



U.S. Department
of Transportation
**Federal Aviation
Administration**

Policy Statement

Subject: Structural Certification Criteria
for Antennas, Radomes, and Other
External Modifications

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Summary

This policy statement identifies applicable structural requirements and acceptable means of compliance for certification of external modifications, such as antennas, radomes, cameras, and external stores, on transport category airplanes.

Current Regulatory and Advisory Material

This policy statement provides guidance on application of the following structural requirements to external modifications: title 14, Code of Federal Regulations (14 CFR) 25.23, 25.301(b), 25.305(e), 25.307, 25.365(e), 25.571, 25.581, 25.603, 25.605, 25.609, 25.613, 25.629, 25.841, 25.901(c), 25.903(c), 25.1419, 25.1529, 26.45, 26.47, and appendix H to part 25.

The guidance documents below are related to this policy statement. The latest version of each guidance document is shown as of the publication date of this policy statement. If a guidance document is revised after this date, you should refer to its latest version.

Relevant advisory circulars (ACs) include the following:

- AC 20-107B, Change 1, *Composite Aircraft Structure*, dated August 24, 2010.
- AC 25-20, *Pressurization, Ventilation and Oxygen Systems Assessment for Subsonic Flight including High Altitude Operation*, dated September 10, 1996.
- AC 25-24, *Sustained Engine Imbalance*, dated August 2, 2000.
- AC 25-28, *Compliance of Transport Category Airplanes with Certification Requirements for Flight in Icing Conditions*, dated October 27, 2014.
- AC 25.307-1, *Proof of Structure*, dated October 7, 2014.
- AC 25.571-1D, *Damage Tolerance and Fatigue Evaluation of Structure*, dated January 13, 2011.

- AC 25.613-1, *Material Strength Properties and Material Design Values*, dated August 6, 2003.
- AC 25.629-1B, *Aeroelastic Stability Substantiation of Transport Category Airplanes*, dated October 27, 2014.
- AC 120-27E, *Aircraft Weight and Balance Control*, dated June 10, 2005.
- AC 120-93, *Damage Tolerance Inspections for Repairs and Alterations*, dated November 20, 2007.

Relevant FAA orders include the following:

- Order 8110.54A, *Instructions for Continued Airworthiness Responsibilities, Requirements, and Contents*, dated October 23, 2010.
- Order 8300.16, Change 1, *Major Repair and Alteration Data Approval*, dated December 7, 2015.

Job aid, *Major Repair and Alteration Data Approval Online Job Aid*, dated September 2017, provides relevant guidance on this subject.

Relevant Past Practice

In recent years, there has been a significant increase in the number of certification projects involving external modifications, especially large antenna installations. To help standardize the certification of these projects, the FAA developed an issue paper, *Structural Certification Criteria for Large Antenna Installations*, which identifies applicable structural requirements and provides guidance on compliance. The FAA applied this issue paper to numerous projects involving external modifications since 2004. As compliance issues and questions arose on different projects, the issue paper was updated. This policy statement replaces that issue paper.

Policy

1 CERTIFICATION REQUIREMENTS.

1.1 This policy statement provides guidance on the application of structural certification requirements to external modifications, such as antenna and radome installations, cameras, external stores, etc.

1.2 The structural certification requirements identified in this policy statement apply to all external modifications. However, for smaller, less complex modifications, such as a blade antenna, the information needed to demonstrate compliance with the various requirements may be less rigorous. On the other hand, modifications such as the installation of an external tank for firefighting may require substantiation that is more extensive.

- 1.3 Certification requirements will vary depending on the certification basis established for the modification. An applicant for a type certificate change must show that the areas affected by the change comply with the requirements in effect on the date of the application, except as provided in 14 CFR 21.101, *Designation of applicable regulations*. This policy statement provides information relevant to all amendment levels of part 25 except where noted.

