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[4910-13]

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 25

[Docket No. FAA-2017-0636; Special Conditions No. 25-726-SC]

Special Conditions: The Boeing Company Model 777-8 and 777-9 Airplanes; Folding Wingtips

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final special conditions.

SUMMARY: These special conditions are issued for The Boeing Company (Boeing) Model 777-8 and 777-9 airplanes. These airplanes will have a novel or unusual design feature when compared to the state of technology envisioned in the airworthiness standards for transport-category airplanes. This design feature is folding wingtips. The applicable airworthiness regulations do not contain adequate or appropriate safety standards for this design feature. These special conditions contain the additional safety standards that the Administrator considers necessary to establish a level of safety equivalent to that established by the existing airworthiness standards.

DATES: Effective **[INSERT DATE 30 DAYS AFTER PUBLICATION IN THE FEDERAL REGISTER]**.

FOR FURTHER INFORMATION CONTACT: Ian Won, FAA, Airframe and Cabin Safety Section, AIR-675, Policy and Innovation Division, Transport Standards Branch, Aircraft Certification Service, 2200 South 216th St., Des Moines, Washington, 98198-6547; telephone 206-231-3217.

SUPPLEMENTARY INFORMATION:

Background

On April 19, 2017 (for the Model 777-8 airplane), and May 12, 2015 (for the 777-9 airplane), Boeing applied for an amendment to Type Certificate (TC) No. T00001SE to include the new Model 777-8 and 777-9 airplanes. These airplanes are constructed with new carbon-fiber-reinforced plastic (CFRP) wings with folding wingtips.

The Model 777-9 airplane, a derivative of the Model 777-300ER airplane currently approved under TC No. T00001SE, is a stretched-fuselage, large, twin-engine airplane with seating for 408 passengers and a maximum takeoff weight of 775,000 pounds.

The Model 777-8 airplane, a shortened-body derivative of the Model 777-9 airplane, is a large, twin-engine airplane with seating for 359 passengers and a maximum takeoff weight of 775,000 pounds.

Type Certification Basis

Under the provisions of title 14, Code of Federal Regulations (14 CFR) 21.101, Boeing must show that the Model 777-8 and 777-9 airplanes meet the applicable provisions of the regulations listed in TC No. T00001SE, or the applicable regulations in effect on the date of application for the change, except for earlier amendments as agreed upon by the FAA.

If the Administrator finds that the applicable airworthiness regulations (i.e., 14 CFR part 25) do not contain adequate or appropriate safety standards for the Model 777-8 and 777-9 airplanes because of a novel or unusual design feature, special conditions are prescribed under the provisions of § 21.16.

Special conditions are initially applicable to the model for which they are issued. Should the type certificate for that model be amended later to include any other model that incorporates

the same novel or unusual design feature, or should any other model already included on the same type certificate be modified to incorporate the same novel or unusual design feature, these special conditions would also apply to the other model under § 21.101.

In addition to the applicable airworthiness regulations and special conditions, the Model 777-8 and 777-9 airplanes must comply with the fuel-vent and exhaust-emission requirements of 14 CFR part 34, and the noise-certification requirements of 14 CFR part 36.

The FAA issues special conditions, as defined in 14 CFR 11.19, in accordance with § 11.38, and they become part of the type certification basis under § 21.101.

Novel or Unusual Design Features

The Boeing Model 777-8 and 777-9 airplanes will incorporate the following novel or unusual design features: CFRP wings with folding wingtips.

Boeing will incorporate this on-ground wingtip-fold capability to reduce the wingspan from 235 to 212 feet when folded. These folding wingtips comply with Code E gate[1] compatibility when folded during ground operations.

Discussion

Boeing will add folding wingtips to their Model 777-8 and 777-9 airplane wings to maintain Code E gate compatibility when folded during ground operations. This wing-folding feature will be operable on the ground only. Boeing has no plan to carry fuel in the folding sections of the wings.

[1] A Code E gate is designed to accommodate aircraft wingspans between 170.6 ft. (52m) and 213.3 ft. (65m), and outer main-gear wheel spans between 29.5 ft. (9m) and 45.9 ft. (14m). Boeing 777 airplanes are in this gate-code category.

