Pass the **Salt**

If it's made of aluminium, it's susceptible to the corrosive powers of salt. In New Zealand's marine environment, miniscule aluminium-munching molecules are forming on your aircraft's exposed skin every day. Short of parking up in the Nevada desert, what can you do?

In June this year, an R44 helicopter pilot discovered a five-inch crack in the leading edge of the tail rotor during the pre-flight inspection. Metallurgy testing showed the tail rotor blade failed in part because of exposure to salty air.

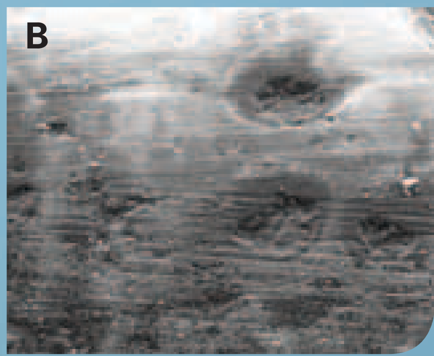
The tail rotor blade was made of Aluminium 2024, the same kind of aluminium as almost all light aircraft. Although R44 rotor blade skins are particularly light and thin, the threat of salt corrosion in New Zealand is significant for all aircraft – particularly where they are exposed to abrasion that compromises the protective paint finish – think main rotor blades, fixed-wing leading edges, propeller blades, vertical stabiliser leading edges, flaps, cowls... To understand how salt affects aluminium; think of aluminium as a highly reactive metal – it is actually more reactive with oxygen than steel. We don't think of it as particularly reactive (or prone to rusting) because when it is cut, it reacts with oxygen in the air within seconds to form a natural oxide layer or protective skin.

But that protective layer is only about 10 nanometres thick (or about 1/10,000th of a human hair) and not impenetrable. Imagine a tail rotor blade that's done a bit of time. It's in good condition, with only a few minor stone nicks and some occasional patches of missing paint that exposes the oxide layer to the air (see figure A).

The aircraft spends the day flying in typical New Zealand coastal air, which contains tiny drops of seawater (that faint haze in the distance), and is then hangared overnight.

If you look carefully in the morning, you may see dried-out particles of salt that have stuck to the aircraft. These are especially noticeable on the propeller or windscreen, which may feel gritty or greasy. The gritty feeling is the fine crystals of salt. The greasy feeling is created when your aircraft has been hangared overnight in high humidity (dew point within a few degrees). The salt crystals start to suck water out of the air (just like the silica gel you get in the little sachets marked 'do not eat').

Now we have little droplets of concentrated corrosive salty water sitting on the thin oxide layer where the paint has worn away. While the aluminium's natural oxide layer resists atmospheric oxygen, it doesn't resist chemical attack from a salt-water solution. Once the oxide layer is breached, the salt starts tunnelling into the metal, creating little pits (see figure B).



These pits are so small, you may not even detect them when running your hand across the blade, and pictured next to them, a small nick from a stone would seem enormous. But because of the way salt eats aluminium, the bottoms of these pits are not smooth, but sharp and jagged. This cragginess means that when the aircraft is flown, the normal

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Photo courtesy of Phillip Treweek

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operating stress is amplified by two to three times at certain points on the bottom of the pits – that causes cracks.

It is the sharpness of the damage, more than its depth, that influences how much the stress is concentrated. A crack is the sharpest possible type of pit. More sharpness, more stress concentration... so cracks breed more cracks.

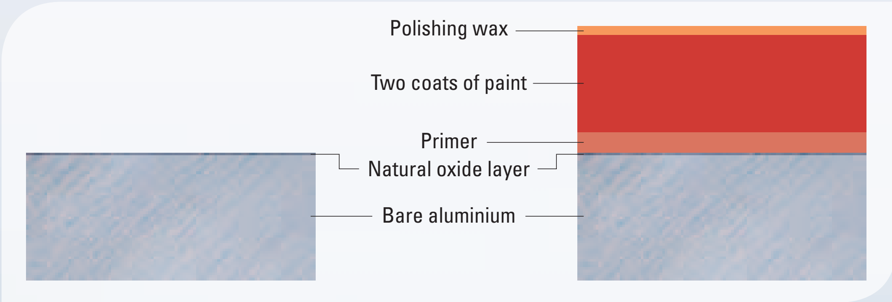
Cracks can extend partially through the thickness of the aluminium skin (see figure C).

Note the initial pits were not all that deep relative to the skin, but they bred very deep cracks.

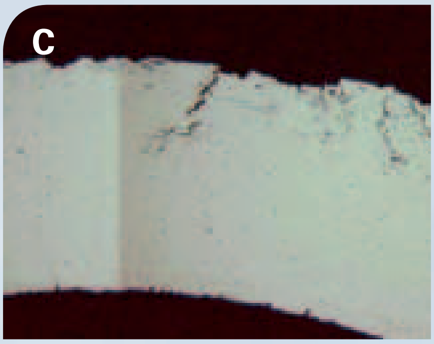
Eventually, they got all the way through (see figure D).

CAA Team Leader Continuing Airworthiness, Jack Stanton, says virtually all aircraft being flown in New Zealand are at risk of salt corrosion to some degree.

"Aircraft manufacturers in the American Mid-west or Continental Europe often struggle to comprehend why New Zealand operators report problems with corrosion. It's the combination of salt and moisture that does the damage. The idea is to stop the salt getting to the aluminium, and we can do that by regularly washing off the salt with fresh water and drying the aircraft, and also keeping up the protective coatings over the aluminium," Jack says.



A painted and polished aircraft provides much better protection from the corrosive powers of salt.



Figures A-D courtesy of Quest Integrity.

"The RNZAF's P-3 Orions are particularly exposed to salt air-induced corrosion because of their long patrols at low altitude over the sea. That's why the RNZAF installed 'bird baths' at Whenuapai to wash aircraft as they taxi in from maritime patrol missions."

Salt Defence

» Wash aircraft with fresh water regularly, then dry.

» Polish often.

» Keep up the paintwork – it's doing more than just looking pretty. ■

Photo courtesy of the NZDF