

**Proposed Special Condition on CS 25.415, 25.703, 25.1385 at Amdt 18 – “Folding Wing Tip”**

**Applicable to Boeing 777-9**

**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**

The Boeing 777-9 aircraft will incorporate on-ground wingtip fold capability which reduces the wing span from 235 to 212 feet when folded. The folding wingtips are added to the 777-9 wing to enable improved aerodynamic performance when extended while maintaining Code E gate compatibility when folded during ground operations.

The current airworthiness regulations in CS 25 do not contain adequate or appropriate safety standards for this novel and unusual design feature.

**Special Condition D-21-9**

**Applicable to Boeing 777-9**

- (a) There must be more than one means that are different to alert the flight crew that the wingtips are not properly positioned and secured prior to take-off. When meeting this condition, the applicant must add a function to the take-off warning system required by CS 25.703 (a)(1) and (a)(2) to warn of an unlocked or improperly positioned wingtip(s), including indication to the flight crew when the wingtip(s) is in the folded position during taxi.
- (b) In addition to a take-off warning in accordance with CS25 25.703, means must be provided to prevent take-off of the airplane if either or both wingtips are not properly positioned and secured.
- (c) The applicant must consider the effects of Folding Wing Tip freeplay when evaluating compliance to the design load requirements of CS 25 Subpart C and the aeroelastic stability (includes flutter, divergence, control reversal, and any undue loss of stability and control as a result of structural deformation) requirements of CS 25.629. Thus, the effects of normal wear and other long-term durability conditions (such as corrosion) of the Folding Wing Tip operating mechanism on freeplay and its impact on loads and aeroelastic stability must be considered. Where freeplay limitations are required to ensure aeroelastic stability, acceptable freeplay limits and freeplay check procedures must be established. If lubrication is required to control excessive wear, lubrication intervals must be established. These procedures and limitations must be documented in accordance with CS 25.1529. The freeplay check and lubrication intervals if required must be documented as a certification maintenance requirement (CMR). Guidance for CMRs can be found in AMC 25-19. The effects of freeplay on wing joint torsional and bending stiffness, as well as wing frequencies, must be evaluated when showing compliance to loads and aeroelastic stability requirements. Also, the effects of freeplay on fatigue and damage tolerance must be considered when showing compliance with CS 25.571.

- (d) The Folding Wing Tips and its operating mechanism must be designed for 65 knot horizontal ground gust conditions in any direction as specified in CS 25.415(a). Relevant design conditions must be defined using combinations of steady wind and taxi speeds determined by rational analysis utilizing airport wind data. The Folding Wing Tip is not a control surface as specified in CS 25.415(b) and (c). Therefore, in lieu of the equation provided in CS 25.415(b), the hinge moment may be calculated from rational wind tunnel data. The 1.25 factor reference by CS 25.415(d) need not be applied to the portion of the system that is isolated in flight and is not critical for safe flight and landing. The Folding Wing Tip system must be designed for the conditions specified in CS 25.415(e), (f) and (g). Runway roughness as specified in CS 25.491 must be evaluated separately up to the maximum relevant aircraft ground speeds. All of the above conditions must be applied to the wingtips in the extended, folded, and transient positions.
- (e) The aircraft must demonstrate acceptable handling qualities during rollout in a crosswind environment as wingtips transition from the unfolded to folded position as well as the unlikely event of an asymmetric wing fold.
- (f) The wingtip fold operating mechanism must have stops that positively limit the range of motion of the wingtips. Each stop must be designed to the requirements of CS 25.675.
- (g) The wingtip hinge structure must be designed for inertia loads acting parallel to the hinge line. In the absence of more rational data, the inertia loads may be assumed to be equal to KW value as referenced in CS 25.393. Hinge design must meet the requirements of CS 25.657.
- (h) [In lieu of CS 25.1385(b)]

The forward position lights must be installed such that they consist of a red and a green light spaced laterally as far apart as practicable and installed forward on the airplane so that, with the airplane in the normal flying position and with the wingtips in the folded position for ground operations, the red light is on the left side and the green light is on the right side at approximately the level of the wingtips in the takeoff configuration. Each light must be approved and meet the requirements in CS 25.1385(a) and (d). Furthermore, the lights must not impair the vision of the flight crew when they are in the folded and transient positions.

- (i) The applicant must include design features that ensure the wingtips are properly secured during ground operations to protect personnel from bodily injury as well as damage to the airframe, ground structure, and ground support equipment.
- (j) The wingtips must have means to safeguard against unlocking in flight as a result of failures, including failure of any single structural element. All sources of airplane power that could initiate unlocking of the wingtips must be automatically isolated from the wingtip fold operating system (including the latching and locking system) prior to flight and it must not be possible to restore power to the system during flight. The wingtip latching and locking mechanisms must be designed so that, under all airplane flight load conditions, there is no force or torque that can unlatch or unlock the mechanisms. The latching system must include a means to secure the latches in the latched position, independent of the locking system. Furthermore, it must not be possible to position the lock in the locked position if the latches and the latching mechanisms are not in the latched position, and not be possible to unlatch the latches with the locks in the locked position.