Boeing has determined that a catastrophic event could occur if the Model 777-8 and 777-9 airplane wingtips are not properly positioned and secured for takeoff and during flight. In service, numerous takeoff operations with improper airplane configurations have occurred due to failures of the takeoff warning systems, or inadvertent crew actions. For these special conditions, a parallel is drawn between taking off with gust locks engaged and taking off with the wingtips folded, as either condition could result in a catastrophic event. Consequently, the FAA has determined that the level of safety in protecting a misconfigured airplane from takeoff with wingtips folded should be the same as taking off with the gust locks engaged. Therefore, condition 2 of these special conditions has the same intent as § 25.679(a)(2). Per § 25.1309, the applicant must show that such an event is extremely improbable, must not result from a single failure, and that appropriate alerting must be provided for the crew to manage unsafe system-operating conditions. In addition, the applicant must ensure that the wingtips are properly secured during ground operations to protect ground personnel against bodily injury.

Factors to be considered when showing compliance to these special conditions include, but are not limited to:

- With wingtips in the folded position, the conventional airplane-wingtip-position lights may have reduced visibility due to the upward position of the wingtips, possibly impacting ground-operation safety. Light placement may require special consideration to retain the current ground-operation safety, and mitigate any adverse impact this light position may have on pilot visibility during night-lighting conditions.
- Due to upward wingtip positioning on the ground, significant loads may be imposed by wind gusts combined with taxi speed during the transition from the unfolded to the folded position.

- The FAA issued Policy Statement No. PS-ANM-25-12, "Certification of Structural Elements in Flight Control Systems," to address structural elements in systems that act as both structure and as part of a system. This policy provides additional guidance on the appropriate application of the fatigue and damage-tolerance requirements of § 25.571, and the system-safety requirements of §§ 25.671 and 25.1309.

These special conditions contain the additional safety standards that the Administrator considers necessary to establish a level of safety equivalent to that established by the existing airworthiness standards.

Discussion of Comments

Notice of Proposed Special Conditions No. 25-17-02-SC for the Boeing Model 777-8 and 777-9 airplanes was published in the Federal Register on November 1, 2017 (82 FR 50581). The FAA received responses from four commenters.

Commenter 1: Air Line Pilots Association (ALPA)

ALPA stated that the special conditions should require demonstration of ground-handling effects due to the folding wingtips, and implementing a robust flight-test procedure to evaluate the effects of the folding wingtips during landing rollout and taxi under high crosswind and gust conditions, to ensure no exceptional piloting skill is required during these operations. ALPA also suggests including, within the Boeing Model 777 series airplane flight manual, the crosswind conditions under which the folding wingtips were studied.

The FAA notes that demonstration of acceptable handling qualities is required by special condition 5 as written. The method of compliance demonstration, and associated documentation, is outside the scope of these special conditions, and the special conditions remain adopted as proposed.

Commenter 2

One commenter suggested various means for the applicant to address the special conditions, for example, the need for additional power cut outs that are separate circuits. The FAA partially agrees with the commenter, noting that special conditions are performance standards that may be satisfied by various means, including those the commenter proposed. However, the method of compliance demonstration is outside the scope of these special conditions. Therefore, the special conditions remain adopted as proposed.

Commenter 3

One commenter expressed concern that the special conditions may be confusing to the United States Congress. The FAA responds that special conditions are part of the Executive Branch rulemaking process, which is independent of the United States Congress lawmaking process. Special conditions are unique to aircraft certification and, therefore, are written with the aerospace-industry audience in mind. The special conditions remain adopted as proposed.

Commenter 4

One commenter stated concern over the applicability of these special conditions to future models on the Boeing Model 777 airplane type certificate. Should Boeing apply at a later date for a change to the type certificate to include another model incorporating the same novel or unusual design feature, these special conditions would apply to that model as well. The FAA responds that these special conditions provide requirements for a safe design for folding wingtips on future Model 777 airplane derivatives, as well as on the current Model 777 airplanes. These special conditions will ensure that future models incorporating the same novel or unusual design feature meet the level of safety equivalent to that established in the regulations.

The commenter suggested that the 1.25 factor specified in § 25.415(d) be applied to the portion of the system that is isolated in-flight, and is not critical for safe flight and landing. The FAA disagrees with the comment. The structure the commenter addressed has no impact on safety of flight. Additionally, the special conditions require that the wingtips must have a means by which to safeguard against unlocking from the extended, flight-deployed position in-flight because of failures, including the failure of any single structural element. The special conditions remain adopted as proposed.

