Confessions of a maintenance dodger...

Some cruises start well then deteriorate, some start badly and get better. David Berry recalls a cruise that started badly... then got worse

David and Ann Berry keep their Moody Eclipse *Aderyn Glas* in Greece

Do you do preventive maintenance? I bet you do although you might not think of it that way. If you change your engine oil regularly, change your stern gland when you are supposed to, check your running rigging and mooring lines rather than wait until they break, service your outboard, oil the teak, antifoul and so on then you are doing planned preventive maintenance.

The alternative (that is, my way, until recently) is to wait until something breaks then fix it, which worked for quite a while – until it didn't!

This summer in Greece, in quick succession we had four water leaks: rain, sea, drinking water and engine cooling water. Then the solar panels packed up and the holding tank pump started falling apart and dripping. Finally the unimaginable: the anchor chain broke!

I was forced from my somewhat arrogant strategy of 'if it breaks I can fix it'. I had to admit that I was wrong and needed to institute preventive maintenance again. I don't know how it went by the wayside in the first place: my profession as an engineer designing Naval equipment required that I consider every possible failure mode of my designs and the effect they would have on the vessel, a formal system known as FMECA. I guess when you retire and don't have to do this stuff any more then the discipline fades. So we were compromised.

I don't want to make this a long story of failing systems so I'm going to examine each of these events in the light of what I could, and arguably should, have done to prevent each failure happening: the retrospective blinding light of preventive maintenance!

'I was forced from my somewhat arrogant strategy of "if it breaks I can fix it"'

ABOUT THE AUTHOR

David Berry began sailing dinghies on the local lake. Now he has the Moody Eclipse *Aderyn Glas* which he owns with his wife Ann and keeps in Preveza in Greece. David retired from his profession as senior design engineer where he was responsible for a team working on equipment for the Royal Navy. Together with Ann he has written an account of their voyage from France to Greece entitled *Time to go South*, available from Amazon. He also runs a website aimed at providing tips and tricks for part time liveaboards at seasolutions.co.uk

CASE 1

SOLAR PANEL INPUT FAILURE

We had watched the output from the panels falling over the past few years and had put it down to age. They were, after all, 11 years old.

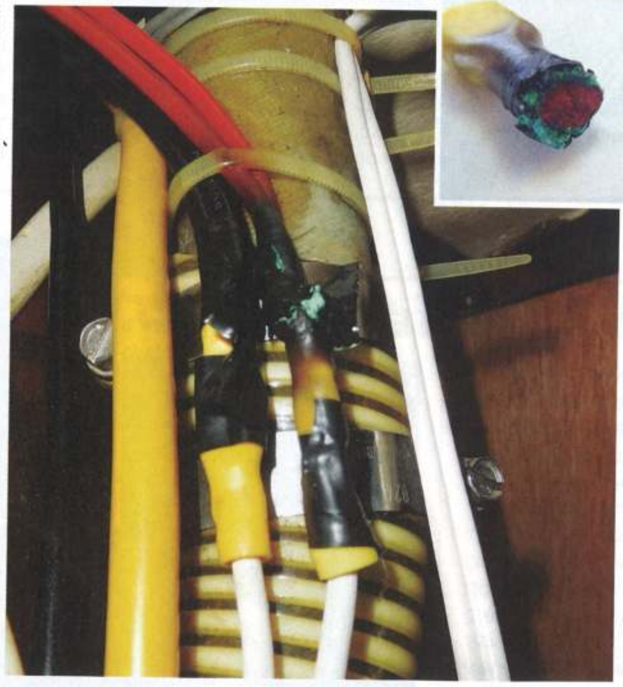
I'd assumed degradation of solar cells would be a photo-chemical reaction but this seems not to be so. Work done by Professor Veroustraete in Antwerp shows that ageing is more likely due to metal fatigue in the substrates and conductors.

Then the output stopped completely. No energy from the panels meant the fridge would have to be fed from the batteries alone which meant running the engine – a noisy, hot prospect in the 30°C environment of the Saronic islands. I took the meter to the MPPT (maximum power point tracking) controller and measured a voltage.

I swapped the MPPT controller for the earlier model assuming that a voltage meant intact wiring – no change. Still no current.

I put the multimeter on the panels and found good open circuit voltage and short circuit current – exactly as the figures told me there should be.

