

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 Co. \*

Regulatory Docket No. 117CE

for exemption from § 23.181(b) of \*  
the Federal Aviation Regulations \*

\* \* \* \* \*

GRANT OF EXEMPTION

By letter L178-61-93-462 dated May 13, 1993, Mr. Donald W. Mallonee, Executive Engineer, Cessna Aircraft Company, P.O. Box 7704, Wichita, Kansas 67277, petitioned for exemption from § 23.181(b) of the Federal Aviation Regulations (FAR) as presently stated in the type certification basis of the Cessna Model 525 CitationJet, Type Certificate No. A1WI. This exemption would permit Cessna to amend the Model 525 type certificate utilizing the directional stability damping criterion of § 25.181 in lieu of the damping criterion of § 23.181(b). The exemption would allow compliance with an appropriate level of lateral-directional dynamic stability solely by aerodynamic means. It would also allow removal of the present operating limitation which requires the airplane to descend to an altitude of 18,000 feet or lower if the yaw damper becomes inoperative. While yaw dampers would continue to be fitted on Model 525 airplanes, their purpose would be limited to enhancing passenger comfort rather than certification compliance.

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

Cessna petitioned the FAA to allow amendment of the Model 525 type certificate to utilize the directional stability damping criterion of § 25.181 in lieu of the damping criterion of § 23.181(b).

Section 23.181(b) of the FAR requires that any combined lateral-directional oscillations ("Dutch roll") occurring between the stalling speed and the maximum allowable speed

appropriate to the configuration of the airplane must be damped to 1/10 amplitude in 7 cycles with the primary controls - (1) free; and, (2) in a fixed position.

The petitioner supports their request with the following information:

The petitioner asserts that, "Limitations presently in effect for Model 525 require the pilot to descend to altitudes of 18,000 feet, or lower, if the yaw-damper mode of the flight guidance system becomes inoperative. Compliance with this limitation actually exposes operators to a less safe environment where it is exposed to conflicts with slower aircraft that normally operate in uncontrolled airspace at lower altitudes.

With respect to operating safety in the pilot's handling of the airplane with and without yaw dampers, the requested exemption has no discernible effect that would diminish safety. At this time Cessna 500 series airplanes, in the same general size range of Model 525, have in excess of twenty years of operating experience (including more than fifteen years of operations without a second-in-command) without a requirement for an operational yaw damper. There have been no questions of safety raised with these aircraft because of aerodynamic yaw damping characteristics, yet the aerodynamic yaw damping of Model 525 is superior to all its sister aircraft: Models 500, 501, 550, 551, 552, and 560. The weight range of all of these airplanes is within the scope of weights eligible for FAR 23 certification, i.e., less than 19,000 lb, to which § 23.181 is expected to apply." The petitioner continues, "As...the achieved damping of Model 525 at maximum authorized altitude (FL410) and at  $M_{MO}$  is 1/10 amplitude in approximately 12.2 cycles. Pilots report that this damping is quite controllable when viewed against the criterion of the requested exemption. Moreover, pilots assert that there is no apparent advantage from the yaw damping system beyond enhancement of passenger comfort. At the other end of the scale, the curve plot shows a data point for 1.15  $V_S$  at 41,000 ft where damping in 6.91, within the range specified by § 23.181 is achieved.

From the above, Cessna must assert that, arbitrarily drawn certification standards notwithstanding, the actual operational safety of Model 525 is not degraded by the requested exemption. Grant of the exemption has the effect of enhancing safety by preventing traffic conflicts with slower aircraft if mandatory descents, as in the existing limitations, are removed as a requirement.

Public interest elements of the requested exemption lie parallel to safety elements since the aviation community would be relieved of the potential safety degradation of a jet airplane with inoperative yaw damper being compelled to operate, at cruise airspeeds, in the environment populated by slower propeller aircraft.

A more general point of public interest is that the exemption would address a void that has now been confirmed by type certification of Model 525 in a configuration and at altitudes not contemplated in the arbitrary selection of damping criteria for Amendment 23-21."

Cessna's entire petition was not included in this document since not all of the petition pertained to the safety issues considered. Also, for clarification, part 23 covers turbojets up to 12,500 pounds and commuter airplanes up to 19,000 pounds.

Comments to published petition summary:

A summary of this petition was published in the FEDERAL REGISTER for public comment on July 8, 1993. The comment period closed July 28, 1993. There were no comments.

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

To obtain an 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.

