

UNITED STATES OF AMERICA
DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
KANSAS CITY, MISSOURI 64106

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In the matter of the petition of *
CESSNA AIRCRAFT COMPANY *
for an exemption from § 23.207(c) *
of the Federal Aviation Regulations *

Regulatory Docket No. 011CE

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GRANT OF EXEMPTION

By letter dated March 13, 1986, Mr. Donald W. Mallonee, Post Office Box 7704, Wichita, Kansas 67277, on behalf of the Cessna Aircraft Company, petitioned for an exemption from § 23.207(c) of the Federal Aviation Regulations (FAR) to permit type certification of derivative models of the Cessna Models 406, 435, 441, and 208 airplanes with a stall warning beginning at airspeeds greater than 10 knots or 15 percent above the stalling speed.

Section of the FAR affected:

Section 23.207(c) requires, in pertinent part, the stall warning must begin at a speed exceeding the stalling speed by a margin of not less than 5 knots, but not more than the greater of 10 knots or 15 percent of the stalling speed, and must continue until the stall occurs.

The petitioner's supportive information is as follows:

The petitioner contends that Cessna Aircraft Company has diligently sought to develop compliance through feasible alteration of the proposed type designs. Cessna's conclusions from those explorations are that compliance is not possible by means of reasonable aerodynamic adjustments or by utilization of the kinds of devices traditionally used for stall warning (devices that Cessna believes the Administrator contemplated in the promulgation of § 23.207 and its predecessor requirements in the Civil Air Regulations). Cessna's further conclusion is that the only known technical means for achieving compliance with § 23.207 as presently stated would be through utilization of highly sophisticated devices utilizing a multitude of sensors throughout the airplane that would feed

into a specialized computer device for generation of a stall warning signal.

The petitioner contends the concept of an upper limit for stall warning, introduced by Amendment 3-4 of Part 3 of the Civil Air Regulations (CAR) in 1950, appears to have contemplated low performance small airplanes of low power-to-weight ratios. In such airplanes, the difference between power-off and power-on stalls was not great. It is noted that all of the models for which this exemption is requested are turbine-powered and have power-to-weight ratios much larger than contemplated by § 3.120 of the CAR, as amended by Amendment 3-4, effective January 15, 1951.

The petitioner states that there are two effects, both undesirable with respect to stall warning, related to high power-to-weight ratios: First, a one-knot-per-second entry rate will produce large cockpit deck angles when the stall occurs, which means that when the stall occurs, the airplane is already at a higher pitch attitude than the 30 degrees that would have been permitted during stall recovery in the applicable Part 3 requirements. If the requirements, the petitioner contends, were meant to avoid unusual attitudes as a consequence of the stall, then it seems doubtful that such a higher pitch attitude before the stall is a safety enhancement. Secondly, but of a higher safety concern, is the fact that for the multiengine airplanes involved, a stall warning in compliance with § 23.207(c) would not activate in the power-on case until a speed well below the minimum control speed, V_{MC} . As an example, utilizing speeds typical of the Cessna Model 406 airplane, the minimum control speed is approximately 90 knots. In the landing configuration, the power-on stall occurs at approximately 70 knots. Therefore, the stall warning complying with the requirement of § 23.207(c) limits would occur between 75 and 80 knots, well below the minimum control speed. If the stall warning was keyed to the power-off stalling speed, approximately 77 knots, the stall warning range would be between 82 and 89 knots, which is still below the minimum control speed, but much more likely to provide an effective stall warning in the event of pilot inattention during a missed approach, go-around situation.

The petitioner contends that a system utilizing contemporary electronic technology to effect stall warning within the ranges of § 23.207(c) would be highly sophisticated, of doubtful reliability for a Part 23 airplane, and subject to maintenance errors. To augment aerodynamic warning in providing regulatory stall warning margins for the Cessna Citation III, Cessna gained manufacturing and operational experience with a system that is similar to, but less sophisticated than, a system needed to comply with the requirements of § 23.207(c). From this experience, Cessna is strongly persuaded that such a system is useless for a Part 23 airplane. In addition, the provisions of present § 91.30, Inoperable Instruments and equipment for multiengine airplanes, would demand that such a system have built-in preflight checks to assure correct functioning, and Cessna further notes that many pilots of small airplanes are less than rigorous in completing preflight procedures before takeoff.