After some head scratching I disconnected the wire at the junction box near the panels then ran a separate one from the junction box to the controller and suddenly had loads of power. It was some weeks before I could investigate further then I found the corroded joint. ➔



ABOVE The turquoise copper oxide colour was a giveaway! This was the likely source of the high resistance that was providing a voltage measurement but preventing any current getting to the controller

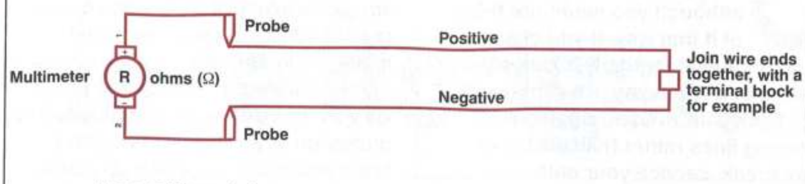
ABOVE In close up the oxide around the crimped connectors was evident. This connection was behind a locker in the aft cabin of the boat and should have been dry. Certainly there was no direct water spray onto the joint under any conditions so I had to conclude this was simply the result of 11 years in a salt-laden environment

LEFT My solar panels mounted on *Aderyn Glas*'s stern gantry around a decade ago – not long after they were installed

CASE 1 continued

Solar panels get-us-home fix meant running the wire from this box local to the panels to the controller along the outside of the boat...

... and taped inconveniently across the floor of the saloon



Loop resistance test
1) There must be no devices in the circuit
2) Connect together the wires to be measured at one end
3) Set your multimeter on a low value resistance scale
4) Connect the meter to the other end of the wire to be measured
5) The value of resistance is now the loop resistance

Loop resistance measurement. Any number of cores can be joined together as long as the measurement is taken between every pair

Preventative maintenance

We are careful with the boat's external wiring and the panel wires are run in flexible conduit which is sacrificial and gets replaced every two seasons or so when it becomes brittle. This protects the wire itself.

But what could I have done to catch this unexpected loss of input before it became a problem? We are always wise after the event and experience is what you get ten seconds after you need it.

This test technique applies to any wiring loops (such as the wiring run to my wind instrument – but that's another story).

The fundamental idea is to take a resistance measurement as soon as possible after original installation of the item concerned then compare the measurements taken in subsequent seasons with the first, baseline, measurement. So once I'd repaired the joint I took a loop resistance measurement. This is done by simply joining the wire cores together at one end of the loop (as many cores as you have can all be joined together, in this case there were only two), then measuring the resistance between each pair of cores and noting the results – in our case 2.5Ω (ohms). Every season or so I shall check the resistance of the loop and compare it to the baseline.

While loop resistance is a worthwhile method of determining the degradation of any wiring, in the specific case of the photovoltaic panels a simpler method is to disconnect the cable at the controller then measure open circuit voltage and short circuit current at the controller input. This has the advantage of testing both the panels and the wiring in one go.

CASE 2

WORN COOLING WATER HOSE

One of the things I'm always careful about is ensuring the hoses in my engine do not rub against each other or against other fittings which would cause them to chafe and be holed.

I do this by cutting small pads of other pipe, slitting them so they'll sit over the existing then holding them in position with cables ties. These sacrificial bits of protective hose can be replaced once they start to wear.

So it was with the greatest of irony we discovered that the tail end of a cable tie holding one of these protectors had cut into the feed hose from the header tank.

Preventative maintenance

Pretty obviously the idea of sacrificial pads is sound. But each season the interfacing pads should be examined at all the locations in the engine where hoses rub and they should be replaced when necessary.

ABOVE A nasty case of cable ties cutting into the outer casing of the header tank feed hose

BELOW Since the inner, water carrying, part of the hose had not been compromised a get-us-home fix was a case of adding a new protector. Before next season the feed hose will have to be replaced with new

CASE 3

BROKEN ANCHOR CHAIN

I have never heard of an anchor chain breaking nor has anyone I've spoken to. We were reversing into a quayside when we heard a loud bang. Ann, on the foredeck, pulled on the chain with the windlass expecting to dig the anchor in and was a little surprised to find the broken end of the chain coming out of the sea onto the foredeck

Having someone retrieve the anchor and chain cost us €200 but since the Rocna anchor had cost £500 it had to be done. The chain was less than five years old and not rusty. Nor was it a C-link joiner that had broken.

We thought at first that we should buy stainless chain but couldn't find any that came with any kind of documentation. So eventually we opted for Lofrans galvanised steel chain which came with a Certificate of Analysis detailing its strength and test results.