2 **SELECTED STRUCTURAL REQUIREMENTS.**

The applicant should provide to the certifying office their proposed means of compliance for each of the following selected structural requirements, as well as any other applicable structural requirement not addressed in this policy statement. The selected structural requirements addressed in this policy are those considered most relevant and significant for external modifications. These requirements apply to the exterior of the modification, such as a radome, as well as any interior components identified as part of the modification.

2.1 **Load Distribution Limits—§ 25.23.**

- 2.1.1 The effect of the external modification on the weight, center of gravity (CG), and load distribution limits of the airplane must be considered. These changes must be documented in the weight and balance document as required by § 25.1519.

- 2.1.2 AC 120-27E states that the operational empty weight and CG “should be reestablished through calculation whenever the cumulative change to the weight and balance log is more than plus or minus one-half of 1 percent (0.5 percent) of the maximum landing weight, or whenever the cumulative change in the CG position exceeds one-half of 1 percent (0.5 percent) of the mean aerodynamic chord (MAC).”

2.2 **Design Loads—Subpart C.**

- 2.2.1 The applicant must demonstrate compliance with the design flight loads and ground loads requirements in part 25, subpart C for the modified airplane, unless the applicant shows that the modification does not affect the original compliance finding for those loads requirements. A comparative analysis may be used for this assessment. The applicant must also demonstrate that the external modification itself can withstand the aerodynamic, inertial, and pressurization loading that it would be subject to under the design load requirements of subpart C.

- 2.2.2 Particular attention should be paid to large modifications that could affect the aerodynamic flow field around the airplane, thereby affecting the external loads on other parts of the airplane. Also, external modifications that include large items of mass must be evaluated for both static and dynamic loads, including gust conditions and landing conditions.

2.2.3 Flight Loads Validation—§ 25.301(b).

Methods used to determine load intensities and distribution must be validated by flight load measurement unless the methods used for determining those loading conditions are

shown to be reliable. The FAA accepts the guidance provided in European Aviation Safety Agency (EASA), *Certification Specifications and Acceptable Means of Compliance for Large Aeroplanes CS-25*, Acceptable Means of Compliance (AMC) No. 2 to CS 25.301(b), *Flight Load Validation*.

2.3 **Vibration and Buffeting—§ 25.305(e).**

2.3.1 Section 25.305(e) requires the airplane be designed to withstand any vibration and buffeting that might occur in any likely operating condition up to V_D/M_D . The effects of vibration and buffet on the airplane must be considered, as well as on the external modification itself. Potential vibration sources include unsteady flow conditions on the modification, fuselage, tail assembly, or control surfaces arising from shocks, flow separation or other unsteadiness in the flow. The applicant may either demonstrate compliance with the rule directly by analysis or test, or show that the modification does not affect the original compliance finding for § 25.305(e).

2.3.2 At amendment 25-77, the structural design requirement for vibration and buffeting was moved from § 25.251 to § 25.305(e), while the flight test requirement was retained in § 25.251. Therefore, if the certification basis for § 25.251 is amendment 25-77 or later, then the certification basis for § 25.305(e) must also be amendment 25-77 or later, to ensure that no requirements are missed.

2.3.3 This policy statement does not address § 25.251. However, if the applicant shows compliance with § 25.251 by flight test for their external modification, or if the applicant shows that the modification does not affect the original compliance finding for § 25.251, then no further showing is necessary for § 25.305(e).

2.4 **Proof of Structure—§ 25.307.**

2.4.1 The applicant must demonstrate the structural strength of the external modification for the applicable aerodynamic, pressurization, and inertial design loads. Structural analysis is normally used to demonstrate adequate strength. However, analysis alone may only be used if it has been shown to be reliable on similar structures. Some proof testing may be necessary to demonstrate structural strength of the modification, or to validate the analysis methods.

2.4.2 AC 20-107B provides guidance on compliance with the proof of structure requirement for composite structures and on other subjects addressed by this policy statement, such as fatigue and damage tolerance, fabrication methods, and material strength properties.

