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Safety of Composite 787 questioned; Airbus sides with Boeing

An engineer fired by Boeing under disputed circumstances charges in an 11 page letter to the Federal Aviation Administration that Boeing's new 787 composite structure isn't as safe as the traditional aluminum. The engineer charges composites aren't as crash-worthy as aluminum and will produce toxic fumes in a fire. Airbus, Boeing's bitter competitor, says the engineer's fears don't measure up.

In a letter dated July 24 to the FAA, Vincent Weldon of Enumclaw (WA) charged that Boeing isn't testing the 787 composite structure adequately in addition to the crash-worthiness and toxicity issues.

We've linked *The Seattle Times* article and the letter to our web site under News Articles, along with the HD Net investigative report by Dan Rather that prompted the local news items.

Boeing, as expected, denied Weldon's allegations in what has become a messy dispute over Weldon's departure from Boeing that essentially frames the issue as two adversaries whose vested interests taint both positions. So we reached out to Airbus, which has been using composites on airplanes for a couple of decades, to a consultant to the FAA and to a composites engineer who worked on the Northrop B-2 bomber program to get their take.

Airbus' view is particularly noteworthy, first because of its long history with composites and secondly its plans to build the A350 as a composite airplane. If Weldon is right in his underlying safety assertions about composites, Airbus would potentially be affected, although there are also years in which Airbus could fix any problems while Boeing is racing to deliver the 787 next May.

"Nobody has more experience working with composites than Airbus. We know this stuff well," says Clay McConnell, vice president for corporate communications at Airbus North America.

"The properties of composite structures vary greatly according to their design purpose. Any suggestion that 'composites behave in a certain way' doesn't give the whole story. The orientation of the carbon fibers in the various layers in a composite structure is design-engineered to give the desired strength across various axes. The carbon fiber structure is going to vary according to the unique purpose for that structure and the certification requirement in each area of the airplane," McConnell says.

"Both US and European airworthiness authorities are charged with assuring all airplanes, regardless of the materials from which they are constructed, are going to meet or exceed regulations for crash- and fire-worthiness. We expect the certification process for aircraft for composite fuselages will assure that all concerns along those lines are addressed. That's what the certification process is for," the Airbus spokesman says.

Hans Weber, owner of the consulting firm Tecop International in San Diego (CA), and a past and present consultant to the FAA on safety issues, also believes that Weldon's concerns are off base.

Weber is former chairman of the FAA's Committee for Fire Safety Research and currently chairs the FAA's Technical Oversight Working Group for Aircraft Cabin Environment. He also was one of four authors of a financial report critical of the Airbus A380 that was funded by Boeing.

"There are two issues: first is crash-worthiness and crash behavior. I really think this is a total red herring," Weber says of the Weldon complaints. "The difference of composites vs. aluminum is well known and taken into account. The [Boeing] drop test completely validated the design codes.

"The FAA, because this is new material, requested the validation of the design codes," Weber says, "and the design codes have to come from a Finite Element Model."

(The FEM is a highly sophisticated computer program that computes the stress in airplanes and ships. The FEM analyzed previously unidentified stress points in after-market Boeing 727 freighter conversions, leading to FAA airworthiness directives. The FEM was also used by the Discovery Channel to assess the stress of the *RMS Titanic* to determine the stress that caused the ship to break in two when sinking in 1912.)

Weber likewise says the burning properties of composites are well known to scientists. Among the properties: composites don't conduct heat like aluminum.

"It takes a lot longer to burn through than aluminum," Weber says, although a composites engineer, Chris Wilt, says the burn point is 350 degrees vs. 600 for aluminum.

Wilt, who worked for Vought until 2006 (but not on the 787 program, for which Vought is a contractor), was a composites engineer sub-contracting to Northrop on the B-2 bomber and to Boeing on the C-17 military cargo plane. Boeing, he says, is using graphite epoxies on the 787. The design and construction optimizes the characteristics so the fibers carry the loads and the resin bonding the epoxies gives the composite stiffness and strength, Wilt said, essentially echoing Airbus' comments.

