FLY TO FAILURE

By Sabrina Woods

In aviation maintenance there is a category of parts that are considered "fly-to-fail" components, meaning that the item is replaced once it reaches its visible wear limits or completely fails through normal wear and tear (e.g. light bulbs). While this is a calculated decision in order to economically balance service life, these items are generally not critical to flight. There are many other components that *are* critical to flight. Their lifespans are typically measured in cycles, hours, or time between overhauls. The one thing that every single component on the aircraft is subject to, however, is that under extreme conditions, they *will* fail, regardless of robustness or designed life limit. When this happens, the category "fly to failure" takes on a far more pernicious meaning.

You might be wondering what kind of pressure could buckle a wing spar like a tin can, or snap the lines of a secondary flight controls like twigs. You need not look much further than this edition of *FAA Safety Briefing* to find your answer. In this edition we discuss the dangers of winds, icing, low visibility, and precipitation. While these things can certainly play havoc with your nerves, test the limits of your skill, and affect aircraft performance, what you might not realize is the effect that these things have on your aircraft *itself.*

Hitting the Overload

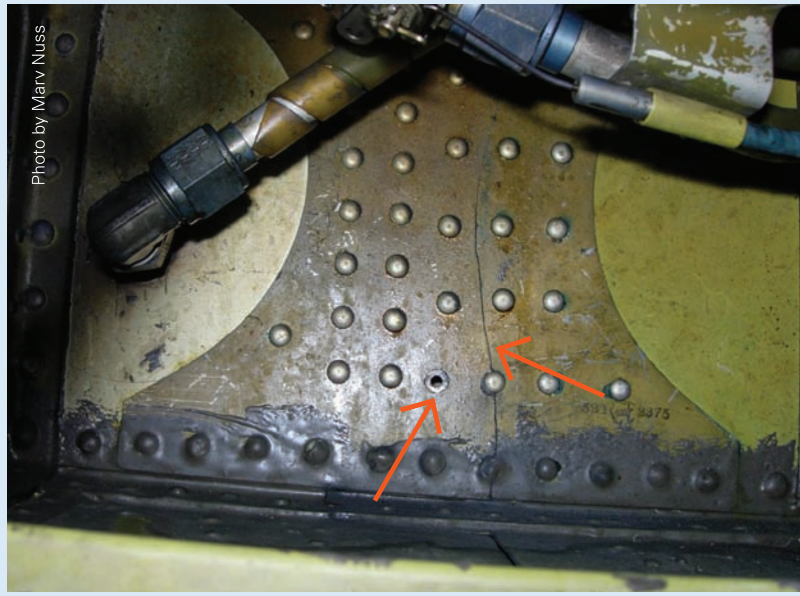
Your aircraft is designed to withstand a certain amount of forces or loads. The forces are a result of basic lift, weight, thrust, and drag, supplemented by maneuvers and turbulence. The aircraft load limits are typically expressed as a load factor which is the ratio of aircraft lift to its weight. The internal structural response to the loads is commonly referred to as stress, which can be thought of as a kind of "pressure" inside the material. All of these terms are used to measure what the aircraft is being subjected to.

Structural load limit varies from make and model but the gist is the same: exceeding that design limit eats into the strength margin and could have a catastrophic effect. Some of the ways this happens include aggressive maneuvering, exceeding maneuvering speed (V_A), and encountering turbulent forces. And as we all (should) know, there is no force more powerful, awesome, and fiercely unsympathetic than Mother Nature in all her fury. Getting caught up in a storm with extreme winds, rough air, or hail leaves you ripe for just such a situation.

Bending Like Beckham

A metallurgy instructor of mine had his students straighten out a paper clip. After completing our task he asked us to put the paper clip back right again. Couldn't be done. Not even with my best multi-tool. The damage inflicted on the paperclip was permanent. Then the instructor had us bend a piece of the paperclip back and forth until it broke off in our hands. For some it took a few bends — others a little longer — but eventually they all snapped.

Metal fatigue is the weakening of materials that are being subjected to repeat loading and unloading. Tiny microcracks and fissures start to show up in the structure and as they grow in size, the structure loses strength until it fails altogether. What most people don't realize is that this damage is *cumulative*, meaning that even if you get back down on the ground safely, the cracks remain and grow in subsequent use until that entire component is replaced. Your airplane is designed to withstand a lot of metal fatigue before it gets too weak.



Fatigue induced auxiliary pump crack and popped rivet.

Some in-flight failures can be the result of flying beyond the design capability of the aircraft, but *nothing* produces the environment to start and exacerbate fatigue as quickly as severe weather. Strong gusty winds, crosswinds, and turbulence can exert an overwhelming amount of stress on the aircraft — in particular the wings — causing them to extend beyond the normal flex that comes with routine flight. Although the wings are the most likely victims given their naturally aerodynamic properties, (they *want* to catch the wind) other components such as the propeller, empennage, rudder, and flaps, can be subject to abuse as well. As the aircraft loses strength through fatigue, it is also losing stiffness or resistance to deforming. This is a secondary effect that can lead to other catastrophic failures, such as flutter.

On the Straight and Level

So now that you know how dangerous it is, what can you do?

First, know and understand the design capabilities of your aircraft — pay particular attention to manufacturer limitations — and adhere to them. Next, don't fly into known adverse weather. It can be lethal in far more ways than I have denoted here, so just don't do it! Last, should you have a severe weather encounter, have your plane inspected before your next flight. I can't say it enough — even though you made it through ok, the effect on your aircraft is <u>cumulative</u> and on the next flight, the real damage could present itself. Leave "fly to failure" to the light bulbs.

Sabrina Woods is an associate editor for FAA Safety Briefing. She spent 12 years as an aircraft maintenance officer and an aviation mishap investigator in the Air Force.