Special Condition on installation of three points restraint and pretensioner system

Applicable to A330 NEO

Introductory note:

The following Special Condition has been classified as an important Special Condition and as such shall be subject to public consultation, in accordance with EASA Management Board decision 12/2007 dated 11 September 2007, Article 3 (2.) of which states:

"*2. Deviations from the applicable airworthiness codes, environmental protection certification specifications and/or acceptable means of compliance with Part 21, as well as important special conditions and equivalent safety findings, shall be submitted to the panel of experts and be subject to a public consultation of at least 3 weeks, except if they have been previously agreed and published in the Official Publication of the Agency. The final decision shall be published in the Official Publication of the Agency.*"

Statement of Issue

In order to show compliance with JAR 25.562 the installation of shoulder harnesses with pretensioners on seats is installed as a means to reduce the potential for occupant injury in the event of an accident.

The pretensioner works similarly to an automotive pretensioner, except that the pretensioner acts on the shoulder harness only and not to the lap belt.

The PHARS (Pretensioning Head Arc Reduction System) is a self-contained restraint system specifically designed to improve occupant protection especially in FWD facing and angled seat orientations (not designed for side facing seats that are installed at 90 degrees with respect to the longitudinal axis of the aircraft) from serious injury during a survivable accident. The seat belt is a three-point restraint system with standard webbing, end fittings, and push button buckle. Only the shoulder belt is attached to an inertia reel with a pre-tensioner (figure 1 below). The Mechanical Crash Sensor Unit (MCSU) activating the pretensioning feature is lithium battery powered and completely independent without any interface to aircraft wiring.

The 3-point diagonal restraint system with inertia reel pre-tensioner consists of three (3) top level components:

(1) Restraint System including inertia reel equipped with pre-tensioner

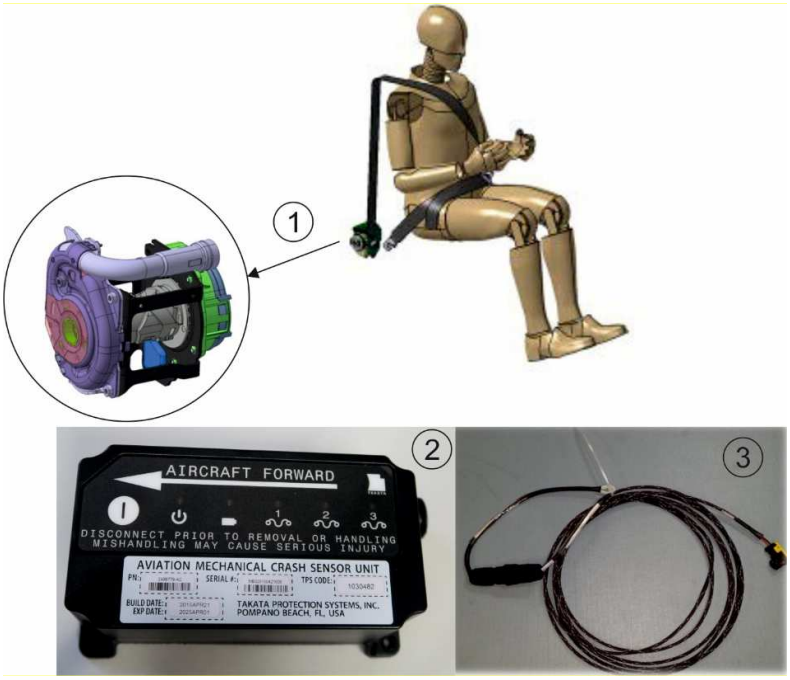
(2) MCSU

(3) Cable Harness

The pre-tensioner is activated by a crash detection unit (MCSU, figure 2) in case of a high deceleration of the aircraft in forward direction. Before and after activation, the pre-tensioner does not affect the function of the inertia reel. Activation of the pre-tensioner function is done electrically by igniting a micro gas generator that accelerates a piston. The piston pushes metal balls through a pipe and a ball wheel is set into counter-clockwise rotation. A clutch engages the ball wheel to the spool pot such that it is set into rotation and the harness slack is removed. The piston passes an exhaust hole that reliefs the driving gas pressure.

