

Q&A with Chris Heintz

Background information regarding AMD's Safety Alert (November 7, 2009), and the forthcoming "Upgrade Package" for the Zodiac CH 601 XL/CH 650 aircraft. Please note that the following was drafted prior to the FAA issuing the Special Airworthiness Information Bulletin (SAIB) CE-10-08:

After much anticipation and in response to persistent calls for such a solution, Chris Heintz has released a comprehensive "Upgrade Package" for the CH 601 XL and CH 650 (simply referred to as the "aircraft" or as the "Zodiac" below) which will result in a significantly stronger, "over-built" design. AMD, the US manufacturer of the factory-built SLSA version of the aircraft has issued a Safety Alert to inform Zodiac owners of this "Upgrade Package"; Heintz says this same upgrade should be implemented by all individual builders/owners of the kit-version of the aircraft as the purpose of the alert is to increase safety margins all around.

To help builders and owners better understand this "Upgrade Package", designer Chris Heintz was asked to respond to some of the more obvious questions raised by the AMD Safety Alert.

Chris Heintz: First I want to thank all the builders and owners for their trust and for their patience while awaiting this response (the "Upgrade Package"). As will hopefully become apparent, a huge amount of research and design went into these modifications and I am pleased with the outcome. This package is not so much a specific fix for a single problem; rather, it is a "comprehensive approach" to better the aircraft as a whole. It addresses the elements of properly building, flying and maintaining our aircraft, starting with a significantly "beefed-up" (overbuilt) design.

Question #1: Why are you recommending this Upgrade Package? What has prompted this "180-degree" shift, from insisting that the CH 601 XL design was fine "as is", to now mandating a list of upgrades requiring more than a dozen modifications?

Answer: The past two years have been challenging for the CH 601 XL community around the world. As we all know, a number of accidents have occurred over the span of a few years for which no common cause has been determined. This lack of a "smoking gun" has caused all kinds of conjectures and wild guesses as to probable cause, and each time a new "theory" or "solution" is proposed, I and numerous engineers spend long hours trying to validate or rebuke the latest round of speculation. To this date, after thousands of man-hours of investigations, multiple design reviews and an unheard-of amount of testing, the accidents in question still do not share a common cause. In offering this "Upgrade Package" I have had to set aside my own professional opinion (that the design is sound) as well as legal counsel's advice in order to provide builders, owners and pilots the "fix" that they have been asking me for. With these upgrades (my "180° shift"), the safety margins of key airframe components have been dramatically increased...

Question #2: So the modifications you are calling for are precautionary in nature?

Answer: Very much so. I have been criticized during the current process for not being forthcoming enough about the on-going relevant research and analysis. Anyone with experience in this field in the US will understand that in most cases, our hands are tied: On the one hand, we are bound to confidentiality regarding on-going investigations (the NTSB requires this in order for us to participate in and contribute to the accident investigations); on the other hand, as you might expect, we are being sued and cannot discuss anything which could affect our defense in a negative way. As a result of the information vacuum, a number of “solutions” have been proposed from various sources that I think need to be addressed to benefit owners.

Question #3: Are you not in agreement with the “third-party” solutions being proposed?

Answer: Some of the solutions being proposed are, in my opinion, not fully thought through and/or properly engineered. This is a problem! As a general rule, I do not object to non-structural modifications made to my designs. The modifications being proposed by third parties and installed now are mostly structural; some of them make no sense, and some have the potential for degrading the integrity of the design. We must remember that one change in an aircraft structure creates a domino effect that will affect numerous other elements; the airframe must be reviewed as a whole for each modification.

Question #4: Why so many changes with this upgrade?

Answer: Besides addressing the “domino effect” previously mentioned, my hope is to satisfy most of those who think they have found “the” solution by incorporating their proposed modification into the design in a lucid and meaningful way. Since we do not know the root cause for most accidents, we must approach prevention from numerous angles: Design, construction, maintenance and operation, to mention the most obvious. Significantly overdesigning major structural components is part of the solution; this is what this upgrade accomplishes. Overall, the modified aircraft will be vastly more robust than its operating parameters call for. With all the changes installed, it will be that much more difficult for a pilot to inadvertently “over-stress” the aircraft; the airframe will also be less sensitive to abuse and/or neglected maintenance.