The petitioner states that the Cessna Model 406 presently in the process of being type certificated has a "twin brother" in the type design data,

the Model F406. Through a long and involved process of negotiations, the Model F406 is constructed by Reims Aviation in France to type design data developed by Cessna in the United States. Key to this process is utilization of identical type design data for both the Models 406 and F406 airplanes.

The Model F406 airplane has received Certificat de Navigabilite' de Type No. 175 in compliance with a certification basis that is as nearly identical as possible to the U.S. certification basis for the normal category Cessna Model 406 airplane, including § 23.207(c). It is contended that a grant of the exemption would relieve the United States of any problems that might incur by the apparent disregard of the Franco-U.S. Bilateral Agreement requiring one civil airworthiness authority to accept as valid the findings of the other civil airworthiness authority.

Furthermore, the petitioner contends that advancing technologies place heavy pressures on the manufacturers to comply with certain requirements, such as § 23.207(c), and has previously discussed the "big-engine-in-a-small-package" effect of presently available turbine engines. Proportionally high fuel loadings that accompany such engines, the large useful load proportions made available by contemporary airplane construction techniques, and the application of stability augmentation principles have resulted in ever expanding widths of the center-of-gravity (c.g.) envelope of small airplanes. As an example, a range of 5 percent to 40 percent mean aerodynamic chord (MAC) is proposed for the Cessna Model 208B. A by-product of such a wide c.g. envelope is a large variation between the stall speed values at the forward and aft limits. In the petitioner's view, the capability for such wide c.g. loadings could not have been contemplated when the stall warning criteria that are the predecessor to § 23.207(c) were promulgated. The language of § 23.207(c) differs from § 3.120, circa 1950, only in the change from miles per hour to knots and the relieving alternative of 15 percent in the upper limit for stall warning that was adopted by Amendment 23-7, effective September 14, 1969. It is stated that, although the preceding may be a persuasive argument for a requirement change, that amendment relief is too far in the future to help the instant case; therefore, making exemption relief the only acceptable alternative at this time.

The petitioner's review of the history of stall warning reveals two general safety concerns: (1) that the crew receive sufficient warning to avoid unexpected stalls, and (2) the earlier criteria which placed emphasis on limiting attitude and altitude changes following a stall so as to assure that the pilot can manage the consequences of the inadvertent stall. This latter concept has apparently retreated from type certification criteria, except as it may be administered in the "catch-all" provisions of § 21.21. Cessna still subscribes to the historical principles of stall warning/stall characteristics and sees nothing in the requested petition for exemption to diminish that view and suggests that the requested exemption would enable its continuity without resort to excessive airplane system "gadgetry" to comply with the current requirements of § 23.207(c).

The petitioner further contends that delving into the regulatory history, some within the FAA suggested that compliance with § 23.207 contemplated

a wings-level stall in which a level flight path; i.e., without climbing, was maintained. Such a further constraint, when applied to turbine-powered airplanes, would be even further evidence of the need for exemptive relief in complying with the requirements of § 23.207(c).

In the petitioner's view, the preceding provides ample evidence that a grant of the requested exemption would not adversely affect safety and that it would be in the public interest.

In response to the FAA's acknowledgement of receipt of the petition for exemption and request for further information, the petitioner agreed to confine the petition for exemption to the Cessna Model 406 airplane and the exemption issue be considered at a later date for the Cessna airplane Models 208B, 435, and 441BPC.

The petitioner reiterated the extent of relief requested in the petition that was related in part to a compliance position that the stall warning of § 23.207(c) is required in the case where the elevator control reaches the stop and the airplane is at a controlled minimum speed, V_{MIN} . The petitioner contends that since this condition is separated in § 23.201 from the stalled condition by the use of the word "or", it is clear that the airplane is not stalled and that application of § 23.207(c) is inappropriate. The petitioner states that reconsideration of the compliance position and acceptance that V_{MINs} are excluded from § 23.207(c) compliance would greatly narrow the extent of relief required because without the complication of V_{MINs} , compliance with the lower stall warning limit of five knots would be straight forward.

Furthermore, the petitioner contends that the engine power effects on compliance with § 23.207(c) comprise the greatest need for relief in the Cessna Model 406 airplane type certification program, as well as the other models cited in the original petition. The petitioner's flight test personnel have evaluated the Cessna Model 406 airplane and have concluded that reducing the power used for compliance with § 23.201 to that required for level flight does not change the power-on and power-off stall speeds sufficiently for a showing of compliance and still leaves a substantial difference; i.e., in excess of 10 knots or 15 percent, between the conventional stall warning indication and the power-on stall speed.