The above sequence happens before the occupant starts to move due to inertia forces. When the occupant starts forward displacement the inertia reel locks due to the activation of the standard webbing sensitivity feature and increase in load will disengage the clutch. This stops the pre-tensioning function.

The electrical pre-tensioner activation function is testable via a switch on the MCSU.



Pretensioners on passenger seats are a design feature that is not specifically addressed in JAR-25. Therefore, in accordance with Part 21.A.16B a special condition is needed to address the installation of such system on large aeroplanes.

Special Condition D-06 – Installation of three points restraint and pretensioner system

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1) HIC Characteristic

The existing means of controlling Front Row Head Injury Criterion (HIC) result in an unquantified but normally predictable progressive reduction of injury severity for impact conditions less than the maximum specified by the rule. Pretensioner technology however involves a step change on protection for impacts below and above that at which the device deploys. This could result in the HIC being higher at an intermediate impact condition than that resulting from the maximum.

It is acceptable for HIC to have such a non-linear or step change characteristic provided that the value does not exceed 1000 at any condition at which the Pretensioner does or does not deploy, up to the maximum severity pulse specified by the requirements. Tests must be performed to demonstrate this taking into account any necessary tolerances for deployment.

2) Intermediate Pulse Shape

The existing ideal triangular maximum severity pulse is defined in FAA AC 25.562-1B. EASA considers that for the evaluation and testing of less severe pulses, a similar triangular pulse should be used with acceleration, rise time, and velocity change scaled accordingly.

3) Protection During Secondary Impacts

EASA acknowledges that the pretensioner will not provide protection during secondary impacts after actuation.

Therefore, the case where a small impact is followed by a large impact must be addressed. In such a case if the minimum deceleration severity at which the pretensioner is set to deploy is unnecessarily low, the protection offered by the

pretensioner may be lost by the time the second larger impact occurs. It must be substantiated that the trigger point for the activation of the pre-tensioner has been chosen to maximize the probability of the protection being available when needed.

4) Protection of Occupants other than 50th Percentile

The existing policy is to consider other percentile occupants on a judgmental basis only i.e. not using direct testing of injury criteria but evidence from head paths etc. to determine likely areas of impact.

For pre-tensioned shoulder harnesses, test results for other size occupants need not be created if sufficient evidence is provided that other size occupants are protected.

A range of stature from a two-year-old child to a ninety-five percentile male must be considered.

In addition no hazard shall be introduced by the pre-tensioner due to the following seating configurations:

- The seat occupant is holding an infant, including the case where a supplemental loop infant restraint is used.
- The seat occupant is a child in a child restraint device.
- The seat occupant is a pregnant woman

5) Occupants Adopting the Brace Position

There is no requirement for protection to be assessed or measured for seat occupants in any other position or configuration than seated alone upright, as specified in FAA AC 25.562-1B.

In addition it has to be shown that there is no adverse effect on PAX adapting the traditional brace position if the pre-tensioner is activated.

6) The probability of inadvertent actuation must be shown to be acceptably low. The seated occupant must not be seriously injured as a result of the actuation. Inadvertent activation must not cause a hazard to the aircraft or cause injury to anyone who may be positioned close to the retractor or belt (e.g. seated in an adjacent seat or standing adjacent to the seat).

7) There must be a means for a crewmember to verify the availability of pre-tensioner function prior to each flight, or the probability of failure of the pre-tensioner function must be demonstrated to be acceptably low between inspection intervals. It must be demonstrated that an acceptable level of performance of the pre-tensioner is maintained between inspection intervals.

8) It must be shown that the system is not susceptible to inadvertent actuation as a result of wear and tear, or inertial loads resulting from in-flight or ground manoeuvres likely to be experienced in service

9) It must be ensured by design that any incorrect orientation (twisting) of the belt does not compromise the pre-tensioning protection function.

10) The equipment must meet the requirements for HIRF and Indirect Effect of Lightning with additional tests as per the applicable category of RTCA DO-160 Section 20 and 22, Issue G.

11) The mechanisms and controls must be protected from external contamination associated with that which could occur on or around passenger seating.

12) The pre-tensioner system shall not induce a hazard to the occupants in case of fire.

13) The system must function properly after loss of normal aircraft electrical power and after a transverse separation in the fuselage at the most critical location. A separation at the location of the system does not have to be considered.