Seeking advice from an expert I contacted Vyv Cox, well known contributor on the subject of mechanical engineering, chain and anchoring in general (**coxeng.co.uk/anchoring/chain**). Vyv was as surprised as I was that a chain which should have been ductile had somehow become embrittled. Unfortunately the broken link was lost in the mud at the bottom of the harbour so we could not rescue it for analysis.

Preventative maintenance

We'd heard the generally accepted advice that chain should be replaced after five years but Vyv feels that such a simple generic answer is not globally correct (though if you want to err on the safe side perhaps we could take this a rule of thumb). I would like to record my thanks to Vyv for the following:

"There is a 'rule' about the composition of all steel anchoring equipment that limits the carbon content to a maximum of 0.22%. It applies to anchors, chain, shackles, C-links and swivels. Exceeding the magic 0.22% offers many benefits in increased strength and fatigue resistance but it also provides a risk of creating brittleness if heat treatment is not carried out correctly. In chain manufacture, there are several ways in which weakness can be introduced during welding of the links. These include poor current control, impurities in the steel wire and surface dirt.

"On the subject of galvanising I doubt it has much of an influence on strength, so I suggest chain should be renewed when rust on the decks becomes a major issue. From an inspection point of view the contact points between links should be checked and if more than about 10% cross sectional area has been lost the chain should be scrapped.

"Swivels and shackles should be inspected regularly, at least a couple of times per season. Crosby C-links have perfectly adequate strength but they are only electroplated, so rust quite quickly. They need to be inspected regularly and painting them will help to delay corrosion.

"Stainless chain can be weaker than the average chandlery-supplied galvanised species. Stainless steel 316 is rated to Grade 30, as are many galvanised chains. Cromox, a duplex stainless, is rated to Grade 50, higher than your average chandlery chain that is Grade 40 at best."

Checking all components of the anchor assembly from the anchor itself through the swivel, any shackles and the connection of the bitter end should be a seasonal task.

I have heard stories of the swivel pins loosening and falling out so mine are always peened over with a hammer and punch as well as using Loctite thread lock on the threads.

Lofrans' WINDLASSES
THE ORIGINAL WINDLASS

Certificate of Analysis

FACTORY QC TESTING INSPECTION CERTIFICATE – No [illegible]

PRODUCT SPECIFICATIONS OF ITEM NO. 72313

Grade: 40
Treatment: Hot Dip Galvanised
Calibrated: Yes
Standard: ISO4565 / DIN766

Size: 8mm
Length: 120m
Weight: 1.42 kg/m
Hallmark: LFR

CHAIN STRENGTH

Elongation	18.5%
Working Load Limit	1.100 kg
Proof Test	21.5kN
Minimum Breaking Strength	43.2 kN (Required) 47.2 kN (Actual)

