Saving the Aviation Disaster Case, with Engineering Teamwork

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It’s never just an engine failure

In every aviation disaster, there are always many, many variables at work. As a result, legal cases involving aviation accidents are usually incredibly complex, often with a variety of “probable causes” and a range of “reasonable scenarios”. Putting your client in the best possible position to win the case involves appropriately identifying, substantiating, proving and often mitigating each of those factors. A strong legal team and aviation engineering teamwork are imperative to finding answers through this process — even in the most daunting of aviation disaster cases.

I recently provided engineering consulting services on a small plane crash caused by an engine failure, and collaboration was key to our success in the case.

The case was anything but cut and dry, if such a case even exists, but this one was particularly messy by all accounts. Nonetheless, the plaintiff was awarded a substantial settlement without trial, partially due to some skillful legal negotiating, and partially due to the power of physics and engineering.

Post-accident investigation showed several major engine bolts, known as thru-bolts, loosened completely with significant damage to the pistons, connecting rods, and crankshaft readily apparent. Liability was mainly but not entirely directed at an Airframe and/or Powerplant (A & P) Mechanic who recently replaced the cylinders during a scheduled engine overhaul.

Evidence against the mechanic seemed quite strong at first, and then things began to unravel. Quickly.

A tricky case just means there's more blame to go around.

Just prior to the crash, the owner/pilot who is not an A & P mechanic was observed changing the oil. He logged the activity but noted no peculiar incident with respect to the oil change. During discovery, however, the hangar owner who is friends with the owner/pilot, gave a detailed account of a discussion the two men had. The owner noticed a "light metallic sheen" on the oil surface and inquired with several other pilots on a proper course of action.

Everyone he spoke with advised against flying and recommended contacting the mechanic who did the overhaul. The mechanic was unavailable and the owner/pilot became noticeably agitated. He was further cautioned against flying and told to at least cut open the filter and inspect for metal filings. He refused to follow recommendations from his own friends and colleagues and simply replaced the oil and filter.

The owner/pilot, who has over 3000 hours of flight experience, gave an account of poor engine performance quickly leading to a loss of all engine power less than one-half hour after takeoff. He executed an emergency landing described by the NTSB as one of 'superior airmanship', and was hospitalized along with his passenger who sustained very serious injuries.

Toxicology showed trace amounts of alcohol, to which the defense attributed his 'agitation and poor judgement', essentially arguing a severe hangover on the part of the owner/pilot.

The mechanic then justifiably stated that if he had done the oil change, he would have taken appropriate action regarding the metallic sheen, including but not limited to a re-torque of the thru bolts which would have prevented the accident altogether.

It’s hard to argue against the facts

Now, it’s not so simple. While contributory negligence and the like can be argued endlessly, an engineering calculation, done right, is so valuable in a circumstance like this. At the core of the engine failure lies a simple question: *Were the bolts improperly torqued by the mechanic at the time of the rebuild?*

The answer to this question is independent of illicit substances and a stubborn pilot who was too eager to fly, *but the result is the same*.

It’s time to get technical

The torquing down of a nut draws the bolt up through the nut by way of a mechanical interference. That mechanical interference is the interlocking of the two thread helixes and the bolt is measurably stretched. The result is a high tensile load in the bolt known as pre-load, and this tensile pre-load in the thru-bolts is what holds the engine together. I have extensive experience in analyzing heavily loaded bolted connections, but how do you determine a torque-up value from a measured un-torque value with a reasonable amount of certainty? It can be done.

The governing equations are analytically derived and are infinitely accurate, but one unknown that always comes into play is lubrication on the threads *at assembly*. Cranking extra-hard on the wrench to overcome friction from rust and corrosion does nothing to preload the bolt, and the reading on the torque wrench is then incorrect, often very significantly. This applies during the torquing and un-torquing procedure(s).

But nuts and bolts have been around for a long time, and friction coefficients for threads which are lubricated, corroded, rolled, machined, dry, etc. do exist. The key is knowing where to find this information, and how to use it. Machinery’s Handbook is a good starting place of course, but that’s all it is. Hard-to-find experimental data, often carried out by the aerospace majors is invaluable, and we do have access to this information.

In this case I used our resources, and created an analytical experiment of sorts, consisting of multiple what-if scenarios, some of which included very unlikely extremes. The solution set also included reasonable and probable values for the friction coefficients and more likely torque-up value(s) given the evidence and the data.

The power of communication and engineering teamwork

The use of subjective terms like “reasonable,” “possible,” and “likely” is intentional here. It is the job of the expert to relay this technical information to the attorney so he or she can negotiate effectively. This was accomplished by taking a rather lengthy report and summarizing it into one effective, efficient, easy-to-read table that told the story in a very concise manner.

Getting to the finish line

In this case, the plaintiff was awarded a substantial settlement without trial.

The takeaway is that effective communication between an attorney and their subject matter experts can yield answers which would have otherwise gone unnoticed. With legal and engineering teamwork, and everyone sharing one common goal, the opportunities for winning a case increase tremendously.

The biggest breakthroughs come when an attorney can effectively discuss a potential strategy or assess a finding with their experts and have them prove (or disprove) the theory. This requires mutual listening, clear communication, and most importantly, working together.

With an appreciation for engineering teamwork and effort, problematic and even seemingly un-winnable cases can go your way.

Do you need an engineering expert for an aviation disaster case?

At Armellino Engineering, we specialize in airframe structural analysis. We provide expert testimony, engineering consulting and technical advisory services on aviation disaster cases.
If you have a case that requires engineering teamwork and expertise, then please give us a call so we can assist. There is never a charge for an initial consultation.

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