Exemption No. 5573A

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

In the matter of the petition of FAIRCHILD AIRCRAFT CORPORATION for an exemption from § 23.207(c) of the Federal Aviation Regulations	Regulatory Docket No. 109CE

GRANT OF AMENDMENT TO EXEMPTION

By letter dated January 22, 1993, Mr. A. Pickens; Manager, Airworthiness; Fairchild Aircraft; Post Office Box 790490; San Antonio, Texas 78279-0490, petitioned for an amendment to include exemption from § 23.207(c) in the grant of exemption, Exemption No. 5573. Fairchild is seeking type certification of the SA227-CC, SA227-DC and all subsequent commuter category airplanes approved on type certificate A18SW, with certain stall characteristics and airspeed indicator markings that are appropriate to this category of aircraft. The exemption from stall warning was inadvertently omitted from the original exemption.

The petitioner requires relief from the following regulations:

Section 23.207(c) requires 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 petitioners supports its request with the following information:

To date, Fairchild has succeeded in complying with all of the cited rules, but only by significantly increasing the complexity of the airplane, and at great cost. This was accomplished by installing a Stall Avoidance System (SAS), which provides stall warning, an artificial stall (stick push). Originally, the system was a relatively simple, single-channel affair. However, when the SA227-AC was

recertified to the commuter category rules (and became the SA227-CC and SA227-DC) it became necessary to comply with the accelerated stall requirements of § 23.203, which proved to require maneuvers not appropriate to this type of airplane. To limit the exposure of the airplane and crew to the very significant hazards attendant to showing compliance with the accelerated stall rules, it was necessary to dualize the SAS system so that the artificial stall could be substituted for the aerodynamic stall. Development and approval of the system required a long and costly flight test program. The end result was a complicated system that added stick shakers, lights, and aural devices, as well as the basic warning and stick push features.

Fairchild cites Exemption No. 5078 as their technical basis for the petition. Exemption No. 5078 is for the Beech 1900D petition. A summary of the supportive information from that exemption is as follows:

1. The stall warning must occur at a speed exceeding the stall 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 in the wings-level, power-off, condition at the forward center of gravity (C.G.) at the maximum takeoff and landing weights. This evaluation must be performed at all approved flap settings.

2. The wings-level stall warning must occur at a speed no greater than the maximum speed specified in "1" above at the forward C.G. regarding of weight, the forward C.G. at the maximum takeoff weight, and the aft C.G. at the maximum takeoff weight. This must be shown for power-on and power-off conditions with the flaps in all approved settings. Power-on is defined as 75 percent of maximum continuous power.

3. The stall warning must occur no less than 5 knots above the actual stalling speed. This must be shown for wings-level flight in the power-on and off conditions, and in 30-degree banked turns to the left and right in the power-on condition.

4. The turning flight stall warning must occur at a speed no greater than the maximum speed specified in "1" above adjusted for the turning flight load factor.

5. In the case where a condition exists such that the pitch control reaches the full-up stop without the airplane stalling, the stall warning must occur before the pitch control reaches the stop.

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

7. The stall warning must, after beginning within the margins specified above, continue until the stall occurs.

Beech stated that flight testing utilizing the B300 prototype, FA-1, conducted during the month of November 1988, explored the stall warning characteristics of an angle of attack sensing system at various combinations of C.G., weight, flap settings, and landing gear positions. The parameters measured during these tests included, but were not limited to, angle of attack, angle of side slip, airspeed, "G" force, aircraft deck angle, and elevator position. Reduction of this data has shown that trying to produce a stall warning in conjunction with the current requirements would require the utilization of several additional, sophisticated devices, and sensors located throughout the aircraft linked together by a stall warning computer. Assessment of existing and near term technology indicates that such a system at this time appears infeasible. If such as system could be developed it would be less reliable, subject to maintenance error, and require stringent preflight checks not generally performed by pilots of small airplanes. The continuing effort of both pilots and maintenance personnel to ensure proper functioning of such a system and the associated cost would not be in the best interest of the public.

In addition, Beech felt that the installation of the necessary system, if it were able to be developed, would lead to unsafe flight conditions when power-on stalls are encountered. Specifically, given a one-knot-per-second entry rate, the 1900D power-to-weight ratio is large enough that during a power-on stall, the stall warning will not occur until flight deck angles of over 30 degrees are achieved. It was Beech's opinion that, concurrent with the achievement of these flight deck angles, the aircraft attains unusual attitudes which detract from the safety meant to be gained by the stall warning system.

