Exemption No. 5599

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<br><br>BEECH AIRCRAFT CORPORATION<br><br>for an exemption from § 23.53(c)(1) of the Federal Aviation Regulations | Regulatory Docket No. 110CE |

GRANT OF EXEMPTION

By letter dated October 28, 1992, Mr. A. C. Jackson, Group Manager Product Design Assurance and FAA Liaison, Beech Aircraft Corporation, Post Office Box 85, Wichita, KS 67201-0085, petitioned for an exemption from § 23.53(c)(1) of the Federal Aviation Regulation (FAR) to permit type certification of the Beech Model B300 and B300C. The requested exemption would allow the use of ground minimum control speed ($V_{MCG}$) for determination of the takeoff decision speed ($V_1$).

The petitioner requires relief from the following regulation(s):

Section 23.53(c)(1) requires that, for commuter category airplanes, the takeoff decision speed, $V_1$, is the calibrated airspeed on the ground at which, as a result of engine failure or other reasons, the pilot is assumed to have made a decision to continue or discontinue the takeoff. The takeoff decision speed, $V_1$, must be selected by the applicant, but may not be less than the greater of the following: (i) 1.10 $V_{S1}$, (ii) 1.10 $V_{MC}$ established in accordance with § 23.149; (iii) A speed at which the airplane can be rotated for takeoff and shown to be adequate to safely continue the takeoff, using normal piloting skill, when the critical engine is suddenly made inoperative; or, (iv) $V_{EF}$ plus the speed gained with the critical engine inoperative during the time interval between the instant that the critical engine is failed and the instant at which the pilot recognizes and reacts to the engine failure as indicated by the pilot's application of the first retarding means during the accelerate-stop determination of § 23.55.

The petitioner supports its request with the following information:

This exemption will provide a benefit to current and future operators of the Model B300 and B300C aircraft. The current field length of the Model B300/B300C, at maximum takeoff weight (15,000 pounds) at sea level standard day condition, is 3,737 feet. Granting of this exemption would reduce the field length under the same conditions to about 3,300 feet.

At this time, due to the high $V_{MC}$ speed, the $V_1$ speed is a constant 102 knots indicated airspeed, regardless of airplane weight. For example, reducing the takeoff weight 2,500 pounds to 12,500 pounds, reduces the field length only to 3,400 feet. The new $V_{MCG}$ would allow off-loading of payload to have a more significant reduction in field length.

An example of the change in $V_1$ speed is shown below

Conditions

15,000 pounds MTOGW
Approach Flaps
Sea Level Standard

Present Method - FAR § 23.53(c)

$V_{MCA}$ = 94 KCAS X 1.1 = 103.4 KCAS
$V_S$ = 90 KCAS X 1.1 = 99 KCAS
$V_1$ = 104 KCAS
Field Length = 3,737 Feet

$V_{MCG}$ is approximately 99 KCAS on the airplane at this time.

Proposed Method

$V_{MCG}$ (Maximum Goal) = 95 KCAS
$V_1$ = 97 KCAS, including speed buildup
Field Length = 3,300 Feet

The proposed reduction in $V_1$ speed is also expected to reduce brake energy requirements in the event of a RTO.

Beech does not intend to change rotation speed ($V_R$) or takeoff safety speed ($V_2$) since there are no changes presently proposed which would impact $V_S$ or $V_{MC}$. Rotation speed at 15,000 pounds is 106 KCAS, or 1.13 $V_{MC}$.

Background

The Model B300 has proven to be a safe and reliable airplane with excellent load carrying capabilities. However, former owners of Beech Model 200 or Model 300 Super King Airs who have transitioned to the Beech Model B300 are finding that the commuter category field performance limitation is quite restrictive in comparison to their prior airplanes. It is important to note that the Beech Model 300 could be operated to FAR Part 23 performance under 12,500 pounds and, therefore, is similar to the Model 200 performance.

This situation initiated a program to attempt to reduce the field length of the Model B300, while maintaining safe operating characteristics.

In an April meeting at the Wichita FAA Aircraft Certification Office, Beech and FAA personnel discussed a Beech proposal to use criteria similar to FAR § 25.107(a) for determination of takeoff decision speed, $V_1$, in lieu of current FAR § 23.53(c)(1). Based on $V_{MCG}$ development tests to date, Beech believes this will be a viable way to decrease the takeoff field length by about 400 feet, without jeopardizing safe operation of the airplane.

