L1I/AAAAAAAAANq0/QUCd3YGOwzY/s1600/lightning41.jpg>]

The powercat HERO has full lightning management system, air terminal way above all antennas

II - MARINE LIGHTNING PROTECTION SYSTEMS – Rather than “Lightning Protection Systems,” I’d rather consider the term “Lightning Management Systems.” The word “protection” is ambiguous: protection FROM a strike or protection FOR the yacht? As cruisers swear repeatedly—and specialists agree--there is no way to avoid a lightning strike. But there are many ways to manage the strike and the way it discharges, as well as to manage the backflow to equipment.

BLB #3 - "[MLPS] can cause more problems than solutions".

John Payne calls this the "Great Myth" [<http://www.kp44.org/ftp/LightningStrikesOnboard.pdf>] (8)

BLB #4 - "Nothing can be done."

Perhaps the most interesting response I've had during my survey came from C. Freeman who took the time to post a technical and informative paper on the Yahoo Group and I reposted on my Google docs [<https://docs.google.com/document/d/1RI5B5FibiYUUqjVgqa43MsdjBRvd2s8gfNmf3eVcKsA/edit?usp=sharing>] . *"Lightning is not a mystery and electronic damage is not inevitable. If that were the case there would be no cell phones, radio or TV stations; all those sites are filled with sensitive electronics that continue to work after having taken direct hits. Why? Because they are protected. How? Can we do it on our boat? The answer is "maybe" (11)*

1 - Goals of protection - ABYC is clear: *"The primary purpose of a lightning protection system is to provide for the physical safety of all aboard your vessel."* (12)

- to the boat - The basic components of a MLPS are an air terminal, a main conductor, and a ground plate.

- to the crew – Bonding the boat to create a Faraday Cage.

- to the electronics – Preventing residual electricity to backflow through the circuits, using clamps, arrestors and other preventors.

- sidestrikes management – Sidestrikes are "a lightning detour" (4) and can happen through the air, but also at the surface of the water or of the earth (13).

I am not going to belabor the components of a complete protection system. Professionals in the field are much more qualified. So, I'm listing here the main links to what I have found to be the most complete and informative sites.

- ABYC Guidelines [http://www.kp44.org/LightningProtectionABYC_Standards.php]

- John Payne on Lightning [<http://www.kp44.org/ftp/LightningStrikesOnboard.pdf>]

- Marine Lightning Protection [<http://www.marinelightning.com/>] by Ewen Thomson

- Brewer's Complexities [<http://www.evaluationengineering.com/>] by Ron Brewer



[http://2.bp.blogspot.com/-ZvFDFo_7ZBE/UeFBACqeEII/AAAAAAAAANuI/WvVvKAFSLFbI/s1600/falcon.jpg]

The Maltese Falcon in Antigua, Dec. 2010

2 – Static Electricity Diffusors (SEDs)

Perhaps the most controversial issue in my survey has been the effectiveness of those funny-looking little brushes, or SEDs.

- The cruiser's point of view:

BLB #5 - "They are inexpensive and can do no harm."

- The seller's point of view

- **LightningMaster Corp.** [<http://www.lightningmaster.com/Product-Catalog>] distributes the "Streamer Delaying Air Terminals."

- **Forespar** [<http://www.forespar.com/products/boat-lightning-static-dissipater.shtml>] makes a case for their product, showing the MALTESE FALCON setup as their champion. This surprised me a bit and I pulled out a photo that I took of the Falcon while in Antigua. Massive lightning rods at the mastheads. Of course, I shot an email to the Falcon's captain who kindly responded, "*We have lightning rods at mast head and on the yard tips.*" Whether the Falcon has SEDs on top of its lightning rods is unclear (but it seems so on my photo above.) Perhaps they make for better attachment points, as suggested by Ron Brewer below?

- **The insurance company point of view** – I am perplexed as to the lack of consensus in the



[<http://1.bp.blogspot.com/-jA6tC5wEWUI/UeFA6RoohqI/AAAAAAAAANuA/1EFHzZfIHbM/s1600/Maltese+Falcon.jpg>]

insurance world. I would have thought that with all their actuarial data, insurance conglomerates would have a standard recommendation on the subject. Yet, some insurance companies request the SEDs, some do not.

- The consultants' opinion-

* **Ron Brewer** is of the opinion that *"Dissipators make for good air terminals. They may even be better at streamer initiation than a single rod."*⁽⁴⁾

* **Ewen Thomson** is of the opinion that dissipators might displace the charge a few inches, *"in other words, enough to deflect the attachment point from its intended target, the air terminal, to an antenna or the top of the mast. This is especially problematic for carbon fiber masts which cannot carry a lightning current without localized damage to the CFC composite."*

* **Nigel Calder** agrees with Brewer and Thomson. *"Almost all the support for these concepts...comes from people either directly involved with the manufacture and marketing of these devices or with links to the manufacturers."*⁽¹⁸⁾

- **Survey says** - Of the 18 yachts that were hit, 3 had dissipators. Of the 6 yachts that reported no event (2 owners,) 5 had dissipators.