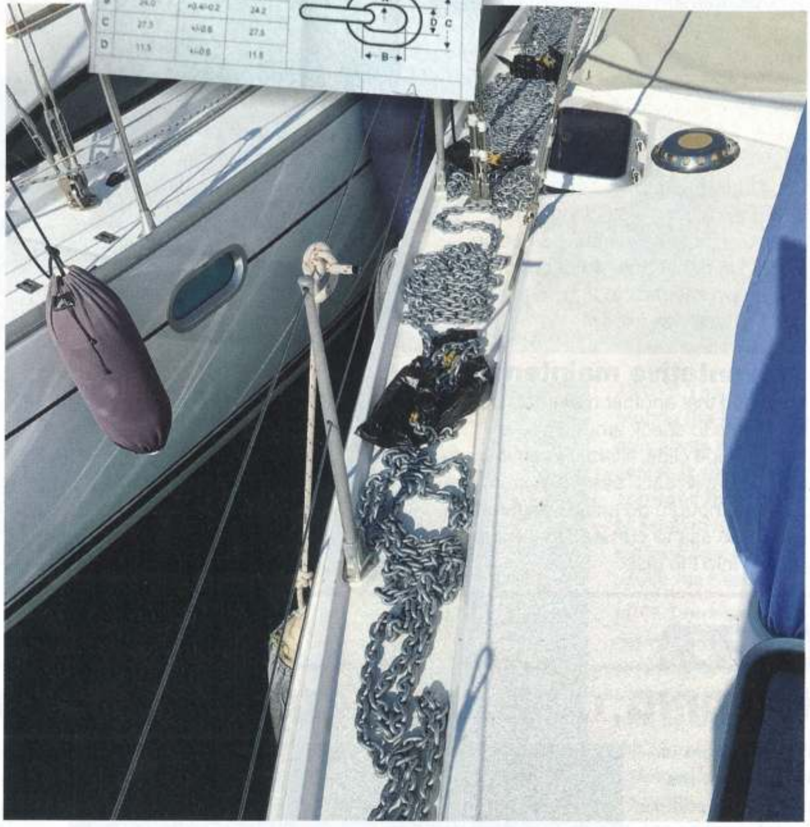
CHEMICAL COMPOSITION

C	0.18	S	0.018
Si	0.27	Cr	
Mn	0.93	Ni	
P	0.034	Mo	

PRODUCT MEASUREMENTS

	Specification dimensions	Tolerance	Actual measurement
A	8.0	+/-0.3	8.0
B	24.0	+0.4/-0.2	24.2
C	27.3	+/-0.8	27.5
D	11.5	+/-0.8	11.6

A certificate of analysis is a good thing to ask for whatever chain you are buying. This one is Grade 40 and has a working load of 11kN (roughly 1.2 tonnes), has been proof tested to 21kN but won't break until it sees 47kN – at which time it has an elongation of 18%, showing how ductile it is



Out with the old and in with the new. Our 60m of new galvanised chain from Lofrans is stamped with their hallmark every few links. At the same time I replaced the swivel that joins chain to anchor

This is the old chain which, on the face of it, doesn't seem in too bad a condition. It was less than five years old, still well galvanised which all implies a source manufacturing problem. It was supposed to be of reliable Italian manufacture, but we now have some doubts

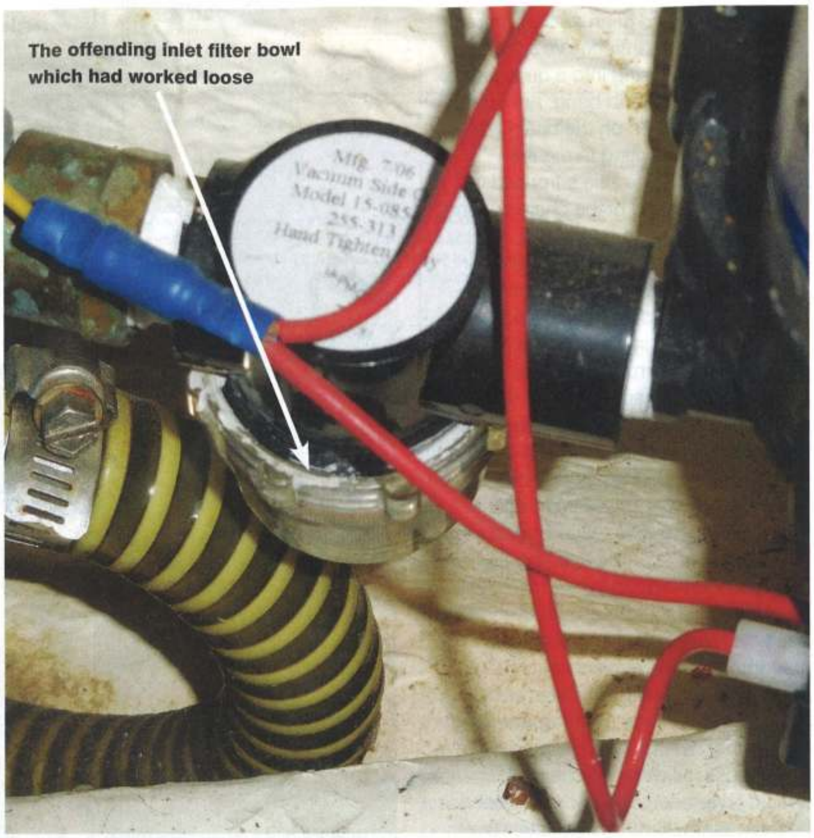
CASE 4

LEAK IN THE DOMESTIC WATER SYSTEM

Often the problem we're faced with is not one of remedy but one of diagnosis, so when the bilge started filling with water it took days to find where the leak was coming from.

We did the usual test which is basically scooping up a sample and letting it dry out to see if there are salt crystals left. This is easy for us in Greece but for those in more northern waters you'll probably have to taste the stuff. Good luck!

Anyway, this was not salty so we were not sinking. Then I had my head in the bilge for some reason when Ann turned the tap on and there it was – a steady drip as the pressurised water system ran. Oddly the drip was from the filter on the inlet, suction, side of the pump which ought to have meant air being sucked in rather than water pouring out. It took two seconds to tighten the bowl and the leak was fixed.