Equivalent Level of Safety

The proposed criteria provides an equivalent level of safety based on the use of criteria, for determination of takeoff decision speed, $V_1$, similar to that in Part 25 of the Federal Aviation Regulations, § 25.107(a), including the definition of $V_{MCG}$ in FAR § 25.149.

Because the Model B300 is certified in the commuter category, and is required to comply with performance limitations (takeoff field length, maximum takeoff weight to achieve takeoff climb requirements), which are similar to FAR Part 25 transport category requirements, it appears to be logical to allow the use of the transport category takeoff decision speed definition.

Due to the fact that the proposed criteria is based on existing transport category rules, it is considered to provide an equivalent level of safety to that provided by FAR § 23.53(c)(1).

Public Interest

Based on airport data there are approximately 600 airfields with lengths between 3,750 and 3,300 feet in the United States.

As noted earlier, Beech is seeking a reduction in field length, which would allow the Beech Model B300/B300C to operate in many more airfields than the present airplane. This is a benefit to the operators.

Beech also proposes to offer a retrofit kit that would improve the flexibility of airplanes already in operation.

It is estimated that, with off-loading of the payload, the field length could be reduced below 3,300 feet, which would provide even greater flexibility with this airplane since there are an additional 350 airfields with lengths between 3,300 and 3,000 feet.

This is a tangible improvement to the airplane, with a change that would maintain safety of operation.

Beech proposes the following criteria in lieu of FAR § 23.53(c)(1):

$V_1$ must be established in relation to $V_{EF}$ as follows:

(1) $V_{EF}$ is the calibrated airspeed at which the critical engine is assumed to fail. $V_{EF}$ must be selected by the applicant, but must not be less than $V_{MCG}$ as defined in (3).

(2) $V_1$ in terms of calibrated airspeed is the takeoff decision speed, selected by the applicant; however, $V_1$ may not be less than $V_{EF}$ plus the speed gained with the critical engine inoperative during the time interval between the instant at which the critical engine is failed and the instant at which the pilot recognizes and reacts to the engine failure, as indicated by the pilot's application of the first retarding means during the accelerate-stop tests.

(3) $V_{MCG}$, the minimum control speed on the ground, is the calibrated airspeed during the takeoff run at which, when the critical engine is suddenly made inoperative, it is possible to maintain control of the airplane using the rudder control alone (without the use of nosewheel steering), as limited by 150 pounds of force, and the lateral control to the extent of keeping the wings level to enable the takeoff to be safely

continued using normal piloting skill. In the determination of $V_{MCG}$, assuming that the path of the airplane accelerating with all engines operating is along the centerline of the runway, its path from the point at which the critical engine is made inoperative to the point at which recovery to a direction parallel to the centerline is completed may not deviate more than 30 feet laterally from the centerline at any point.

$V_{MCG}$ must be established with:

(1) The airplane in each takeoff configuration or, at the option of the applicant, in the most critical takeoff configuration;
(2) Maximum available takeoff power or thrust on the operating engines;
(3) The most unfavorable center of gravity;
(4) The airplane trimmed for takeoff; and
(5) The most unfavorable weight in the range of takeoff weights.

Comments on published petition summary:

A summary of this petition was published in the FEDERAL REGISTER for public comment on December 21, 1992. The comment period closed January 11, 1993. One commenter responded with several comments.

The commenter states that if Beech wants to have the benefits of Part 25 for takeoff performance, then they should be made to comply with all of the takeoff performance and accelerate-stop certification criteria stipulated for transport category aircraft.

The FAA does not agree that this is the case, in fact, the exemption allows the airplane to be closer to Part 25, not further. With this exemption, the airplane will meet or exceed all Part 25 takeoff and accelerate-stop criteria. It will also be consistent with the latest Part 23 proposals with regard to JAR/FAR Harmonization.