Dutch roll is a combined rolling, yawing and side-slipping motion. This particular motion concerns the FAA in the interest of safety because it has a direct impact on pilot workload, especially during flight in instrument conditions. Part 23 requirements deal with the dutch roll mode simply by addressing the damping ratio. But the problem is more complex. The roll-to-yaw ratio is an important characteristic of the oscillation and in conjunction with the frequency and damping ratio, determines whether or not the Dutch roll characteristic is acceptable. There are combinations that are easily controllable by the pilot as well as combinations that may diverge with and without the pilot in the loop. The frequency may be such that it is easy for the pilot's inputs to get "out-of-phase" with the oscillations resulting in divergence. An early jet

transport exhibited this characteristic and in one case the pilot-aggravated oscillations were large enough that one of the engines was torn from the wing. The FAA understands these issues and relies heavily on the ability of our test pilots to determine if a condition is acceptable. In the case of the Cessna 525, FAA test pilots found the airplane to have easily controllable flight characteristics with the yaw damper off, primarily because the Model 525 Dutch roll characteristics are mainly in yaw and exhibit very little roll coupling. No unsafe condition exists with the characteristics exhibited by the airplane.

The part 23 requirement for dutch roll oscillations to be damped to 1/10 amplitude in 7 cycles is, in part, a result of few small airplanes having yaw damper systems. In contrast, nearly all current transport category airplanes are type certificated with yaw dampers since the ride quality must be tailored to maximize passenger comfort and safety. In addition to the yaw damper requirement differences between part 23 and part 25, the standards for part 25 do not address single pilot operations. Part 25 airplanes are typically flown by a crew of specifically trained pilots. This is the reason that the part 23 requirements are and should be more stringent for airplane handling characteristics.

The FAA has determined that the FAR 23 rule is satisfactory for part 23 airplanes designed for operation without a yaw damper. But, damping to less than 1/10th amplitude in 7 cycles may be acceptable for part 23 airplanes designed for operation with a yaw damper if, following a failure of the yaw damper, the unsatisfactory damping is confined to an avoidable flight regime or configuration, and the aircraft is controllable to return to a satisfactory operational condition for continued safe flight, or controllability can be easily maintained after the failure. The FAR 25 requirements specify only that the characteristics be positively damped, which is not enough for turbojet part 23 airplanes. "Positively damped" does not adequately define the characteristics that a part 23 airplane needs to exhibit. The damping ratio required should be related to the frequency and amplitude characteristics of the oscillation, the pilot tasks. The characteristics of the airplane need to be determined to be satisfactory throughout the approved operating envelope (including IFR and turbulence) following failures which affect the damping of the Dutch roll mode.

The FAA has reviewed the information contained in the petitioner's request for exemption. We have determined that the current standards are appropriate minimum standards for typical part 23, single pilot airplanes; however, for part 23 airplanes that are type certified with a yaw damper, a smaller damping ratio would be acceptable if an evaluation finds the flight characteristics after a yaw damper failure to be satisfactory. The facts supporting Cessna's petition for the Model 525 are as follows:

1. It operates at 41,000 feet, requires a type rated pilot, and is operated as an airplane type certified with a yaw damper.
2. FAA flight test pilots found that no unsafe condition exists with the characteristics exhibited by this airplane after a yaw damper failure.
3. The predecessors to the Model 525, the Cessna Citation 500 series airplanes were certificated to part 25 standards and operate without a requirement for an operational yaw damper.
4. The Cessna Citation 500 series airplanes were awarded the Collier Trophy in 1985 for an outstanding safety record of a worldwide fleet of almost 1400 aircraft, which reflects a positive service history.
5. And finally, the autopilot must be operational to fly the Model 525 with a single pilot. The autopilot will not operate with a failed yaw damper.

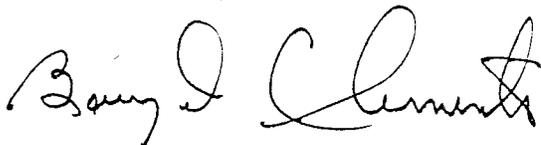
In consideration of the foregoing, I find that a grant of exemption is in the public interest and will not adversely affect safety. Therefore, pursuant to the authority contained in Sections 313(a) and 601(c) of the Federal Aviation Act of 1958, as amended, delegated to me by the Administrator (14 CFR 11.53), Cessna is hereby granted an exemption from § 23.181(b) of the FAR to allow amendment of the Model 525 type certificate to the extent necessary to permit the type certification of its CitationJet Model 525 airplane without having to descend below 18,000 feet in the event of a yaw damper failure. For the Model 525, this exemption is subject to the following conditions and limitations:

1. For operation above 18,000 feet, any combined lateral-directional oscillations ("Dutch roll") occurring between the stalling speed and the maximum allowable speed appropriate to the configuration of the airplane

must be damped to 1/10 amplitude in 13 cycles with the primary controls free, and in a fixed position. The current standards still apply below 18,000 feet.

2. A pilot evaluation must be made to verify that no unsafe condition exists within the airplane's handling characteristics with the yaw damper disabled at the limiting speed and altitude combinations reasonably expected during normal operations. The evaluation should be conducted by at least two Aircraft Certification Office (ACO) test pilots and at least one Aircraft Evaluation Group (AEG) pilot.

Issued in Kansas City, Missouri on October 1, 1993.



Barry D. Clements  
Manager, Small Airplane Directorate  
Aircraft Certification Service