2.5 **Pressurized Compartment Loads—§ 25.365(e).**

2.5.1 For external modifications that include a radome and antenna or similar structure, rapid pressurization of the external modification must be considered as outlined in § 25.365(e) if its failure could interfere with continued safe flight and landing. Section 25.365(e)(3) requires the consideration of the maximum opening caused by airplane or equipment failures not shown to be extremely improbable. The applicant

does not need to evaluate the risk of impact on the main structure from non-critical structures detached from the airplane due to a decompression event.

- 2.5.2 The formula hole size requirement in § 25.365(e)(2) was introduced in amendment 25-54. Compliance with this requirement can be problematic when evaluating a radome, for example, because the hole size may equal or exceed that of the radome. Therefore, the applicant does not need to assume the formula hole occurs directly under the radome or other external modification. Rather, the focus for compliance to the decompression requirement when analyzing external modifications should be § 25.365(e)(3), which requires consideration of any airplane or equipment failures not shown to be extremely improbable.
- 2.5.3 For external modifications to the fuselage, such failures may include fuselage skin cracking, or failure of any attachments, through fittings, or seals. Venting of the external modification may be used to mitigate the effects of any unintended pressurization.
- 2.6 **Damage-Tolerance and Fatigue Evaluation of Structure—§§ 25.571, 26.45, and 26.47.**
- 2.6.1 Compliance with § 25.571.
Section 25.571 requires an assessment of principal structural elements, which are defined in AC 25.571-1D as “structure that contributes significantly to the carrying of flight, ground, or pressurization loads and whose integrity is essential in maintaining the overall structural integrity of the airplane.” Therefore, an external modification such as a large radome attached to the fuselage crown would not typically be classified as a principal structural element. However, such a modification could affect the fatigue and damage tolerance capability of the fuselage structure to which it is attached. Any modifications to the fuselage must be assessed in accordance with § 25.571.
- 2.6.2 Compliance with §§ 26.45 and 26.47.
Sections 26.45 and 26.47 address “fatigue critical baseline structure” and “fatigue critical alteration structure.” A fuselage-mounted radome, for example, would not typically be considered fatigue critical alteration structure. However, as noted above, such an alteration would affect the fatigue critical baseline structure (the fuselage). Therefore, type certificate holders are required to comply with the applicable requirements in § 26.45, and supplemental type certificate holders and applicants must comply with the applicable requirements in § 26.47. The data required for compliance to § 25.571 at amendment 25-45 or later supports compliance with §§ 26.45 and 26.47. AC 120-93 provides guidance on evaluating the effects of modifications on fatigue critical structure.
- 2.6.3 Parts Departing the Airplane.
The applicant should show that no part of the external modification will depart the airplane due to any foreseeable circumstance, including fatigue, environmental or accidental damage, or bird strike, unless it can be shown that such a departure would not be hazardous to the airplane. The applicant may use damage-tolerance analysis

methods to show that an external modification will remain attached to the airplane under operating loads. The applicant may establish inspections or other procedures to prevent failure of the attachments of the external modification to the airplane.

2.7 **Bird Strike—§ 25.571(e)(1).**

- 2.7.1 Bird strike certification requirements applicable to the airframe were introduced at amendment 25-45 and vary depending on amendment level. The applicable bird strike requirements must be considered unless it can be shown that a bird cannot strike the modified structure at any airspeed up to the speeds required by § 25.571(e)(1).
- 2.7.2 Amendments 25-45 and 25-54 require assessment at “likely operational speeds at altitudes up to 8,000 feet.” This includes any speed up to V_{MO} . Amendments 25-72 and 25-86 require assessment at “ V_C at sea level to 8,000 feet.” Amendments 25-96 and 25-132 require assessment at “ V_C at sea level or $0.85 V_C$ at 8,000 feet, whichever is more critical.”
- 2.7.3 The applicant must consider all phases of climb-out, cruise, descent, and approach, from sea level to 8,000 feet, at the full range of certified design weights, CG limits, and the airspeeds defined in § 25.571(e)(1).
- 2.7.4 Section 91.117 of 14 CFR, *Aircraft speed*, which restricts airspeed in the United States, is an operational requirement, not a design requirement, and therefore is not applicable to the bird strike requirement of § 25.571(e)(1) and may not be used as a means of altering this requirement.
- 2.7.5 Probabilistic arguments (for example, the likelihood of impact based on consideration of frontal area, flight phase, aircraft speed, and altitude) are not acceptable by the FAA as a means of showing compliance to the bird strike requirement of § 25.571(e)(1), or as the basis for not complying with this requirement.
- 2.7.6 To determine whether a fuselage-mounted radome can be “exposed” to a bird strike (not shielded by the forward crown of the airplane), the applicant should assume the following conditions:
- 1g flight.
 - Any airspeed up to V_C for flaps up conditions and any airspeed up to V_F for flaps down conditions.
 - Any altitude between sea level and 8,000 feet.
 - Any gross weight and CG condition achievable under the weight and balance document.
 - Steady level flight, as well as any reasonable descent or climb rates.
 - Any flap setting and any reasonable horizontal stabilizer setting.
 - No sideslip, maneuvers, or gust conditions need to be considered.