The commenter is also concerned that this exemption may expose the pilot and the passengers to a potentially dangerous situation by having the $V_1$ speed much lower than the established $V_R$. Although the go/no-go decision of pilot is made sooner, this may prohibit the aircraft from being able to accelerate to $V_R$, continue to accelerate and climb safely with one engine inoperative. If an engine were to fail at the new $V_1$ speed at a maximum gross takeoff weight (MGTOW) of 15,000 pounds, will the aircraft be able to safely accelerate 9 knots between the proposed $V_1$ of 97 KCAS

and the required $V_R$ of 106 KCAS? The 9 KCAS required to accelerate to $V_R$ may not be achievable if, during high density altitude conditions, an engine is lost at $V_1$ and the pilot elects to continue the takeoff. What is the time and distance involved? And, will the aircraft be able to clear all obstacles after using the increased distance required to accelerate to $V_R$ under these conditions. These questions must be answered during the certification process.

The commenter infers that there will be no attempt to ensure that the $V_1$ to $V_R$ acceleration will be safe and acceptable. FAA flight testing will be accomplished to ensure compliance and safety. Testing will include both large and small single-engine accelerations. At high altitudes the acceleration segment between $V_1$ and $V_R$ will probably be nearly the same as the current acceleration segment. The ability to reduce $V_1$ will primarily be useful at low altitude, lower temperature conditions.

The FAA disagrees with the commenter who does not consider this petition for exemption to be in the best interest of the traveling public. Accident histories have shown that a lower $V_1$ is in the direction of safer operations. The lower the speed at which the decision to abort is accomplished, the more likely a safe outcome will occur. The decision to continue a takeoff, climb out, and return for landing has historically been a safe decision.

<u>The Federal Aviation Administration's (FAA) analysis is as follows:</u>

To obtain this 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 that is equal to that provided by the rules from which the exemption is sought.

The FAA has carefully reviewed the information contained in the petitioner's request for exemption.

The FAA agrees that the requirements proposed by Beech, which are similar to transport category requirements, will allow the airplanes to safely operate from shorter runways. By granting this exemption, Beech Model B300/B300C airplanes will have a shortened accelerate-stop distance while lengthening the accelerate-go distance. Since the accelerate-stop distance is the

more limiting factor in determining the runway length required for takeoff at lower altitude and lighter weight conditions, this will effectively reduce the runway required for takeoff under those conditions.

Discussion:

FAR § 23.53(c)(1), Takeoff Speeds, Commuter Category Airplanes - The takeoff decision speed, $V_1$, is the calibrated airspeed on the ground at which, as a result of engine failure or other reasons, the pilots is assumed to have made a decision to continue or discontinue the takeoff. The takeoff decision speed, $V_1$, must be selected by the applicant but may not be less than the greater of the following: (i) 1.10 $V_{S1}$, (ii) 1.10$V_{MC}$ established in accordance with § 23.149, (iii) A speed at which the airplane can be rotated for takeoff and shown to be adequate to safely continue the takeoff, using normal piloting skill, when the critical engine is suddenly made inoperative; or, (iv) $V_{EF}$ plus the speed gained with the critical engine inoperative during the time interval between the instant that the critical engine is failed and the instant at which the pilot recognizes and reacts to the engine failure as indicated by the pilot's application of the first retarding means during the accelerate-stop determination of § 23.55.

FAR § 25.107(a), Takeoff Speeds, $V_1$ must be established in relation to $V_{EF}$, as follows: (1) $V_{EF}$ is the calibrated airspeed at which the critical engine is assumed to fail. $V_{EF}$ must be selected by the applicant, but may not be less than $V_{MCG}$ determined under § 25.149(e). (2) $V_1$, in terms of calibrated airspeed, is the takeoff decision speed selected by the applicant; however, $V_1$ may not be less than $V_{EF}$ plus the speed gained with the critical engine inoperative during the time interval between the instant at which the critical engine is failed and the instant at which the pilot recognizes and reacts to the engine failure, as indicated by the pilot's application of the first retarding means during accelerate-stop tests.