The offending inlet filter bowl which had worked loose

Preventative maintenance

I decided that another maintenance task should be to check around all the fittings, pipe clips, filters and anything else of that ilk each season. A word of warning though: do not over-tighten pipe clips as this can lead to the clip cutting into the pipe.

CASE 5

HOLDING TANK EVACUATION PUMP LEAK


RIGHT My get-us-home fix for the diaphragm pump's broken plastic clamp ring meant taking some stainless mousing wire and making three individual wraps around the broken fixing then holding the wire on the slippery surface with a few blobs of epoxy

Everyone's worst nightmare: the clamp ring that secures the holding tank pump diaphragm in place had broken.

This presented itself in the obvious way: we pumped the tank and watched in horror as drips of brown liquid splashed into the shower tray followed by a piece of plastic.

When I investigated I discovered the plastic had come from the part of the clamp where the screw and nut that pull the clamp together were housed. Now there was nothing to stop the clamp, and then the diaphragm, from falling off.

Preventative maintenance

Pretty obviously the pump was long overdue for swapping out. We'd fitted this pump ten years previously and did not even carry a spares set for it. What's more I'd changed the ball valve which the pump was connected to and not thought for one moment of changing the pump itself. I guess I deserved every drop of brown stuff I had to clear up! It's now on the schedule for replacement after five years.

As this was going on I realised the holding tank itself was ten years old and we also never spared a thought for its lifetime. So I contacted Tek Tanks who had supplied it and was reassured when they reported that a custom tank like ours should have a life of 20 years.

CASE 6

SPOT OF BOTHER WITH THE RAW WATER PUMP

In our search for a saltwater leak (see Case 7, below) we discovered the screw securing the cam plate on the raw water pump had corroded away and was weeping slightly.

I had noticed when I replaced the pump seals (see PBO March 2018) that the screw was brass and was already showing signs of dezincification – it was turning pink – and I should really have replaced it there and then with a stainless steel screw. Failure of the brass screw could have resulted in the cam coming loose and the pump packing up.

When I tried to remove the screw the head simply snapped off, leaving just a crusty stump.

The only way to properly solve the issue would be to remove the pump from the engine, drill out the corroded screw and re-tap the thread ready to accept a new stainless steel screw.

Of course I didn't have time for that right then, but I came up with a get-us-home solution: underwater repair epoxy putty.

I cleaned up the area around the broken screw as best I could, then applied a good splodge of putty over the hole and local area. Because the fix was only to stop the weep – water wasn't gushing out – the putty did its job and held firm.

Preventative maintenance

Obviously I should have replaced the screw when I first saw it was suffering from dezincification.

Following on from that, raw water pump impellers and seals should be on the regular maintenance inspection schedule, and a set of spares should be in your onboard inventory, particularly if you're sailing far from home or civilisation.

ABOVE The whitish blob in the top of the pump was once a screw. It was so well corroded that trying to remove it with a screwdriver simply broke the head off

LEFT There was really no way to repair this properly other than by removing the pump and re-tapping the hole so in the meantime underwater epoxy putty was called for

CASE 7

ENGINE COOLANT PIPE LEAK

I said earlier that finding the source of a leak could be the most difficult part of the repair process and, after all, the whole point of preventive maintenance is to avoid having to deal with unexpected issues in an environment you can't control. Here was another one.

The bilge under the engine was filling with water, many litres each time we ran the engine. This time it was salt but finding the leak took some time.

Eventually we tracked it to the strange neoprene seals that Volvo use on their coolant pipes and it then took the best part of a day to separate the pipes and insert a second seal into the cavity. So now there are two seals and that works.

Preventative maintenance

The original problem was with the Volvo seals and I reluctantly have to accept that these should be replaced every five years or so.

There are many of them in the Volvo Penta 2003 engine and replacing them all will be an awkward and time-consuming job. So much so that I'll probably revert to my earlier philosophy of 'wait till it breaks' then fix them as and when.

I do, however, carry a spares stock of both sizes of the seals (ASAP Supplies carry these) and I will inspect the joints when I run up the engine at the start of the new season.

Scheduling maintenance

So the thing to do now is schedule all these maintenance activities. First is to identify the activities that need to be done frequently, maybe many times during the typical three-month cruise, things such as checking the sacrificial protection on the engine pipework. Next is to identify those which need to be done at the start of each season, such as checking the pipe clips and external wiring and conduit. Finally there are the jobs that can be left longer, such as the loop resistance check of important wiring installations.

I'm also scheduling a trouble-free cruising season for next year!