Question #5: Which models of the Zodiac are affected by these upgrades?

Answer: Only the CH 601 XL series and the new CH 650 are concerned; All US-registered aircraft (and others) that are typically flown to American LSA limits should have the upgrade kit installed. Earlier Zodiac models such as the Zodiac CH 600, 601 HD, HDS, UL, or the four-seat Zodiac CH 640 are not affected.

Question #6: How does the installation of these upgrades affect the operating limitations imposed on the aircraft in your letter of July 7, 2009?

Answer: During the recent US-lead (NTSB and FAA) design review, it was pointed out that the original “Ultimate load” calculations for the Zodiac only took into account “full fuel loads”. This is a common engineering approach for many FAR 23 aircraft, however, certification of S-LSA aircraft requires calculations to also consider “minimum-fuel loads”. AMD immediately imposed operational limits on the S-LSA fleet until this could be addressed; I recommended the same operational limits on the “Experimental” fleet as a precautionary measure and so that the FAA would not have to intervene.

With the upgrades installed, the precautionary measures are no longer necessary and all limitations from my July 7 letter are lifted. With the upgrades, pilots may operate the aircraft to its original design limits. Note that these should be clearly spelled out in every POH.

Questions #7: What can you tell us about the issue of flutter with the Zodiac design?

Flutter was first suggested as a possible culprit when no other explanation could be found for some of the accidents we were seeing. I had flight-tested the aircraft for flutter myself in 2000 and had found that the prototype had no flutter issues. Was it possible for flutter to occur when the aircraft was not built to given specifications? It was reported by a number of pilots that they had experienced “aileron flutter” (more likely severe vibrations), a phenomena which can be associated with loose control cables, so we reminded all Zodiac owners to ensure the control cables on their aircraft were well within tolerances.

Having delivered this reminder, a number of Civil Aviation Authorities (CAA) eager to show their pro-active stance used it as justification to ground their national fleets until a redundant remedy could be found. However, in the ensuing months, extensive Ground Vibration Testing (GVT) demonstrated that the aircraft actually does NOT have a flutter issue. These CAA (and the UK in particular) were now stuck with grounded airplanes, looking for a solution to a problem that did not exist.

Based on FAR 23 flutter prevention requirements which state that control-surface-counter-balance-weights eliminate the possibility of flutter in this class of aircraft, we were faced with massive pressure from a number of authorities to offer aileron counterweights and be done with the issue. My position was (and remains) that the fix could be worse than the “problem” if not properly designed. Maintaining proper cable tension (like proper prop-bolt torque) seems so much easier and more reasonable; it just requires periodic checks...

Questions #8: Why are you now proposing aileron counter-weights as part of your upgrading package?

Answer: Because of the strongly-worded NTSB recommendation issued earlier this year, there has been a strong push to blindly install counter-weights on the aircraft. Some people have acted on this recommendation, but I am quite concerned about a number of the counter-weight solutions presently being installed and promoted. The UK LAA has extensively flight-tested the system they are now mandating on UK registered aircraft. Their design is the one that is now part of this upgrade. At this point, my goal is to reassure Zodiac owners that this comprehensive upgrade addresses the widest possible range of concerns. With these counterweights installed, flutter concerns should soon be only a distant bad memory.

Questions #9: Why are you suggesting stiffeners in the aileron bellcrank area?

Answer: This was the last addition to the list of upgrades. While no aircraft design conceived to meet ASTM standards is engineered to take into account the effects of non-linear vibrations, Dutch investigators (that normally work on Airbus/Boeings/etc.) looking into the CH 601 XL design have been applying airliner standards to the Zodiac. Being pro-active, Zenair contacted the German flutter lab again, for guidance on how to best prevent hypothetical non-linear vibrations in the Zodiac design. Upon further study, their response was that by stiffening this one area of the aileron control system, even the remotest possibility for such vibrations had been taken care of. The modification is being called-for preemptively, to avoid one CAA or another feeling the urge to put new restrictions on our aircraft while speculative “non-linear issues are resolved”...

