



# Federal Aviation Administration

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## Memorandum

Date: May 29, 2015

To: Manager, Wichita ACO, ACE-115W

From: Manager, Transport Airplane Directorate, ANM-100

Prepared by: Tina Miller, ACE-117W

Subject: INFORMATION: Equivalent Level of Safety (ELOS) Finding for Continuous Gust Design Criteria on Cessna Model 680 and Model 680A Airplanes, FAA Project Numbers TC2548WI-T and Cessna-072100

ELOS Memo # TC2548WI-T-AG-6

Regulatory Ref: 14 CFR 21.21(b)(1) and 25.341(b)

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This memorandum informs the certificate management aircraft certification office of an evaluation made by the Transport Airplane Directorate (TAD) on the establishment of an equivalent level of safety (ELOS) finding for Cessna Model 680 and Model 680A airplanes.

### **Background**

Cessna Aircraft Company requested a ELOS finding to Title 14, Code of Federal Regulations (14 CFR) 25.341(b), "Continuous Gust Design Criteria," for Model 680 airplanes. Cessna subsequently requested to extend the ELOS finding to include the Model 680A. Cessna proposed replacing the existing continuous design criteria of § 25.341(b), which does not accurately account for the distribution of turbulence in the atmosphere, and complying with the criteria contained in the proposed notice of proposed rulemaking (NPRM), dated June 24, 1999, titled "Revised Requirements for Gust and Continuous Turbulence Design Loads." This proposed NPRM, the result of the harmonization of the Joint Aviation Requirements (JAR) and FAA 14 CFR part 25 requirements, will update § 25.341(b) while maintaining and enhancing the level of safety.

### **Applicable regulation(s)**

14 CFR 21.21(b)(1) and 25.341(b)

## Regulation(s) requiring an ELOS finding

14 CFR 25.341(b)

### Description of compensating design features or alternative Methods of Compliance (MoC) which allow the granting of the ELOS (including design changes, limitations or equipment needed for equivalency)

The criteria is based on the proposed NPRM for Revised Requirements for Gust and Continuous Turbulence Design Loads.

*Continuous Turbulence Design Criteria.* The dynamic response of the airplane to vertical and lateral continuous turbulence must be taken into account. The dynamic analysis must take into account unsteady aerodynamic characteristics and all significant structural degrees of freedom including rigid body motions. The limit loads must be determined for all critical altitudes, weights, and weight distributions as specified in § 25.321(b), and all critical speeds within the ranges indicated in paragraph (3).

- (1) Except as provided in paragraphs (4) and (5), the following equation must be used:

$$P_L = P_{L-1g} \pm U_\sigma \bar{A}$$

Where –

$P_L$  = limit load;

$P_{L-1g}$  = steady 1-g load for the condition;

$\bar{A}$  = ratio of root-mean-square incremental load for the condition to root-mean-square turbulence velocity; and

$U_\sigma$  = limit turbulence intensity in true airspeed, specified in paragraph (b)(3) of this section.

- (2) Values of  $\bar{A}$  must be determined according to the following formula:

$$\bar{A} = \sqrt{\int_0^x |H(\Omega)|^2 \Phi(\Omega) d\Omega}$$

Where –

$H(\Omega)$  = the frequency response function, determined by dynamic analysis, that relates the loads in the aircraft structure to the atmospheric turbulence; and

$\Phi(\Omega)$  = normalized power spectral density of atmospheric turbulence given by –

$$\Phi(\Omega) = \frac{L}{\pi} \frac{1 + \frac{8}{3}(1.339L\Omega)^2}{\left[1 + (1.339L\Omega)^2\right]^{\frac{1}{6}}}$$

Where –

$\Omega$  = reduced frequency, radians per foot.; and

$L$  = scale of turbulence = 2,500 ft.

(3) The limit turbulence intensities,  $U_{\sigma}$ , in feet per second true airspeed required for compliance with this paragraph are –

(i) At airplane speeds between  $V_B$  and  $V_C$ :

$$U_{\sigma} = U_{\sigma\text{ref}} F_g$$

Where –

$U_{\sigma\text{ref}}$  is the reference turbulence intensity that varies linearly with altitude from 90 fps (TAS) at sea level to 79 fps (TAS) at 24000 feet and is then constant at 79 fps (TAS) up to the altitude of 60000 feet.

$F_g$  is the flight profile alleviation factor defined in paragraph 25.341(a)(6);

(ii) At speed  $V_D$ :  $U_{\sigma}$  is equal to 1/2 the values obtained under subparagraph (3)(i) of this paragraph.

(iii) At speeds between  $V_C$  and  $V_D$ :  $U_{\sigma}$  is equal to a value obtained by linear interpolation.

(iv) At all speeds both positive and negative continuous turbulence must be considered.

(4) When an automatic system affecting the dynamic response of the airplane is included in the analysis, the effects of system non-linearities on loads at the limit load level must be taken into account in a realistic or conservative manner.

(5) If necessary for the assessment of loads on airplanes with significant non-linearities, it must be assumed that the turbulence field has a root-mean-square velocity equal to 40 percent of the  $U_{\sigma}$  values specified in subparagraph (3). The value of limit load is that load with the same probability of exceedance in the turbulence field as  $\bar{A}U_{\sigma}$  of the same load quantity in a linear approximated model.

### **Explanation of how design features or alternative Methods of Compliance (MoC) provide an equivalent level of safety to the level of safety intended by the regulation**

The proposed NPRM is the result of Aviation Rulemaking Advisory Committee (ARAC) harmonization of the JAR and FAA 14 CFR part 25 requirements and is consistent with maintaining and enhancing the level of safety. The criteria specified in this ELOS finding are now embodied in Amendment 25-141.

### **FAA approval and documentation of the ELOS finding**

The FAA has approved the aforementioned ELOS finding in Model 680 project issue paper AG-6 and Model 680A project issue paper G-5. This memorandum provides standardized documentation of the ELOS finding that is non-proprietary and can be made available to the public. The TAD has assigned a unique ELOS Memorandum number (see front page) to facilitate archiving and retrieval of this ELOS. This ELOS Memorandum number must be listed

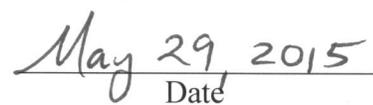
in the Type Certificate Data Sheet under the Certification Basis section. An example of an appropriate statement is provided below.

Equivalent Level of Safety Findings have been made for the following regulation(s):

14 CFR 25.341(b) Gust and turbulence loads

(documented in TAD ELOS Memo TC2548WI-T-AG-6)

  
Transport Airplane Directorate,  
Aircraft Certification Service

  
Date

ELOS Originated by Wichita ACO	Tina Miller	ACE-117W
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