

Unapproved Aircraft Seat Modifications

What you can, and cannot do, to modify aircraft seating.

Over the past twelve months, the CAA has become increasingly concerned about the extent of modifications to aircraft seats.

This is particularly so with regards to 'dynamic' seats – those compliant with TSO C127 (series), or the Federal Aviation Administration (FAA) airworthiness requirements of FAR 2X.562.

Dynamic seats can be found in most aircraft from General Aviation to air transport, including helicopters.

The CAA has invested a significant amount of research into the issue, aimed at better understanding, and if possible, simplifying current international guidance on dynamic seat modifications. That involved much discussion with the FAA and EASA, which both reaffirmed the safety benefits of dynamic seats, and reinforced the need for the proper validation of all dynamic seat modifications.

In the past, aircraft seats have traditionally been designed to comply with static strength requirements (FAR 2X.561). Compliance with those standards establishes a baseline level of impact protection by assessing the strength of the occupant/seat tie-down chain.

In the late 1980s, the dynamic seat performance standards (FAR 2X.562) were adopted to further improve occupant survivability, and address the crashworthiness aspects of aircraft.

Like the static requirements, the dynamic performance standards assess the structural strength of the occupant/seat tie-down chain (although in a different environment), while also going beyond a strength assessment to evaluate the potential for occupant injury.

The dynamic standards require seats to comply with a number of criteria during two distinct dynamic test conditions that simulate the decelerations most likely experienced in emergency landings, and in which the occupant is reasonably expected to survive.

The main focus of the first test is to evaluate the means provided to reduce spinal loading and injury during a crash event. The second test assesses the occupant restraint system and seat structural performance. This type of testing is an extremely intensive, lengthy, and expensive process.

The pass/fail criteria of the tests ensure that the occupant/seat/restraint system responds in such a way that reduces injuries and fatalities in survivable crash events.

The main criteria involve limitations regarding:

- » maximum tension loads in upper torso straps (chest injuries)
- » maximum compressive load in the spine of the ATD (spinal injuries)

- » restraint straps remaining in place (occupant flailing)
- » maximum head injury criteria (head injuries)
- » maximum compressive loads in the femur (leg injuries)
- » seat remaining attached at all points (preserving occupant survival space)
- » seat structural deformation that would prevent occupants evacuating quickly.

It's the performance of the seat system that's evaluated, which includes the seat structure, seat track fittings, energy-absorbing mechanisms, cushions and upholstery, and restraints. These are all components of the seat system that, when combined into a unique seat combination, meet the above criteria. The system as a whole has been carefully designed, analysed, and tested to demonstrate compliance with the criteria of the FAR 2X.562 regulations.

TSOs vs Airworthiness Requirements

A TSO is a set of minimum performance standards (MPS) issued by the FAA for specified materials, parts, processes, and appliances used on civil aircraft.

The main TSOs relevant to seats are TSO C39 series (Aircraft Seats and Berths) and TSO C127 series (Rotorcraft, Transport Airplane, and Normal and Utility Airplane Seating Systems).

TSO C39-compliant seats must meet the MPS outlined in National Aircraft Standard (NAS) Specification 809 Specification – Aircraft Seats and Berths, which requires that the seat structure be protected from deterioration/loss of strength, that the seat be statically tested, and that the covering and upholstery meet fire protection requirements.

TSO C127 requires seats to meet the MPS detailed in Society of Automotive Engineers, Aerospace Standard Document No. AS8049 "Performance Standards for Seats in Civil Rotorcraft and Transport Airplanes", as amended by Appendix 1 of the TSO document. Many of the requirements in AS8049 are the same as those in FAR 2X.562.

It's important to understand that TSO compliance is not the same thing as an approval to install and use the seat in the aircraft. TSO compliance means only that the seat meets the MPS of that specific TSO. Further demonstration may be needed to show that the installation of the seat meets the applicable airworthiness requirements of the aircraft.

For example, although TSO C127 requires that head injury criteria (HIC) and femur loads be measured and recorded, it doesn't require those values to meet criteria listed in FAR 2X.562: for example, HIC < 1000, femur loads < 2250 lb.

So, when modifying and installing a seat into an aircraft, there are two separate but related issues that must be considered: compliance to the seat TSO, and compliance to the applicable airworthiness requirements.

Guidance Regarding Modifications

As mentioned earlier, it's the total seat system that's been demonstrated to show compliance with the criteria specified in the dynamic FAR 2X.562 requirements or the TSO MPS. If one (or more) of the seat system elements is modified, even by seemingly simple modifications and repairs, the dynamic response of the seat may be affected, possibly invalidating the TSO and making the seat non-compliant.

Seats are often modified by people other than the original equipment manufacturer, therefore the detailed design and substantiating data for the seat is not always available. As seats have developed into complex energy-absorbing systems, it can be difficult to truly understand what effect modifying one element of the seat may have on its overall performance.

The CAA recently wrote to all Part 145, 146, and 148 certificated organisations with guidance for modifying aircraft seats, for instance, changes to upholstery.

Continued compliance to the TSO MPS must be demonstrated for any modification made to a TSO C127 series seat.

In addition to maintaining TSO compliance, any modification to an aircraft seat must also continue to meet the applicable airworthiness requirements of the aircraft.

Fabric changes may be considered a minor design change, provided they don't have fibre fill/backing foam/trim foam, and require a Part 146 design approval. For any other proposed change to a dynamic seat, such as changes to the foam squabs, the CAA can help interpret whether the change is considered major or minor, and it can also help determine what level of compliance must be demonstrated. Please contact the Aircraft Certification Unit, airlines@caa.govt.nz.

Acceptable Technical Data

Installing any design change onto an aircraft, including modifications to seats, requires the use of acceptable technical data, which is listed in CAR Part 21 Appendix D. Without acceptable technical data, the article cannot be legally installed onto a New Zealand-registered aircraft.

The modified items should have part numbers and markings to indicate the acceptable technical data that approves the change. The acceptable technical data that was used should also be recorded in the modification section of the aircraft logbook.

The CAA, or a Part 146 design organisation, should be contacted for advice before repairs or modifications are carried out on a TSO C127 series seat.

If the seats in your aircraft have been modified through the use of unacceptable data and/or appear to be lacking the proper documentation and paperwork, please notify the CAA. It's important that all design changes to aircraft seats are fit for purpose and approved correctly to ensure the safety of the aircraft occupants. ■



It's important that the Anthropomorphic Test Device (the dummy) used in dynamic testing be as realistic as possible, like this dummy getting ready for testing at the FAA CAMI lab in Oklahoma City. There are detailed specifications that must be met for everything from the dummy's clothes to his shoes.