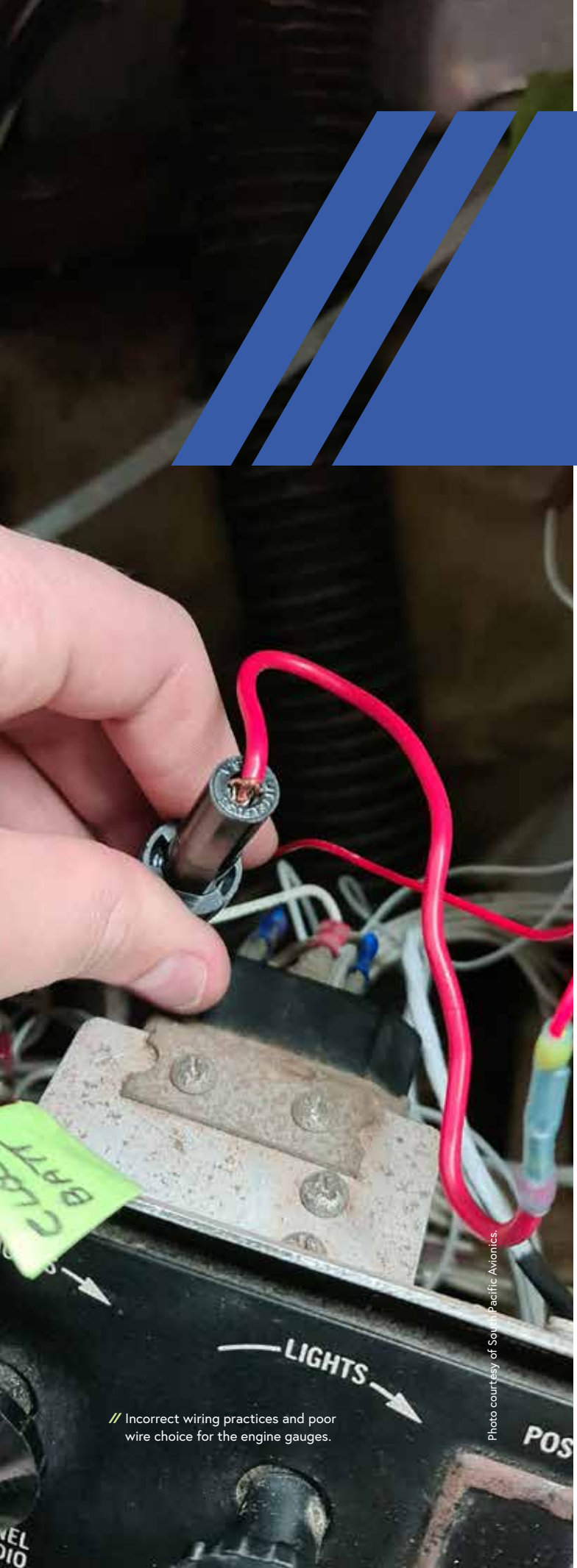
AGEING AIRCRAFT WIRING

// By Philip Hutchings, South Pacific Avionics



// Incorrect wiring practices and poor wire choice for the engine gauges.

Photo courtesy of South Pacific Avionics.

It can't be easily seen but that doesn't mean it's working properly.

Aircraft wiring is sometimes compared to the circulatory system in the human body.

A network of arteries, veins and capillaries extend, in bundles, branches and even on their own, to the furthermost parts of the body carrying life-supporting blood and oxygen.

In the same way, wiring in an aircraft carries voltages and signals to every part of the airframe and engines, and all the way to the wing tips and top of the fin.

The human body cannot function without a circulatory system. An aircraft cannot function without a working wiring system.

But, as with our veins, which are largely unseen and simply presumed to be working, we often don't worry about our aircraft's wiring until it gives us problems.

A great number of the GA aircraft in New Zealand, however, are now over 30 years old. So should we be inspecting the wiring system in our aircraft *before* it gives us problems?

What happens as wiring ages

The wiring originally installed in older aircraft has been subjected to different environmental conditions – hot and humid to cold and icy – that it was not designed to forever withstand.

It was also never designed to resist the environmental onslaught of modern-day synthetic lubricants and cleaners. »

As a consequence, it's degrading. Wires chafing against each other, incorrectly supported in the wiring harness, and rubbing against pipes or aircraft structure all eventually cause wire insulation to deteriorate. It eventually fails one way or another by having an open circuit, or even more seriously, a short circuit.

Wiring harnesses are also subject to the buildup of lint or metal shavings, and exposure to certain oils, fuels or other lubricants – from a leaking pipe, or accidental spillage during a routine maintenance activity.

Items and techniques used 30 years ago to repair wiring did not seal the repair from the environment, leading to likely failure sooner or later.

(Incidentally, the wiring in modern aircraft has much better insulation properties. Proof of this is the difference in weight between the wiring of the different eras. Newer wires are noticeably lighter. The conductor specification, however, is still the same.)

