

**Equivalent Safety Finding
and Interpretative Material**

Doc. No. : M-TS-0000492

Issue : 2

Date : 23 April 2024

Proposed ☐ Final ☒

Deadline for comments: 29 SEP 2023

SUBJECT : Vibration and Buffeting

REQUIREMENTS incl. Amdt. : CS 25.251(b) and (d) at Amdt. 28¹

ASSOCIATED IM/MoC : Yes ☒ / No ☐

ADVISORY MATERIAL :

¹ This ESF may be applied to the listed certification specifications at the amendment or JAR 25 change used for the original type certification basis of the basic aircraft as defined in the relevant EASA TCDS.

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Equivalent Safety Finding

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1. APPLICABILITY

This ESF is applicable to CS-25 Large Aeroplanes fitted with large radome or antenna fairing on the fuselage. This ESF may be applied on a case-by-case basis to other externally mounted fairings or protrusions, subject to agreement from EASA.

1.1 AFFECTED CS

CS 25.251(b) and (d) at Amendment 28

2. SCOPE

In lieu of showing direct compliance for the modified large aeroplane with CS 25.251(b), or CS 25.251(b) and (d), by using flight test only, and provided that the below compensating factors are complied with, large radomes or antenna fairings might be installed on the fuselage of a large aeroplane without demonstrating in flight that:

- there is no perceptible buffeting condition in the cruise configuration in straight flight at any speed up to V_{MO}/M_{MO} , except that the stall warning buffeting is allowable and/or that
- the aeroplane is free from excessive vibration under any appropriate speed and power conditions up to V_{DF}/M_{DF} .

3. COMPENSATING FACTORS

The applicant must show, by using proposed method (taking into account the attached Interpretative Material), that the design change does not invalidate the original demonstration of compliance with CS 25.251(b), or CS 25.251(b) and (d).

To evaluate whether the design change could affect the original compliance finding, the applicant may propose to use any suitable combination of the following below mentioned factors 1-4 to address CS 25.251(b) or factors 1-3 to address CS 25.251(b) and (d) :

1. Similarity analysis to other EASA approved designs. (Consider the size, shape, and location of the respective fuselage modifications, the aeroplanes they are installed on, the respective V_{MO}/M_{MO} and V_{DF}/M_{DF} speeds, and the means of compliance used for the approved designs.)
2. Flowfield analysis using an acceptable computational fluid dynamics (CFD) tool. The applicant must show that the tool is valid for its intended use. For example, the tool must be capable of accurately assessing whether a shock is present, including its strength and location, and the area of separated flow. Generally, a full Navier-Stokes code with robust turbulence modelling is needed for such an analysis. Validation of the CFD tool using flight test data is preferred, but suitable wind tunnel data may be acceptable. The applicant should also address other known limitations and characteristics of the code to be used, such as:

- a. Grid sizes and spacing.
 - b. Geometric fidelity of the aeroplane model – the effect of simplifications of the model (e.g., ignoring flap track fairings, vortex generators, small gaps, etc., how the engines are modeled, aeroelastic effects, other differences between the actual aeroplane and the digital model used in the analysis).
 - c. CFD modelling errors, particularly in turbulence modelling.
 - d. Location of the transition point from laminar to turbulent flow.
 - e. Boundary conditions (e.g., ensuring that far field conditions are applied sufficiently far away).
3. A dynamic response analysis, usually based on the results of the flowfield analysis addressed in (2).
 4. Flight testing to a speed from which the analyses described in paragraph (1), (2) and (3) can be used to extrapolate the findings to V_{DF}/M_{DF} . As a minimum, flight testing must include the critical flight conditions to cover the complete flight domain from low speed to speeds up to and including V_{MO}/M_{MO} which may include high lift configurations, landing gear extended and sideslips which could be experienced in service.

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Interpretative Material

Vibration and Buffeting

The associated Interpretative Material is published for awareness only and is not subject to public consultation.

CFD Code Validation

To use a CFD tool in showing that the design change does not affect compliance with CS 25.251(b), or CS 25.251(b) and (d), or to extrapolate findings beyond V_{MO}/M_{MO} , the applicant should show that the tool is valid for its intended use. The CFD tool needs to be capable of accurately assessing whether a shock is present, including its strength and location, and the area of separated flow.

Generally, a full Navier-Stokes code with robust turbulence modelling is needed for such an analysis. Validation using flight test data is preferred, but suitable wind tunnel data may be acceptable.

Code validation includes:

1. Showing that the code accurately models flow phenomena of interest (e.g. transonic shocks, shock induced flow separation, shock-boundary layer interaction and separated flows) that may result from the modification.
2. Showing that the person/organization performing the analysis is experienced and qualified to properly run the code and interpret the results.

The accuracy of the modelling of the flow field phenomena of interest should be demonstrated by comparing flow field characteristics (e.g., pressure distributions, shock strength/location, etc.) predicted by the model to flight test or wind tunnel data for a configuration (including shape, location, and airframe) similar to the modification being evaluated at airspeeds up to V_{DF}/M_{DF} .

In addition, if there are no significant flow field phenomena of interest (e.g. transonic shocks, shock induced flow separation, shock-boundary layer interaction and separated flows) shown with the configuration being evaluated, a comparison should be made to another configuration that does exhibit such phenomena. (The validation depends on the flow phenomena of interest being present to show that the code will accurately model such flow phenomena.)

Known limitations and characteristics of the model should be addressed, such as grid sizes and spacing, geometric fidelity of the aeroplane model, turbulence modelling fidelity, boundary conditions, and strength and location of shocks/ recovery.

The test cases used to validate the code should be agreed to in advance by the EASA.

Aerodynamic Analysis

An aerodynamic analysis using the validated code may be used to show that compliance with CS 25.251(b), or CS 25.251(b) and (d), will not be affected by the modification provided the code validation has been accepted by the EASA.

The aerodynamic analysis need not cover all flight conditions. The critical flight conditions should be identified and those that need to be analysed in detail selected. The applicant should document how these critical flight conditions have been identified.

The applicant should analyse the effects of all simplifications or assumptions applied to the aerodynamic model (i.e., the analytical representation of the modified and unmodified aeroplanes) and show that these simplifications would not lead to an inappropriate conclusion.

After EASA acceptance of both the code validation and the results of the aerodynamic analysis, it is not required to perform:

- a flight test to V_{MO}/M_{MO} to show that no buffeting condition exists up to that speed to show compliance with CS 25.251(d) and/or
- a flight test to V_{DF}/M_{DF} to show that the modification did not affect compliance with CS 25.251(b).