FAR § 25.149(e), $V_{MCG}$, the minimum control speed on the ground, is the calibrated airspeed during the takeoff run at which, when the critical engine is suddenly made inoperative, it is possible to maintain control of the airplane using the rudder control alone (without the use of nosewheel steering), as limited by 150 pounds of force, and the lateral control to the extent of keeping the wings level to enable the takeoff to be safely continued using normal piloting skill. In the

determination of $V_{MCG}$, assuming that the path of the airplane acceleration with all engines operating is along the centerline on the runway, its path from the point at which the critical engine is made inoperative to the point at which recovery to a direction parallel to the centerline is completed may not deviate more than 30 feet laterally from the centerline at any point. $V_{MCG}$ must be established with -- (1) The airplane in each takeoff configuration or, at the option of the applicant, in the most critical takeoff configuration; (2) Maximum available takeoff power or thrust on the operating engines; (3) The most unfavorable center of gravity; (4) The airplane trimmed for takeoff; and (5) The most unfavorable weight in the range of takeoff weights.

Proposed JAR 23.51(c), Takeoff Speeds, for commuter category airplanes the following apply. (1) $V_1$ must be established in relation to $V_{EF}$ as follows: (i) $V_{EF}$ is the calibrated airspeed at which the critical engine is assumed to fail. $V_{EF}$ must be selected by the applicant, but must not be less than 1.05 $V_{MC}$ determined under JAR 23.149(b). NOTE: $V_{MCG}$ determined under JAR 25.149(e) is acceptable in lieu of 1.05 $V_{MC}$. $V_1$ has the same definition as FAR § 25.107.

The FAA has evaluated the proposed conditions that the petitioner has requested and agrees that they are reasonable based on the wording of FAR Part 25 and the proposed wording of JAR 23. Approving this request will not change the accelerate-go $V_R$ or $V_2$ speeds. The accelerate-stop maneuver will not change except that the decision will be made earlier. This will enable the stop to occur from a lower speed. Accident history has shown that rejected takeoffs from high speed (and corresponding high brake energies) are increasingly hazardous as the speed for the decision increases. Therefore, decreasing the speed at which the decision to stop is made, is increasing safety. The accelerate-go will require an acceleration with one engine failed before the rotation speed is reached. This maneuver was demonstrated during certification testing for cases in which rotation speed was greater than $V_1$. Overall, the decrease in $V_1$ will increase safety.

In consideration to 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 Section 313(a) and 601(c) of the Federal Aviation Act of 1958, as amended, delegated to me by the Administrator (14 CFR 11.53), Beech Aircraft Corporation is granted an exemption from the use of § 23.53(c)(1) of the Federal Aviation Regulations to the

extent necessary to allow type certification of the Beech Model B300 and B300C. This exemption is subject to the following conditions and limitations.

(a) Takeoff Speeds, $V_1$ must be established in relation to $V_{EF}$ as follows:

(1) $V_{EF}$ is the calibrated airspeed at which the critical engine is assumed to fail. $V_{EF}$ must be selected by the applicant, but may not be less than $V_{MCG}$ determined under paragraph (b).

(2) $V_1$, in terms of calibrated airspeed, is the takeoff decision speed selected by the applicant; however, $V_1$ may not be less than $V_{EF}$ plus the speed gained with the critical engine inoperative during the time interval between the instant at which the pilot recognizes and reacts to the engine failure, as indicated by the pilot's application of the first retarding means during accelerate-stop tests.

(b) $V_{MCG}$, the minimum control speed on the ground, is the calibrated airspeed during the takeoff run at which, when the critical engine is suddenly made inoperative, it is possible to maintain control of the airplane using the rudder control alone (without the use of nosewheel steering), as limited by 150 pounds of force, and the lateral control to the extent of keeping the wings level to enable the takeoff to be safely continued using normal piloting skill. In the determination of $V_{MCG}$, assuming that the path of the airplane acceleration with all engines operating is along the centerline of the runway, its park from the point at which the critical engine is made inoperative to the point at which recovery to a direction parallel to the centerline is completed may not deviate more than 30 feet laterally from the centerline at any point. $V_{MCG}$ must be established with --

(1) The airplane in each takeoff configuration or, at the option of the applicant, in the most critical takeoff configuration;

(2) Maximum available takeoff power or thrust on the operating engines;

(3) The most unfavorable center of gravity;

(4) The airplane trimmed for takeoff; and

(5) The most unfavorable weight in the range of takeoff weights.

Issued in Kansas City, Missouri on February 2, 1993.

Barry D. Clements, Manager
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