The commenter suggested that the airplane must demonstrate acceptable handling qualities during rollout in a crosswind environment, as the wingtips transition from the flight-deployed to folded position, and transitioning from the folded to the flight-deployed position, as well as during the unlikely event of asymmetric wingtip folding. The FAA agrees with the comment, but it is the FAA's position that the special conditions, as proposed, indicate that the airplane must exhibit acceptable handling qualities under normal and asymmetric operation. The special conditions remain adopted as proposed.

The commenter suggested that the FAA repeat the § 25.675 text in special condition 6, in lieu of only referencing § 25.675 in the special condition. The FAA finds that the special condition has the same legal effect either way, and finds no advantage to repeating the text of § 25.675 in special condition 6.

Applicability

As discussed above, these special conditions are applicable to Boeing Model 777-8 and 777-9 airplanes. Should Boeing apply at a later date for a change to the type certificate to include another model incorporating the same novel or unusual design feature, these special conditions would apply to that model as well.

Conclusion

This action affects only a certain novel or unusual design feature on one model series of airplanes. It is not a rule of general applicability.

List of Subjects in 14 CFR Part 25

Aircraft, Aviation safety, Reporting and recordkeeping requirements.

The authority citation for these special conditions is as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701, 44702, 44704.

The Special Conditions

Accordingly, pursuant to the authority delegated to me by the Administrator, the following special conditions are issued as part of the type certification basis for Boeing Model 777-8 and 777-9 airplanes.

Note: The term "latch" refers to the mechanism that allows the wingtip to carry flight loads in the down (flight-deployed) position. The term "lock" refers to the mechanism that prevents disconnection of the latch when the wing tip is down.

1. More than one means must be available to alert the flightcrew that the wingtips are not properly positioned and secured prior to takeoff. Each of these means must be unique in their wingtip-monitoring function. When meeting this condition, the applicant must add a function to the takeoff warning system, as required by § 25.703(a)(1) and (2), to warn of an unlocked or improperly positioned wingtip, including indication to the flightcrew when a wingtip is in the folded position during taxi.
2. In addition to a takeoff warning in accordance with § 25.703, a means must be provided to prevent airplane takeoff if a wingtip is not properly positioned and secured for flight.

3. The applicant must consider the effects of folding-wingtip freeplay when evaluating compliance to the design load requirements of 14 CFR part 25, subpart C, and the aeroelastic stability (including flutter, divergence, control reversal, and any undue loss of stability and control as a result of structural deformation) requirements of § 25.629. Thus, the effects of normal wear, and other long-term durability conditions (such as corrosion) of the folding-wingtip 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 § 25.1529. The freeplay-check and mechanism-lubrication intervals, if required, must be documented as a certification maintenance requirement (CMR). Guidance for CMRs can be found in Advisory Circular 25-19A, "Certification Maintenance Requirements." 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 § 25.571.
4. The folding wingtips and their operating mechanism must be designed for 65 knot, horizontal, ground-gust conditions in any direction as specified in § 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 wingtip is not a control surface as specified in § 25.415(b). Therefore, in lieu of the equation provided in § 25.415(b), the hinge moment may be calculated from rational wind-tunnel data. The

1.25 factor specified in § 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-wingtip system must be designed for the conditions specified in § 25.415(e), (f), and (g). Runway roughness, as specified in § 25.491, must be evaluated separately up to the maximum relevant airplane ground speeds. All of the above conditions must be applied to the folding wingtips in the extended (flight-deployed), folded, and transient positions.

5. The airplane must demonstrate acceptable handling qualities during rollout in a crosswind environment, as wingtips transition from the flight-deployed to folded position, as well as during the unlikely event of asymmetric wingtip folding.
6. 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 § 25.675.
7. 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 as referenced in § 25.393. Hinge design must meet the requirements of § 25.657.
8. In lieu of § 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 must meet the requirements of § 25.1385(a) and (d). The lights must not impair the vision of the flightcrew when the wingtips are in the folded and transient positions.

9. The applicant must include design features that ensure the wingtips are properly secured during ground operations, to protect ground personnel from bodily injury as well as to prevent damage to the airframe, ground structure, and ground support equipment.
10. The wingtips must have means to safeguard against unlocking from the extended, flight-deployed position in flight, as a result of failures, including the 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, no force or torque 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. 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 it must not be possible to unlatch the latches with the locks in the locked position.

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