In a crash, Wilt says composites have a different failure mode, breaking instead of crunching (or, to use the engineering term, the "yield" is different). "Most composites don't have yield; they just break. In a way you can say aluminum has a softer yield," he says, "but it also fatigues.

"I would say composites are no less crash resistant than aluminum. You just have to design differently."

As for fire, Wilt says the fuselage, whether composite or aluminum, is the least of the problem. "Fuel will be the driver," he says. "Wool suits that men wear gives off enough cyanide to kill everybody on board. It's not the fuselage, it's the fuel, the interior and what people bring on board."

Boeing, as *The Times* reports, denied the charges. Weldon's status as a fired employee immediately raised questions of his credibility and whether he has an axe to grind. Rather's reporting was questioned by those who point to Rather's disastrous reporting about President George W. Bush's National Guard service.

Weldon's letter speaks for itself and setting aside what are clearly some sour grape issues, as an engineer he raises serious points. James Wallace of *The Seattle Post-Intelligencer* first reported about the Rather piece Monday in Wallace's aviation blog.

Weldon's charges became public shortly after Boeing completed a drop test of a half-barrel 787 section designed to gauge the crash-worthiness of the composite structure. Boeing kept results confidential, citing proprietary concerns, but said the test was a success.

Perhaps not coincidentally, Boeing VP-Marketing Randy Tinseth was considerably more forthcoming on his official blog http://boeingblogs.com/randy/ shortly before Wallace's *Seattle P-I* report.

Boeing/Randy's Blog: engineers examine the 787 test rig before the drop test for crash-worthiness.

Ernie Arvai, an industry consultant with AirInsight (with which we also are affiliated) couldn't comment specifically on the Weldon assertions but did have this to say about composites generally.

1. Composite materials are stronger than aluminum, and Cirrus Design, who makes the SR-20 and SR-22 single engine aircraft with parachutes, has had a counterintuitive reaction from insurance companies. They wanted to raise rates on these aircraft because they are finding different types of injuries than in other aircraft -- basically because in other aircraft the injured would be dead. As a result, they were concerned about the rate of injuries in a crash until realizing that the aircraft stayed together so well in a crash that the injured would be dead in other types. Of course, the parachute slows the impact, a 26g seat has been designed to minimize impact, and the landing gear shear to absorb crash impacts -- so the Cirrus is designed for safety. While the 787 is designed to typical airline standards, composite material fuselages can be crashworthy and in fact have higher strength levels than aluminum.

2. Composites are more combustible than aluminum, and at normal fuel fire temperatures. Exiting an aircraft will be critical in a crash situation. However, other than hitting a building (such as the Cirrus Cory Lytle crashed into a building), excessive fires have not been problematic in operations. Fires are catastrophic in each situation, with toxic materials throughout the interior of the aircraft. It could, however, make exiting a composite aircraft, or using a travel smoke hood when you travel more critical in the event of a fire upon crash.

3. The testing protocols are less stringent than in the past, as computer simulations are now acceptable if a demonstration indicates that the simulation maintains an appropriate level of predictive accuracy. While it would be nice to drop a few fuselages, technology has enabled certification processes to move forward more quickly and at lower expense. Technology advances in both regulatory and materials science.

4. The Airbus chief engineer, about 18 months ago, before the change from the A350 to the A350XWB, commented that Airbus would never use an all composite fuselage because of safety concerns. That point now appears moot. Is there a technological breakthrough that caused this change of heart, or the economic reality of orders for the Dreamliner?

5. Composites have a tendency to de-laminate if exposed to water, and new fastener technology is required - and one of the problems holding up the first Dreamliner. Initial manufacturing quality can be carefully controlled in a factory environment. Concerns do emerge, however, regarding composite repairs. What happens when a ramp employee bumps the aircraft with his tug or cart, and puts a hole in the fuselage? The patching process for Aluminum is well known - a scab patch would be installed. With composites, repairs become an art form of polymer science. Could a botched composite repair create moisture, and eventual de-lamination and failure? While I trust Boeing, do I trust the line mechanic?

By Scott Hamilton, September 18, 2007