Also related to this issue of non-linear vibrations: Any free-play in the flaps (one or both) could lead to so-called limit cycle (periodic) vibrations. If the amount of free play (backlash) increases, the vibrations could, under certain circumstances (gust or inertial load), become divergent. This is a non-linear dynamic instability and it could lead to severe vibrations. This is why it is important to properly rig and maintain the flaps. With properly installed flap stops free play is minimized and there appears to be no need for concern

Questions #10: Can you say more about the other modifications?

Answer: Let me first say that the proposed modifications are based on very thorough research and testing. Besides the highly-advanced laboratory research already mentioned (conducted at the [Institute for Reliability Engineering](#) at the Technical University of Hamburg, Germany), I have personally overseen a significant number of load tests over the last few months that most likely make the Zodiac design the most analyzed and tested aircraft of its kind.

One of the more significant load tests was the “full aircraft” wing loading test just recently completed at Zenair’s Canadian facility. The full report for this test can be viewed at the Zenith website. You will notice that the list of modifications tested on the trial airframe is quite a bit

shorter than the list of modifications called for in the “Upgrade Package”. The decision to add more upgrades was taken after the test, to even further increase safety margins wherever this could easily be done (given that certain airframe components already needed to be opened anyway, to install the primary (tested) modifications).

Specifically, with the tested upgrades installed, a factory-built Zodiac airframe exceeds the required safety margin for SLSA aircraft by at least 6%. The same aircraft registered as an ‘Experimental’ exceeds minimum margins recommended by FAR 23 by 10%. With the additional upgrades (parts not installed on the tested airframe), the safety margins on critical wing components for Experimental models increase by over 15%.

Once we had agreed to significantly increase safety margins on the main spar area, it made no sense to keep a number of other key components lighter (i.e. now as “weak links in the chain”). So, a number of them (rear wing spar in three areas, fuselage sides, seat area, etc.) were also beefed up to match the increased strength of the main spar. These are the parts that make up the Upgrade Package.

As an interesting aside, for a test to be deemed successful based on FAR 23, the tested airframe must hold Ultimate loads for three seconds. In our case, we added extra weights beyond Ultimate load and the airframe held for more than one minute (at which point we removed the weights to inspect the airframe)!

Questions #11: Where can one find more details about the modifications that were included on the tested airframe?

Answer: On the last page of the load test report, there is a list of all extra material and/or added parts installed on the airframe that was used for the ASTM-LSA load test. You may note that part numbers had not yet been assigned to these items at the time the report was written; these part numbers are now available and are provided on the supplementary drawings that accompany the upgrade kit. Of course, the list from the end of the report has now been expanded; all pertinent information is included in the upgrade kit mandated by the Safety Alert.

Questions #12: Why is it so important to you to provide such wide margins of safety above and beyond already-built-in safety factors?

Answer: One must remember that the vast majority (literally hundreds!) of Zodiac planes flying today were assembled from a kit by amateur builders. While the process is fairly easy and straight forward for the typical builder, there are some builders who fall considerably below average with some of the required skills (just like we have some builders with far superior-to-average skills who will put a factory-assembled model to shame). Because the accidents we have seen have no obvious common cause, we have to assume that one possible explanation is that the aircraft were not properly built, rigged or maintained. This is one reason I strongly feel we should now do all we can to increase safety margins, wherever we can. Who knows, perhaps

someone will catch something untoward in a plane they did not build while opening a wing to install the upgrades... Such a possibility (avoiding more accidents) is what this upgrade is all about. It is to proactively over-build the aircraft so that current and future builders and owners can have added peace of mind...