Beech was concerned about the situation where a twin-engine aircraft is allowed to be flown below the minimum controllable airspeed while approaching a power-on stall. Specifically, with an aft C.G. and light weight, the stall speed for the B300 with the flaps in the approach position, landing gear down, and 75 percent power, was found to be approximately 64 knots. As required by § 23.207(c), a stall warning must begin at an airspeed no higher than approximately 74 knots (1.15 times the stall speed). The

minimum control speed for the identical configuration is 94 knots. Clearly, the aircraft could be placed in a compromising flight condition should the critical engine fail at the same time or for up to 20 seconds before the stall warning was activated.

Fairchild, repeating Beech's position, asserts that an equivalent level of safety to § 23.207(c) will be established by demonstrating the following flight conditions to ensure no stall warning occurs except as noted:

1. Two-engine takeoff (all approved takeoff flap settings) at the scheduled rotation speed, V_R, minus 5 knots: The climb must be at the minimum scheduled speed, V_2, to 50 feet above the takeoff surface. The stall warning must not sound during the rotation phase except for a short (approximately one second) duration.

2. One-engine inoperative takeoffs with the critical engine made inoperative at the takeoff decision speed, V_1, and the subsequent takeoff climb accomplished in accordance with the AFM schedule: There must be no stall warning using normal control inputs.

3. Two-engine-approach and landing in accordance with the AFM airspeed schedule minus 5 knots, as required by § 23.153: There must be no stall warning before commencing flare to land.

4. One-engine-inoperative approach and landing at the AFM airspeed schedule: There must be no stall warning before commencing flare to land.

5. Two-engine-approaches and balked-landing climb in accordance with AFM schedule: There must be no stall warning.

The petitioner takes the position that the public interest will be served because they believe that the proposed exemption will enhance safety by providing stall warning margins appropriate for the Model SA227-CC and SA227-DC operation. Further, stall warning margins provided by the present § 23.207(c) would lead to possible compromising or unsafe conditions in certain flight conditions.

Comments on published petition summary:

A summary of this petition was published in the FEDERAL REGISTER for public comment on October 2, 1992 (57 FR 45650). The comment period closed October 22, 1992. No comments were received.

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.

Fairchild referenced Beech's citing that a stall warning system that would be necessary for compliance with the applicable requirements would be complex and would tend to be unreliable. The FAA agreed with the need for reliable stall warning systems. The FAA did not agree that a complex system is, of necessity, unreliable. The FAA considered the basic issue was to achieve the intended level of safety. With airplanes that incorporate advancements in technology, such as Beech had incorporated in the Model 1900D, the manufacturer may find it necessary to use complex systems for compliance with the applicable requirements. Beech implied that the sophisticated system would need stringent preflight procedures and that small airplane pilots do not consistently perform vigorous preflights. The FAA agreed that many pilots' preflight inspections are "less than vigorous". As a result, the FAA typically did not allow credit in system reliability for small airplane preflight checks.

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. The specific upper limits for stall warning margins in the current rule were established instead of opening up the upper limit to subjective determinations without specific criteria on which to base those determinations.

Additionally, Fairchild reinforced what Beech cited as a safety consideration in a stall warning: large cockpit deck angles can occur before stall warning with the large thrust-to-weight ratios of current airplane designs. 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 evaluations 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.

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 a warning system 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 a warning requirement appears to be and issue independent of the stall warning envisioned in applicable requirements.

The FAA has evaluated each of the specific conditions proposed by the petitioner with respect to ensuring 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 condition 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, delegated to me by the Administrator (14 CFR 11.53), Fairchild Aircraft Corporation is granted an exemption from § 23.207(c) of the Federal Aviation Regulations to the extent necessary to allow type certification for the Fairchild Model SA227-CC and SA227-DC airplane and all subsequent commuter category airplanes approved on type certificate A18SW, without an exact showing of compliance with the requirements of § 23.207(c).

For the Model SA227-CC and SA227-DC airplane and all subsequent commuter category airplanes approved on type certificate A18SW, this exemption is subject to the following conditions and limitations:

1. 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 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 ensure that the stall warning will not activate at a speed greater than the maximum speed specified in 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 activate 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 as required by § 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 activate 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 January 29, 1993.

Barry D. Clements, Manager
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