

# Struck by lightning

and stuck in harbour in Sweden

Nick Charman

Lightning is rightly feared but seldom impacts the average sailor, so like most people we were not really prepared.

*Fera* is a cat-ketch, a Tanton 43, with unstayed carbon-fibre masts. She is a very easily handled and a comfortable cruising boat that has been

a loved family member for many miles, since 1988.

The summer of 2014 had been spent in the Baltic (including the 2014 RCC Baltic Meet), and we had overwintered in Oxelosund, south of Stockholm. This was the first trip of the 2015 season and in the previous days we had made our way to and through the Gota Canal towards Denmark. On 26 May 2015 we were motoring again, now on the large freshwater Lake Vanern, heading



*Fera*, 1985 Tanton 43 ketch

south for the Trollhatten canal in very light southerly winds.

The crew were my wife Stella and myself on watch, below was Helen, a not-very-seagoing but close friend, who had come to join us on this trip on the assumption that it would be 'safe and in calm water'. She was playing *Connect 4* on the saloon table with the two youngsters aboard, who had been allowed to join us, by trusting (up to this point, anyway) parents who are very close family friends, for their half-term school holiday – Lottie (14) and her sister Tilda (9).

At around midday at about 58°28'N, 12°31'E, the small squall

approaching from ahead had some thunder under it. We agreed I should take the usual precautions of putting the small electronic devices (VHF, mobile phone, EPIRB) in the oven. I was below in the act of opening the oven door when the foremast was struck by lightning. A very loud crack and a bright light.

What are your first actions, when struck by lightning? What are your priorities? Certainly I briefly rehearsed in my mind how to launch the liferaft should it be necessary. Things had taken on some urgency now, and happened in very quick order:

- ***Is anyone hurt?*** Apparently not – shocked but not injured
- ***Why are alarms are going off?*** - the engine is still running - is it OK, or about to seize up? – perhaps the voltage charging alarm?
- ***Is water coming in?*** Bilge board up – no sign of rising water, thank goodness.
- ***There is smoke in the cabin*** – where is it from? From forward. Tentatively I open the forecabin access to the foremast foot. The smoke is thicker. An acrid smell. I can clearly see burned wires and charred insulation, but no flames, so no fire, thank goodness. I open the forehatch to clear the smoke.
- ***Is the VHF working?*** Better check. It is. So who should I alert to our possible plight? It's not a Mayday: we are not sinking and no one is hurt. We are underway in calm water. The main VHF is apparently working. Its aerial is on the mizzen and so should be undamaged.
- ***Check the bilge again*** – still no rising water.
- ***Check the engine*** – oil pressure is good. Amazingly, the volt meter shows the alternator is still charging the battery, but all the engine alarms are still sounding.
- ***The boat's course has gone awry***, but Stella is dealing with it. She has disconnected the autopilot and is hand steering.

As I don't know what might happen next, I decide to call the rescue authorities while I can, to at least alert them to our situation. Stockholm radio on the Gothenburg mast (Ch 24) take the message, but ask us to call Sweden Rescue on Ch16. Sweden Rescue are clear and supportive, promising to come immediately if we need help and meanwhile they will stand by. I agree to proceed to the nearest port, Vanersborg.

Time to talk to the crew, especially the rather frightened junior members. Interestingly, they have taken much comfort from hearing me discuss our status with Sweden Rescue, and now know that help will be at hand if needed. After all, I cannot know if any as-yet-unseen damage will be the cause of yet more excitement.

## Nick Charman

After a further hour or so, we are waiting for the railway bridge to open to admit us to the top of the Trollhattan canal at the southern end of Lake Vanern. I call the marina in Vanersborg by mobile phone to check whether they have the right facilities and are able to lift us out for inspection. They confirm that it is possible, so, after the railway bridge has admitted us, we motor straight there with the alarms still sounding to find the marina owner, Dick Netterlid, waiting for us on the quay. I dare not turn the engine off as the starter motor might be damaged, so Dick puts us in a spot where we can stay, but also from where we can be lifted out.