In addition, just like we have to accept that we may have below-average builders among our many Zodiac builders, we must also accept that we may have pilots of below-average skills among our Zodiac owners. In fact, one reason many pilots are attracted to the Zodiac is because it is such an easy aircraft to fly. This is great with blue skies and no wind conditions, but what happens when the unexpected is encountered? Again, the larger the safety margin we can build into the aircraft, the better, even if this is far beyond the minimum requirements suggested by industry standards. These are some of the reasons why I am using this opportunity to request so many upgrades to the design.

Questions #13: You have mentioned “maintenance” a few times; what about it?

Answer: Maintenance is a big concern, especially as it relates to the second owner of an Experimental plane who will not be familiar with many of the unique features of his/her aircraft. To assist in this area, we now have a 41 page inspection list that addresses all the key issues for the Zodiac. This list should be used as a primary reference during all major Condition Inspections (i.e. annual, 100-hour, etc.). Note: Once an aircraft has been updated with the “Upgrade Package”, all regular maintenance schedules still apply!

When owners and or mechanics do major maintenance or repairs (or the upgrade), I strongly recommend that they have all related documents on hand – including the aircraft drawings (blueprints) – where every aspect of the aircraft can be checked. Before flying again, the 41 page inspection list should be used, along with Appendix 1 in the AMD Service Manual.

Just some of the things found on this list include:

- The ASI which must be properly calibrated and marked by completing an in-flight calibration test. This is critical to make sure flight limitations will not be exceeded.
- The pitot tube on the bottom of the wing that, in many aircraft, is delicate and if inadvertently bumped will no longer provide accurate/calibrated readings.
- The flaps, especially passenger side, which can easily be damaged when stepped on by an inattentive or unknowing passenger...

Such issues are all important and should not be ignored; Safety and reliability will be greatly improved by taking a systematic and common-sense approach to maintenance.

Questions #14: How should owners proceed regarding this call for a general upgrade?

Answer: Owners of an SLSA (AMD-built) Zodiac must comply with the factory-issued Safety Alert. Owners of a self-built “Experimental” Zodiac are officially the manufacturer of their aircraft and are therefore technically free to install (or not) the upgrades. As the designer of the

aircraft, I am strongly urging all owners who operate their CH 601 XL/CH 650 to install the upgrades now being proposed before the next flight. You, more than anyone, know how damaging and demoralizing the doubts and questions regarding the aircraft have been; how they have affected the confidence that many have in the design. Stronger airplanes and better prepared pilots should help us all restore the reputation and desirability of these airplanes you have put so much of yourself into. If for no other reason, install the “Upgrade Package” to maximize resale value of your project: I anticipate that the cost of the Upgrade will be much lower than the increase in resale value.

Questions #15: Where can the owner of a CH 601 XL/CH 650 get the upgrade kit?

Answer: The upgrade kits for Experimental aircraft will be available from Zenith Aircraft Co. in Mexico, MO. and from dealers and builder assist centers. All aircraft should always be built, maintained and flown within their design parameters and in accordance with their POH and design limits.

Questions #16: Any last comments?

Answer: The upgrades called-for take into account the previously-mentioned test data as well as feedback and recommendations from numerous sources including aeronautical consultants and various agencies. My sincere hope is that the upgraded aircraft will now be so obviously and grossly over-designed that, even as a responsive, high-performance LSA, it will be much more difficult to inadvertently overload.

I urge all owners to ensure their aircraft was built to comply with the latest drawings, is maintained according to common aviation standards and practices, and, especially important, that it always be flown within its design limits.

I am confident that this approach combined with on-going pilot education will put an end to the type of accidents that have been occurring. Stronger airplanes and better prepared pilots should help restore the reputation and desirability of this wonderful design, now surely the most analyzed and tested aircraft of its kind.

While I am (officially) retired, I want builders and owners to understand that I have worked tirelessly to offer this Upgrade Package so that all concerned may once again have full confidence in this design.

Related Information:

- **Copy of AMD’s Safety Alert of November 7, 2009**
- **Drawings referenced in the above Safety Alert.**