The petitioner contends that emphasis should be placed on development of stall warning in the power-off case and evaluate the resultant power-on stall warning for a minimum of 5 knots and an upper limit that is not objectionable. It is intended that stall warning margins exist in the power-on case and that their suitability, both as a stall deterrent and with respect to the absence of nuisance warning, be assessed in accordance with the provisions of § 21.21. This would, it is contended, allow establishment of an upper limit that is acceptably safe for type certification of the Cessna Model 406 airplane rather than to establish a firm numerical boundary.

By letter dated May 5, 1986, the petitioner submitted further information to the FAA with regard to specific conditions for establishing a level of safety equivalent to the rule from which the exemption is sought. It is

asserted by the petitioner that the following evaluations for stall warning will establish the level of safety intended by § 23.207(c).

1. The stall warning will be set 5 knots to 10 knots above the wings level power off stalling speed obtained at forward c.g. and maximum takeoff and landing weights.

2. The wings-level stall warning will be examined at forward c.g. regardless of weight, forward c.g. at maximum takeoff weight, and aft c.g. at maximum takeoff weight to assure that the stall warning will not activate at a speed greater than the speed set in item 1 above (5 knots to 10 knots above the power off stalling speed obtained at forward c.g. and maximum takeoff weight). This examination will be performed power-on and power-off at all approved flap settings.

3. Qualitative evaluations will be conducted at various takeoff, landing, and approach configurations to ensure there are no unwanted (nuisance) stall warnings. The following specific conditions will be evaluated:

a. Two-engine takeoff (all approved T.O. flaps) at scheduled takeoff speed minus 5 knots but not less than V_{MC} . Climb will be at minimum scheduled speed to 50 feet. The stall warning will not sound for more than a short duration during the rotation phase.

b. One-engine-inoperative takeoffs with engine out at the scheduled takeoff speed and fly out will be accomplished per schedule. There will be no stall warning using normal control inputs.

c. Two-engine approach and landing per schedule at V_{REF} and minus 5 knots per § 23.153. There will be no stall warning before commencing the flare.

d. One-engine-inoperative approach and landing at V_{REF} and at minus 5 knots. There will be no stall warning before commencing the flare.

e. Two-engine approach and balked landing per schedule. There will be no stall warning.

4. In all configurations, except V_{MIN} , where stall warning may not sound, the stall warning will sound 5 knots or more prior to the actual stall. This examination will be performed with the wings level and 30-degree banked turns.

5. All stalls in this determination will be approached at an entry rate of 1 knot per second.

Comments on published petition:

A summary of this petition for exemption was in the Federal Register on April 24, 1986 (51 FR 15569) and no comments were received in response to the summary.

The Federal Aviation Administration's (FAA) analysis is as follows:

To obtain the exemption, the petitioner must show, as required by § 11.25(b)(5), that: (1) granting the request is in the public interest, and (2) the exemption would not adversely affect safety, or that a level of safety will be provided which is equal to that provided by the rule from which the exemption is sought.

The FAA has carefully reviewed the information contained in the petitioner's request for exemption and subsequent submittal of additional information from the petitioner.

The purpose of the requirement in § 23.207(c) is to alert the pilot to an impending stall condition. The requirement for a stall warning indication was first proposed in 1950 and subsequently adopted as an amendment to § 3.120 of the Civil Air Regulations under the requirements for stalling demonstrations. Section 3.120 stated, in part, a clear and distinctive stall warning shall precede the stalling of the airplane, with the flaps and landing gear in any position, both in straight and turning flight. The stall warning shall occur at a speed exceeding that of stalling by not less than 5, but not more than 10 miles per hour. This requirement was further amplified by stating the manner in which demonstrating the qualities required of the section must be shown and the procedure was, in part, as follows: Pull elevator control back at a rate such that the airplane speed reduction does not exceed one mile per hour per second until a stall is produced as evidenced by an uncontrollable downward pitching motion of the airplane, or until the control reaches the stop. Normal use of the elevator control for recovery shall be allowed after such pitching motion has unmistakably developed.

Section 3.120 of the CAR was subsequently recodified into Part 23 and the requirements of concern were recodified into §§ 23.201 and 23.207. Section 23.201 was later amended to change the power-on stall demonstration from 90 percent of maximum continuous power to 75 percent of maximum continuous power. Section 23.207 was amended to change the reference from miles per hour to knots and to raise the upper limitation for the stall warning to 10 knots or 15 percent of the stalling speed, whichever is greater.