I turn off the engine. The alarm stops. Then, just to test it, I try the engine starter. It works, although the alarms are going again, but I feel this is now of only academic interest. We could not consider her fit for the sea until the boat had been lifted, inspected and checked below the waterline. Now that we are safely tied up, I sign off with Sweden Rescue.

So here we are, and until we can get the damage fully assessed and repaired, here we will stay. And so it has proved; with so much work to be done, it was the end of sailing for *Fera* in 2015.

But what can we do to protect against lightning in the future? After all, for us, being struck once means little, but the odds of being struck again are still about the same as before the strike.

### Anatomy of Lightning

Lightning is an electrostatic discharge, between electrically charged clouds, or between clouds and the ground. It is like a major version of the crackling you may feel or sense when you take off a woollen sweater or walk across some carpets.

In a process that is not well understood, a channel of ionized air, called a leader, is initiated from a charged region in the thundercloud. Leaders are electrically conductive channels of partially ionized gas that travel away from a region of dense charge. Negative leaders are propagated away from densely charged regions of negative charge, while positive leaders are propagated from positively charged regions.

The positively and negatively charged leaders proceed in opposite directions, positive upwards, and negative towards the earth. So as a precursor to the damaging down-strike, your mast is allowing a leader to rise, ionising the air above the boat, and attracting the opposing leader, which results in the massive spark that does the damage. *St Elmos' Fire* is the term for the sparking seen off the top of ships' rigging and upperworks as such leaders build up and discharge, but without attracting a strike.

Anything authoritative you read on the topic, however, (and I have done some now!) says that this process is not well understood. For obvious reasons it is very hard to experiment and measure. The above is necessarily only a brief summary of what I have read, but plenty of

material is available on the subject.

There are places in the world where lightning strikes are far more common, and if you are going to one, this should be a topic for preparation. After being struck, I was told that lightning strikes are relatively frequent in that particular zone of west Sweden.

### Protection?

One theory is that you can protect your boat by stopping that first leader from ionising the air above your boat. There is a static discharge device, that can be seen sprouting from some mastheads and looks like a wire loo-brush. The idea is that the static will discharge from many small points and this device will prevent a single ionised leader path from building up. Does it work? No guarantees!

And then you can try to take the energy of the down-strike itself and guide it 'harmlessly' to the sea. The advice here is to have a pointed lightning rod at the mast head connected to a thick copper cable or woven strap inside the mast, ideally without any sharp bends in it. It should terminate at a large through-hull bolt, which is connected in turn to a large copper plate bonded to the outside of the hull. The edges of the plate should not be straight but wavy to allow a greater edge length, since this is where the electricity discharges into the sea. Some say a radio grounding plate will serve, but this does not stop the destructive electro-magnetic pulse (see below), and there may be side strikes, which can still damage electrical systems.

I have not decided quite what I shall do for *Fera*, but it is never too late to prepare for it until lightning has actually sunk your boat. If lightning energy leaves the hull without a good conductor, it may well explosively melt the hull material, and then you will be faced with leaving the sinking boat very soon if you cannot find and plug the hole quickly enough.

### Lessons

The obvious first lesson was that we should have provided lightning protection in advance. As it turned out, this event proved to be more frightening in subsequent contemplation of 'what might have been', than during the immediate aftermath. Since childhood I have often been at sea during thunderstorms without any incident until now. Perhaps we had become complacent. Certainly I had not rehearsed in my mind what immediate actions I should take. In addition to any personal injuries, the level of the bilgewater, the risk of fire and the vessel's seaworthiness are of immediate concern. We are trained to react appropriately to other possible disasters, such as Man Overboard, but not to a lightning strike. And your reactions may have to be very fast indeed if, for example, a skin fitting has blown out.

The possible effects of a lightning strike are so varied that it is difficult

## Nick Charman

to prepare for them all in advance. If one occurs, you will have to chase around very quickly, but calmly, to identify exactly what the damage is and to respond accordingly. Certainly it must make sense in a lightning storm to put delicate portable electronic items into a Faraday cage, such as the oven. These items may be vital for subsequent communication, rescue, and navigation. After a strike, fire and water ingress must be the immediate concerns along with providing help to anyone who is injured.