Under the radar

I recently asked a well-known member of the New Zealand aviation community if people were concerned about what lies behind their instrument panels. He felt that most owners were oblivious.

Is it time for a change of heart by aircraft owners? I believe owners need to encourage their engineers to inspect the wiring system thoroughly and report any defect they identify. I think owners, being their own maintenance controllers, should insist on their LAMEs fixing any wiring defects properly or replacing that wiring.

Still not convinced?

Here are some facts that might persuade you.

In 1996, TWA flight 800, 12 minutes into a flight between New York and Paris, exploded, killing 230.

// An aircraft cannot function without a working wiring system. //

Although the source of the explosion was never absolutely confirmed, the investigation concluded an electrical failure had ignited a nearly empty centre wing fuel tank in the 25-year-old aircraft.

Two years later, a Swissair MD-11 crashed off the coast of Nova Scotia, killing all 229 on board.

The Transportation Safety Board of Canada concluded the crash was the result of faulty wiring igniting the flammable insulation above the cockpit.

Around this time there was also a growing suspicion at the US National Transportation Safety Board that wiring failures were likely present on all ageing aircraft across the globe – including military aircraft, commercial airliners, private jets and helicopters.

So in 2002, it established a working group to evaluate the wiring harnesses on 39 aircraft, across eight different models.

The working group concluded the aircraft were in overall good condition, but that there were instances of:

- inappropriate wiring repair
- incorrect routing of modification wiring
- inappropriate clamping and wiring support
- structural contact, and
- lack of a 'clean as you go' philosophy (illustrated by the presence of lint, dust and debris in between wiring bundles).

// Wiring bundle attached to a flight control cable – note the metal shavings on the wire.

Photo courtesy of South Pacific Avionics.

The working group identified a whopping 2,256 such issues. On 39 aircraft.

A review of occurrences reported to the UK CAA between 1997 and 2002 indicated that damaged or deteriorating electrical wiring was a causal factor in 221 events.

In New Zealand

In the last 10 years, according to reports to the CAA, there've been about 220 incidents attributed to faulty wiring, and some of those due to ageing.

A good number of those have been discovered by a 'haze' in the cockpit, the smell of electrical burning, a failure of a system, or a warning light.

Many have been the result of poorly secured wiring looms or broken terminations. Others have been due to chafed insulation due to the loom resting on mechanical control cables.

There have also been failures of relays and contactors and circuit breakers.

Time to reconsider?

Most of the ageing aircraft electrical programmes have been directed at larger aircraft but not so much at general aviation aircraft.

In GA there've been mechanical ageing inspections which have focused primarily on corrosion and airframe fatigue in ageing aircraft.

So is it time to consider the following?

- Is it widely understood that aircraft wiring is an important consideration in the maintenance, repair and modification of ageing aircraft?
- What are the causes of ageing wiring?
- What are the consequences of ageing in wiring systems?
- Is the continuing airworthiness of wiring being considered adequately by those doing inspections and new installations in aircraft?
- What are potential solutions to manage ageing wiring?
- How best can operators and maintainers be informed about the importance of maintaining airworthy wiring?
- Is the maintenance/repair of wiring perceived as being too costly?

Circuit breakers

Circuit breakers also deteriorate over time.

The main purpose of a circuit breaker is to protect the aircraft wiring should a short circuit occur.

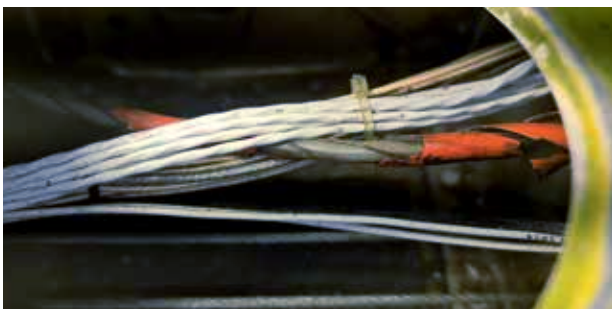


Photo courtesy of South Pacific Avionics.

// Incorrect routing of additional wiring has a pipe running through the middle of the wiring bundle.

The airworthiness standard for circuit breakers is that, if an overload or circuit fault exists, the device will open the circuit regardless of the position of the operating control.

A degraded circuit breaker that fails to trip clearly doesn't meet this standard.

Faulty circuit breakers are considered one of the key sources of electrical arcing. As aircraft age, the likelihood of an arcing event increases.

Older circuit breakers are, at times, very difficult to trip manually, due to corrosion on the contacts or build-up of grime inside the mechanism.

Exercising (cycling) of circuit breakers under no load will help remove any possible internal surface corrosion.

Several circuit breakers, such as those in some Cessna aircraft, cannot be manually cycled, due to their design. It's difficult to test these circuit breakers in-situ so, after a period of time in service, it's appropriate to replace them. This also applies to switches and other electro-mechanical devices.

I would, therefore, strongly recommend inspection and possible replacement as part of the aircraft's scheduled maintenance.

// REFERENCES

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