The FAA is aware of the problems being encountered during type certification programs in showing compliance with § 23.207(c) when airplanes with high power-to-weight ratios are being evaluated. This issue was discussed during the Part 23 Airworthiness Review Conference which was held in St. Louis, Missouri, during the week of October 22-26, 1984. It was concluded at that time that § 23.207(c) needs to be revised and the FAA is considering several proposals addressing this issue.

Cessna presented several positions to justify granting of the exemption. The FAA agrees with many of Cessna's positions; however, the FAA disagrees with some of them. Cessna cited the complexity of a stall warning system that would be necessary for compliance with the applicable requirements and that such a system would tend to be unreliable. The FAA agrees with the need for reliable stall warning systems. The FAA doesn't agree that a complex system is, of necessity, unreliable. The FAA considers the basic issue is to achieve the intended level of safety. With airplanes that incorporate advancements in technology, such as Cessna has incorporated in the Model 406, the manufacturer may find it

necessary to use complex systems for compliance with the applicable requirements. The FAA is not persuaded that a sophisticated system is useless in the airplanes such as the Model 406. Cessna also implies the sophisticated system would need extensive preflight procedures and that small airplane pilots do not consistently perform vigorous preflights. The FAA agrees that many pilots' preflight inspections are "less than vigorous" and that this tendency is more prevalent with pilots of airplanes that do not require type ratings or multi-member crews. As a result, the FAA typically does not allow credit in system reliability for small airplane preflight checks.

Cessna contends that the stall warning requirements as originally set forth in § 3.120 of the CAR envisioned low performance small airplanes with low power-to-weight ratios and that was the reason for the stall warning margins. The FAA agrees that such airplanes were envisioned when the rule was promulgated; however, the specific upper limits for stall warning margins in the current rule were established in lieu of opening up the upper limit to subjective determinations without specific criteria on which to base those determinations.

Cessna cited large cockpit deck angles that can occur before stall warning with the large thrust-to-weight ratios of current airplane designs as a safety consideration in stall warning. The FAA is concerned about these large cockpit deck angles and the characteristics of the affected airplanes in recovering from stalls that occur with such large deck angles. The FAA agrees that operations should not be conducted at such large deck angles and that the stall warning margin requirements were not intended for operations involving such large deck angles.

Cessna also cited as a safety concern that these multiengine airplanes with high thrust-to-weight ratios, when complying with the applicable stall warning margin requirements, may not have a stall warning in the power-on condition until the airspeed has reduced to a speed well below single-engine failure minimum control speed V_{MC} . The FAA agrees that the power-on stall warning should occur prior to the airplane entering a speed range where engine failure would probably be catastrophic, due to loss of control of the airplane. However, such warning systems would need to be activated at some margin relative to V_{MC} . Due to variations in V_{MC} with weight and c.g. location, the FAA does not consider requiring the stall warning to occur at or above V_{MC} to be workable. If a warning keyed to V_{MC} becomes necessary such warning requirement appears to be an issue independent of the stall warning envisioned in applicable requirements.

Cessna referred to dual certification of the Model 406 in the United States with the Model F406 in France and that the French have made findings relative to the stall warning system on the Model F406. They felt that the United States bilateral agreements with France were being questioned relative to the compliance program on the Model 406 being certificated in the United States. The FAA does not consider United States bilateral agreements germane to United States

certification of a domestic aircraft or to grants or denials of exemptions from applicable requirements.

Cessna cited the "big-engine-in-a-small-package" effect of advanced technology turbine engine in that this resulted in proportionately high fuel loadings and expanding widths of the c.g. envelope. Cessna considers these problems to create heavy pressure for compliance relative to the stall warning requirements. The FAA agrees that advancing technology has made possible significant expansions of the airplane c.g. ranges which results in greater spreads in the airplane's stall speeds; however, all technology has advanced, including that technology affecting warning systems. The FAA does not accept advancement of technology as a basis for not complying with the applicable requirements. The FAA agrees the resulting wide c.g. ranges were not envisioned and that changes in the requirements are appropriate as a result.

Cessna contends that stall warning should not be required when the airplane pitch control reaches the full-up position stop and the airplane has not exhibited the classic pitching-down motion of aerodynamic wing stall but instead, enters a minimum air speed condition referred to as V_{MIN} . The petitioner contends that this condition is not intended by the applicable requirements to be a stall and thus, a stall warning is not required. The FAA has reviewed the definition of a stall in § 23.201 and continues to consider this so-called V_{MIN} condition as a stall condition for the purposes of the regulatory requirements and that stall warning requirements continue to be applicable. Section 23.207 does not exempt any condition defined by § 23.201 as a stall from the applicable requirements for stall warning. However, the FAA agrees that the level of hazard is far less in such a stall (V_{MIN}) versus a stall where the wing exhibits aerodynamic stall.