The effectiveness of the SED has, however, been questioned in several studies, as reported by the **Peterson Owner's Group** [<http://www.kp44.org/LightningProtectionAirTerminals.php>]. The effectiveness of SEDs has been studied by NASA, FAA, Army, Air Force, NFPA and DOT. *"None of these agencies supported their use. Scientific papers by scientists in reputable journals have also been negative."*⁽¹⁶⁾

For a striking illustration, see the [photo of a catamaran after a strike](http://www.marinelightning.com/AirTerminals.htm#DAS) [<http://www.marinelightning.com/AirTerminals.htm#DAS>]: the SED is still in place, the boat is burnt.



[http://2.bp.blogspot.com/-MCN_RZZqqUc/Ud2tAAWcR-I/AAAAAAAAANqo/wffuqvTARks/s1600/lightning31.jpg]

JP adds arrestors on our Indel refrigerator

3 – Arrestors and surge protectors, or “The Clamping Game.” In previous posts, [Little Fuses](http://www.blogger.com/dominocatamaran.blogspot.com/2012/09/little-fuses.html) [http://www.blogger.com/dominocatamaran.blogspot.com/2012/09/little-fuses.html] and [Big Fuses](http://www.blogger.com/dominocatamaran.blogspot.com/2012/10/big-fuses.html%E2%80%8E) [http://www.blogger.com/dominocatamaran.blogspot.com/2012/10/big-fuses.html%E2%80%8E], I have developed this subject at length, sharing Internet resources for further research, white papers, and product information. The idea of adding transient surge suppressors and other clamping devices on all vital electronics and RF equipment is not to manage the “*millions of volts*” (as one cruiser puts it) that flow through a strike, but to clamp, in a matter of a picosecond, any residual backflow. Again, here are the links:

- Polyphaser [<http://www.protectiongroup.com/Home>]
- Little Fuses [<http://www.littelfuse.com/>]

5 - Your “Bag of Tricks” – Capt. Tom Serio has an [interesting article](https://drive.google.com/#folders/0B91hSpQXnVPcU1VWZDZrbjNUS1k) [https://drive.google.com/#folders/0B91hSpQXnVPcU1VWZDZrbjNUS1k] ⁽¹⁵⁾ on the subject of what to do if you get hit by lightning. But he also recommends installing some kind of what I now call a “Lightning Management System.” He also points out to the fact that Hatteras and Christensen Yachts are two boat builders who install some kind of MLPS on their yachts.

6 – Our mistakes – So many cruisers tell us *BLB #6 - “See, you had a protection system and you STILL got hit.”* Yep! There is no absolute guarantee when it comes to lightning. We were hit, fried most of our electronics. But the boat kept its integrity, we were unharmed and didn't even realize we had been hit until some 10-15 minutes later. None of our non-grounded equipment was damaged (phones, computers, handheld...)

But we have to admit that we had made **two** major errors that ended up to be costly.

a) Our 16' VHF antenna was taller than our lightning rod, unbeknownst to our lightning consultant. What a great “Pick Me” tease for a lightning strike! Since our 66' powercat was anchored

way away from the rest of the fleet (as usual) we became prime target. But it's not the lightning rod that became prime target. It's the VHF antenna – although the lightning rod is likely to have carried most of the surge. Lightning through an antenna causes much more damage than through a properly grounded air terminal.

b) We had not installed any kind of clamping or surge protection on any electronics. That was weak!

Both errors have been corrected and we now *BLB # 7 - "feel good"* about our lightning management system.

During the last year, we have personally met over a dozen yacht owners who had been struck by lightning (some have participated in our survey, others have not.) In the majority of cases, their apparatus at the top of their masts had blown up: VHF antennas, wind sensors, or "bottle brushes." This makes it all the more obvious to me that no antenna should protrude above the highest level of your mast or lightning rod.

Whatever you do, do not underestimate your risk. Consider the probabilities. With the help of a marine lightning expert, pick a system that's right for your boat's cruising grounds, configuration, size and value. And finally, engage the service of a trained, reputable electrician to help with the installation. (14)

CRUISERS UPDATES - More strikes ---

- July 25, 2013 - San Blas Islands - Sailing vessel - Direct strike - Lost inverter charger, mast lights.
- August 2013 - La Playita anchorage, Panama City - Sailing catamaran - Lost most electronics.
- August 2013 - Las Perlas - a 50' sailing cat - Lost most electronics.
- September 6, 2013 - Las Brisas Anchorage, Panama City - 3 boats hit during a 10-strike intense storm at approximately 0800. Two sailing catamarans and one monohull. Two yachts were on the outer perimeter of the anchorage, one (catamaran) was at the center. All yachts lost their VHF antenna, windex and mast light. Additional damage included engines, inverters, navigation suites, radar, AIS.

Now, let's go cruising!