I was securely in an ‘inland canal’ frame of mind, at the time. We had been in canals and were now on a lake, never far from land (although Lake Vanern is large enough), so we did not have a Panic Box packed. Had we been sinking following the strike, it would have been very useful to have had all the passports, credit cards, a GPS, mobile VHF, and mobile phones in the waterproof Panic Box. And this would have been just as true in a canal within a few feet of dry land if the boat had foundered quickly.

I was relieved to learn that a lightning strike is covered in our insurance policy. This is worth checking in advance, rather than after the event!

The problem with lightning, I have learned, is twofold. First there is the enormous energy involved in the strike itself, which has to be discharged somehow into the water. The second is the EMP, or Electro-Magnetic Pulse, rather like when there is a nuclear explosion. It radiates outwards and will damage electrical and electronic equipment over quite a wide area. Apparently there have been cases where one boat in a marina was struck, and boats nearby with no electrical connection to it have also had major electronic damage from the EMP.

Lastly, you can fit equipment to try to protect your boat against lightning (and how many of us have done so?), but the possible effects of strikes are so variable that no protection is completely guaranteed. You can never feel impervious to lightning strikes, whatever you have installed.

### **Damage on Fera**

In *Fera*’s case, the survey has luckily shown no apparent damage to the hull, skin-fittings, or the mast, but the electrical systems are extensively out-of-action. As I write this, I still have to learn to what degree the equipment failures are simply because of wiring damage rather than damage within the equipment itself. The electrical survey is ongoing and the repair work is still to be done.

The surveyor was reluctant to pass the masts as undamaged (although no damage is visible on the structure of the mast or mast track) and wants me to have Non-Destructive Testing work done. I do not expect all the work to be finished until Spring 2016.

In the days immediately after the strike, I made an inventory of what was working and what was not. The main-mast’s wiring and its lights and instruments have all been fairly well fried or blown up.



Masthead light . . .



. . . and steaming light

The masthead light took the initial strike, of course, and has been partially melted. All the other navigation light fittings on that mast were charred. The burgee pole is now somewhat charred, and metal fittings on it partially melted, but the RCC burgee itself is apparently of tougher stuff, and is undamaged. (May I pause here and expose an image that has come to mind? – that of me explaining to the Commodore at the Beaulieu Meet, why the RCC burgee is now apparently flying inferior to what seems to be an upside-down loo brush . . . Perhaps I shall cross that bridge when I come to it.)

The damage in some places is odd. For example, all the interior LED lights still work, but on the same wiring circuit the 12v cigar lighter type power-sockets have all failed - so on the same circuit the delicate items have survived, while the crude fittings have failed.

The most obvious externally visible damage has been the charred wires in the mast and at the junction boxes. The anchor light LED on the switchboard exploded, leaving a small litter of broken glass below it. The reason why the self steering had ceased to work was that the Tillerpilot, attached to both the taffrail and the Aries, had blown apart. While in light airs we had been using it to drive the Aries, and in the process had formed an electrical path from the taffrail to



Burgee pole



Tillerpilot split by an explosion inside

## Nick Charman

the Aries itself. The Aries top clamp had signs of electrical arcing.

My inventory checklist shows that the majority of electrical items were not working, even those showing no visible signs of damage. The other devices on the taffrail (aerials and so on) do not appear to be providing input signals to their host receivers.

My theory, although not provable, is that the energy in the initial upward leader found a route from the water, via the Aries water servo-blade, to the taffrail via the Tillerpilot, then along the guardrail and forward. The children in the saloon both reported looking up when we were hit and seeing ‘fireballs’ passing along the deck. It may well have been current along the wire guardrails, from aft to forward.

Incidentally, should you be wondering, once the children had decided that there was little more of interest to see or hear, they returned to their games, deciding that *Monopoly* would be the best trauma treatment. They were delighted that the indoor swimming pool in Vanersborg proved to be very close to the marina. I am not sure that our friend Helen will trust my future advice when I say that a particular passage is bound to be calm and free of adventures.

We hope to be back in the water for 2016 to re-start the sailing plans intended for 2015. The insurers seem to be taking a relaxed attitude to the work and the cost involved. Another small consolation is that this year the summer in Danish waters was apparently abysmal. So let’s hope this was a blessing in heavy disguise.