Cessna requested that stall warning requirements be met in power-off conditions, and for power-on, stall requirements be relaxed to stall warning not being objectionable. Previous to this petition, the General Aviation Manufacturers Association (GAMA) petitioned for rulemaking to allow similar requirements (no upper limit, evaluate for being not objectionable). That petition was denied. Cessna is a member of GAMA, is aware of this previous action, and that issue need not be further addressed here.

Cessna letter dated May 5, 1986 presented additional data which the FAA considers to have merit in formulating the conditions necessary for a grant of this petition. That data is previously cited in this document.

The FAA has evaluated each of the specific conditions proposed by the petitioner with respect to assuring a level of safety equivalent to the requirement from which the exemption is sought. Section 23.207(c) includes speed margins such that any other margin does not provide an equivalent level of safety. However, these specific speed margins were selected to achieve the intended level of safety for the airplane envisioned when the rule and its amendments were

promulgated. The FAA has concluded that when compliance is shown with specific conditions, set forth as limitations herein, the level of safety intended by § 23.207(c) will be achieved.

In consideration of the foregoing, I find that a grant of exemption is in the public interest and will not adversely affect safety. Therefore, pursuant to the authority contained in Sections 313(a) and 601(c) of the Federal Aviation Act of 1958, as amended, (the Act) delegated to me by the Administrator (14 CFR 11.53), and Section 603 of the Act, Cessna Aircraft Company is granted an exemption from § 23.207(c) of the Federal Aviation Regulations to the extent necessary to allow type certification of the Cessna Model 406 airplane without an exact showing of compliance with the requirements of § 23.207(c). Other models included in Cessna's petition will be addressed in subsequent amendments to this exemption when additional data relative to those models are supplied by Cessna. For the Model 406, this exemption is subject to the following conditions and limitations:

1. The stall warning must activate at a speed 5 to 10 knots or 15 percent of stalling speed, whichever is greater, above the wings-level, power-off stalling speed obtained at forward center of gravity (c.g.) and maximum takeoff and landing weights.

2. The wings-level stall warning must be examined at forward c.g. regardless of weight, forward c.g. at maximum takeoff weight, and aft c.g. at maximum takeoff weight to assure that the stall warning will not activate at a speed greater than the maximum speed specified in item 1 above. This evaluation must be performed power-on and power-off at all approved flap settings.

3. Evaluations must be conducted at each takeoff, landing and approach configuration for which approval is requested to ensure no stall warnings occur except as set forth in the following specific conditions. The following specific conditions must be evaluated:

- a. Two-engine takeoff (all approved takeoff flap settings) at scheduled takeoff speed minus 5 knots but not less than V_{MC} . The climb must be at the minimum scheduled speed to 50 feet above the takeoff surface. The stall warning must not sound during the rotation phase except for a short (approximately 1 second) duration prior to achieving liftoff from the takeoff surface.

- b. One-engine-inoperative takeoffs with the critical engine made inoperative at the scheduled takeoff speed and the subsequent takeoff climb accomplished in accordance with AFM schedule. There must be no stall warning using normal control inputs.

- c. Two-engine-approach and landing, in accordance with Airplane Flight Manual (AFM) schedule minus 5 knots per § 23.153. There must be no stall warning before commencing the flare to land.

- d. One-engine-inoperative approach and landing at the AFM schedule speed minus 5 knots. There must be no stall warning before commencing the flare to land.

- e. Two-engine-approach and balked landing climb in accordance with AFM schedule. There must be no stall warning.

4. In all configurations, except those resulting in V_{MIN} (pitch control against upper stop without wing aerodynamic stall), the stall warning must sound 5 knots or more prior to the actual stall. When the airplane configuration is such that the pitch control reaches the full-up stop without the airplane exhibiting a pitch-down motion, the stall warning must sound before the pitch control reaches the stop. This evaluation must be performed with the wings level and with 30-degree banked turns to both the right and left.

5. All stalls in demonstrating compliance with the above requirements must be approached at an entry rate of 1 knot per second.

Issued in Kansas City, Missouri on June 9, 1986.



Edwin S. Harris, Director
Central Region