- 2.7.7 Compliance with the bird strike requirements must be shown by tests, or validated analysis. See paragraph 2.4 of this policy. The failure modes of composites in a dynamic non-linear event such as bird strike are not easily predicted by analysis. Therefore, if analysis is used, it must be validated by sufficient testing.
- 2.8 **Lightning—§ 25.581.**
Section 25.581 requires that the external modification be designed such that the airplane is protected against catastrophic effects from lightning.
- 2.9 **Materials—§ 25.603, Amendment 25-46 or Later.**
Materials used in the design must conform to approved material specifications as described in § 25.603. The suitability of the material to withstand the operational environment must be established based on experience or tests.
- 2.10 **Fabrication Methods—§ 25.605, Amendment 25-46 or Later.**
The methods of fabrication used must produce a consistently sound structure in accordance with an approved process specification. Each new fabrication method must be substantiated by a test program.
- 2.11 **Protection of Structure—§ 25.609.**
Each part of the structure must be suitably protected against deterioration or loss of strength in service and must have provisions for ventilation and drainage where necessary for protection.
- 2.12 **Material Strength Properties and Design Values—§ 25.613.**
Material strength properties must be based on enough tests of material meeting approved specifications to establish design values on a statistical basis. Testing must be conducted on materials that meet § 25.603 and that are fabricated in accordance with methods that meet § 25.605. The applicant must take into account the operational temperature when establishing design values. Amendment 25-112 added the requirement to account for the operational environmental condition (including temperature and moisture). AC 25.613-1 provides guidance on compliance with this requirement.
- 2.13 **Aeroelastic Stability Requirements—§ 25.629.**
- 2.13.1 The applicant must demonstrate by validated analysis methods, test, or a combination of both that the airplane is free from aeroelastic instability with the external modification installed. This may be accomplished by a comparative analysis showing that the aeroelastic stability of the airplane will be unaffected by the change. If the external modification itself could be subject to aeroelastic instability, the installation must also be evaluated according to § 25.629.
- 2.13.2 The addition of external stores on the wing or other lifting surfaces requires special attention due to the potentially large and adverse effect they may have on the flutter characteristics of the airplane.