Till next blog

dominomarie

References

- (1) Peterson Cutter Owner Group - <http://www.kp44.org/LightningProtection.php>
[<http://www.kp44.org/LightningProtection.php>]
- (2) The Great Lakes Cruising Club - <http://www.glcclub.com/wings-hit-lightening-lake-st-clair>
[<http://www.glcclub.com/wings-hit-lightening-lake-st-clair>]
- (3) "Eclipse Hit by Lightning" - www.sailingcatamarans.com/lightningarticle.htm
[<http://www.sailingcatamarans.com/lightningarticle.htm>]
- (4) Brewer, Ron, EMC/ESD – "Complexities of Marine Lightning Protection" March 2011
<http://www.evaluationengineering.com> [<http://www.evaluationengineering.com/>]

(5) Lightning! Flash, BANG! Your Boat's Been Hit — Now What? August 2010

<http://www.boatus.com/seaworthy/swlightning.asp>

[<http://www.boatus.com/seaworthy/swlightning.asp>]

(6) National AG Safety Database – “Boating/Lightning Protection – October 1992

<http://nasdonline.org/document/209/d000007/boating-lightning-protection.html>

[<http://nasdonline.org/document/209/d000007/boating-lightning-protection.html>]

(7) Thomson, Ewen - <http://www.marinelightning.com/catamaran/index.html>

[<http://www.marinelightning.com/catamaran/index.html>]

(8) Payne, John - “Lightning Strikes on Board” <http://www.kp44.org/ftp/LightningStrikesOnboard.pdf>

[<http://www.kp44.org/ftp/LightningStrikesOnboard.pdf>]

(9) “Cone of Protection Myth” – http://www.lightningsafety.com/nlsi_pls/cone-of-protection-myth.html

[http://www.lightningsafety.com/nlsi_pls/cone-of-protection-myth.html]

(10) Thomson, Ewen - Air Terminals - <http://www.marinelightning.com/AirTerminals.htm>

[<http://www.marinelightning.com/AirTerminals.htm>]

(11) Freeman, C. - Response to Lightning Survey - Yahoo Group - Sept. 15, 2012

(12) ABYC - Lightning Protection Recommendations

http://www.kp44.org/LightningProtectionABYC_Standards.php

[http://www.kp44.org/LightningProtectionABYC_Standards.php]

(13) Moore et al. *An examination of Lightning-Strike Grounding Physics* - Langmuir Laboratory for Atmospheric Research, NMT, Socorro, NM

(14) Boatsafe.com <http://boatsafe.com/nauticalknowhow/lightning.htm>

[<http://boatsafe.com/nauticalknowhow/lightning.htm>]

(15) Serio, Tom - *Lightning Protection* - Yacht Forum - April 2009 - Permalink #13

<http://www.yachtforums.com/forums/general-yachting-discussion/11059-lightning.html>

[<http://www.yachtforums.com/forums/general-yachting-discussion/11059-lightning.html>]

(16) Lightning Protection - Air Terminals <http://www.kp44.org/LightningProtectionAirTerminals.php>

[<http://www.kp44.org/LightningProtectionAirTerminals.php>]

(17) Thomson, E. *A Critical Assessment of the U.S. Cod for Lightning Protection of Boats* - IEEE Transactions on Electromagnetic Compatibility, Vol.33, No.2, May 1991 <http://www.marinelightning.com/IEEE.pdf>

[<http://www.marinelightning.com/IEEE.pdf>]

(18) Calder, Nigel - *Boatowner's Mechanical and Electrical Manual*, third edition - p.230 - McGraw-Hill, 2005

ADDITIONAL BIBLIOGRAPHY

- Payne, John - *Motorboat Electrical and Electronics Manual* - 2002 - Sheridan House

- Peterson Cutter Owners Group: compendium of articles on lightning

<http://www.kp44.org/LightningProtection.php> [<http://www.kp44.org/LightningProtection.php>]

- Shear Madness Lightning Strike <http://shearmadness72.com/about/lightning-strike/>

[<http://shearmadness72.com/about/lightning-strike/>]

Posted 10th July 2013 by [Domino Marie](#)

Labels: [Domino 20 Power catamaran](#), [domino marie](#), [Dr. JP Dufour](#), [Ewen Thomson](#), [John Payne](#), [Lightning strike](#), [managing marine lightning protection](#), [Marie Dufour](#)

4

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Bob Jones [1/17/2016 4:50 AM](#)

Go to www.empsolutionsinc.com. 100% success rate and a \$500,000 guarantee. Contact them and ask about the 50 meter marine unit. Around \$10,000 installed, I think.

[Reply](#)

Bob Jones [1/17/2016 4:58 AM](#)

There is a new device that has a \$500,000 guarantee and so far has been 100% effective with 8,000 installed world wide (according to their web page, www.empsolutionsinc.com). Not sure of the cost but my impression is that these start at \$10,000 for a "simple" installation.

[Reply](#)

Domino Marie [1/17/2016 10:02 AM](#)

Ok, Bob Jones.... I tried to log on to the Empsolutionsinc website, but no access was granted....??????

[Reply](#)

ashutosh kumar [8/18/2017 1:56 AM](#)

Thank you for your information. It was very easy to understand. You are expressing it in easy way. The images are very helpful. A very useful blog on lightning protection System, I am having this device in my home and also at my office.

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