- 2.13.3 Section 25.629(e) states that full-scale flight flutter tests at speeds up to V_{DF}/M_{DF} must be conducted for modifications to a type design “unless the modifications have been shown to have an insignificant effect on the aeroelastic stability.”
- 2.14 **Cabin Pressurization—§ 25.841, Amendment 25-87 or Later.**
- 2.14.1 Section 25.841 requires applicants to show that occupants will not be exposed to dangerously low cabin pressure following any anticipated failure condition. The applicant should show that its modification does not introduce any potential failure condition that could lead to depressurization of the airplane. This could include fatigue cracking of the modified fuselage, or failure of seals or other attachments to the fuselage. AC 25-20 provides guidance on compliance with this requirement.
- 2.14.2 Certain airplanes approved for operation at high altitude (above 41,000 feet) have special conditions addressing pressurization. For these airplanes, the requirements defined in the special conditions apply to any modification of the pressure vessel.
- 2.15 **Sustained Engine Imbalance (Windmilling)—§§ 25.901(c), Amendment 25-23 or Later, and 25.903(c).**
- 2.15.1 Sections 25.901(c) and 25.903(c) require that the safety of the airplane not be jeopardized because of an engine failure and subsequent windmilling event. Therefore, it should be shown that during such an event, the resulting vibration would not cause a structural failure of the modification or surrounding primary structure, or a system failure, that would jeopardize continued safe flight and landing. AC 25-24 provides guidance on this subject.
- 2.15.2 For external modifications mounted on the fuselage, windmilling design load factors (inertia forces) may be available from the manufacturer. If design load factors are not available, in lieu of a detailed analytical investigation, the applicant may show compliance by test, using the appropriate vibration test standards outlined in RTCA DO-160G, *Environmental Conditions and Test Procedures for Airborne Equipment*, dated December 8, 2010, or later revision. If using this document, the applicant should consider the appropriate test categories specified in that document for short duration transient vibration levels consistent with blade loss, as well as the test categories for robust vibration tests for resistance to long duration exposure consistent with engine windmilling.
- 2.15.3 Certain modifications that are relatively lightweight and have a low CG relative to their attachment may not be susceptible to windmilling-induced vibration sufficient to cause a structural failure. If the applicant determines this is the case for its particular modification, based on an evaluation of mass properties, configuration and method of attachment, the applicant may propose this to the FAA. The certifying office will determine whether any further analysis or tests are required.

- 2.16 **Icing—§ 25.1419.**
AC 25-28 provides guidance on ice shedding from airplane components, including antennas and radomes.
- 2.17 **Instructions for Continued Airworthiness—§ 25.1529 and Appendix H to Part 25.**
The applicant must demonstrate compliance by developing an appropriate maintenance and inspection program. For guidance, please refer to Order 8110.54A.
- 2.18 **Airworthiness Directives.**
Applicants must carefully review each airworthiness directive (AD) that is in the area affected by the modification. In particular, applicants should closely review any inspections mandated by AD or airworthiness limitations in the area of the modification. If the modification affects the operator's ability to comply with the requirements of an existing AD, the applicant must request an alternative means of compliance for that AD from the applicable aircraft certification office.

Effect of Policy

The general policy stated in this document does not constitute a new regulation. Agency employees and their designees and delegations must not depart from this policy statement without appropriate justification and concurrence from the FAA management that issued this policy statement. The authority to deviate from this policy statement is delegated to the Manager of the Transport Standards Branch.

Whenever a proposed method of compliance is outside this established policy, the project aircraft certification office should coordinate it with the policy issuing office. Similarly, if the project aircraft certification office becomes aware of reasons that an applicant's proposal that meets this policy should not be approved, the office must coordinate its response with the policy issuing office. Applicants should expect that certificating officials would consider this information when making findings of compliance relevant to new certificate actions. In addition, as with all guidance material, this policy statement identifies one means, but not the only means, of compliance.

Implementation

This policy discusses compliance methods that should be applied to type certificate, amended type certificate, supplemental type certificate, and amended supplemental type certification programs. The compliance methods apply to those programs with an application date that is on or after the effective date of the final policy. If the date of application precedes the effective date of the final policy, and the methods of compliance have already been coordinated with and approved by the FAA or its designee, the applicant may choose to either follow the previously acceptable methods of compliance or follow the guidance contained in this policy.

Conclusion

This policy statement identifies applicable structural requirements and acceptable means of compliance for certification of external modifications, such as antennas and radomes, on transport category airplanes. This policy statement provides guidance on application of the following structural requirements to external modifications: §§ 25.23, 25.301(b), 25.305(e), 25.307, 25.365(e), 25.571, 25.581, 25.603, 25.605, 25.609, 25.613, 25.629, 25.841, 25.901(c), 25.903(c), 25.1419, 25.1529, 26.45, 26.47, and appendix H to part 25.

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