Exemption No. 4812

UNITED STATES OF AMERICA
DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
SEATTLE, WASHINGTON 98168

In the matter of the petition of

BRITISH AEROSPACE

for an exemption from § 25.571(e)(2) of the Federal Aviation Regulations

Regulatory Docket No. 013NM

GRANT OF EXEMPTION

By letter dated January 3, 1985, R.W. Asplin, Chief Airworthiness Engineer, British Aerospace P.L.C., Aircraft Group, Chester Road, Woodford, Bramhall, Stockport, Cheshire SK7 1QR, England, petitioned for an exemption from § 25.571(e)(2) of the Federal Aviation Regulations (FAR) to permit type certification of the Model 748 ATP without showing that the airplane is capable of successfully completing a flight during which likely structural damage occurs as a result of propeller blade impact.

Prior to the petition, British Aerospace applied on March 26, 1982, for U.S. type certification of the Model 748 ATP by amendment of their Type Certificate No. A24EU. Under the provisions of § 21.101 of the FAR, compliance with § 25.571(e)(2) would not have been required; and British Aerospace was advised that the requested exemption was unnecessary. Their petition was therefore held in abeyance pending advice of their decision to withdraw it.

British Aerospace subsequently determined that a new certificate would be more desirable than amendment of Type Certificate No. A24EU. Their application was changed on September 16, 1986, accordingly. Concurrent with this change, British Aerospace changed the model designation from "748 ATP" to "BAe ATP." In light of their decision to apply for a new type certificate, compliance with § 25.571(e)(2) would be required; and British Aerospace reaffirmed their petition accordingly.

The Model BAe ATP is a derivative of the British Aerospace Model HS 748 Series 2B that is currently type certificated under U.S. Type Certificate No. A24EU. Like the HS 748 Series 2B airplanes, the BAe ATP airplanes are pressurized, low-wing, transport airplanes powered by two turbopropeller engines. The differences between the Model BAe ATP and its predecessor include new-model engines and propellers, a new swept vertical fin, increased maximum weights, and an increase in fuselage length to accommodate 72 passengers. The propellers each incorporate six blades with metal spars and composite outer shell construction.

British Aerospace has applied for type certification of the Model BAe ATP by the Federal Aviation Administration (FAA) under the provisions of § 21.29 and an existing bilateral agreement with the government of the United Kingdom. The U.S. certification basis for the Model BAe ATP consists of Part 25, as amended by Amendments 25-1 through 25-54; Part 36, as amended by Amendments 36-1 through 36-12; Special Federal Aviation Regulation No. 27; and any necessary special conditions.

Section of the FAR affected:

Section 25.571(e)(2), which was introduced by Amendment 25-45, effective December 1, 1978, specifies that the airplane must be capable of successfully completing a flight during which likely structural damage occurs as a result of propeller blade impact (or as a result of uncontained fan blade impact for a turbofan powered airplane). Section 25.571(e)(2) assumes that a propeller blade will fail and therefore allows no relief based on improbability of blade failure. Similarly, it allows no relief based on the possibility that the blade will not impact the structure. The wording of § 25.571(e)(2), together with the preamble of Amendment 25-45, clearly indicates that the rule is concerned only with structural damage due to impact of the failed propeller blade. By omission, other hazards, such as damage to vital systems or structural damage due to severe powerplant imbalance, are not addressed by § 25.571(e)(2).

Due to the recent date of Amendment 25-45, compliance with § 25.571(e)(2) has not been required for any turbopropeller airplane to date. Saab-Scania AB, Empresa Brasileira de Aeronautica SA (Embraer), de Havilland of Canada, and Construcciones Aeronauticas, SA (CASA) have, however, been granted Exemptions Nos. 3469, 3722, NM-102, and NM-103, respectively, from the same provisions of § 25.571(e)(2) for their models SF-340, EMB-120, DHC-8, and CN-235. Like each of the four earlier petitioners, British Aerospace has proposed to comply with the following in lieu of § 25.571(e)(2):

> All practicable precautions must be taken in the design of the airplane, taking into account the design features of the propeller and its control system, to reduce the hazard which might arise from failure of a propeller hub or blade.

The petitioner's supportive information is as follows:

In support of the request, the petitioner contends that it is practically impossible to comply with the requirements of § 25.571(e)(2) based on trajectory analyses for each possible failure mode, i.e., engine shaft failure, propeller overspeed, and fatigue failure. The propeller blade used on the BAe ATP incorporates as its main structural element an aluminum alloy forged spar and shank. The structural forging is enveloped in a urethane foam cell and a one-piece fiberglass shell which provides excellent protection to the primary structural element in areas normally susceptible to abrasion and nicking. The petitioner further contends that § 25.571(e)(2) makes no allowance for probability of failure and that a higher standard is thereby required for propeller failure than for turbine bursts, even though the statistical probability of propeller failure is one-tenth that of turbine failure.

The petitioner asserts that the requested exemption is in the U.S. public interest, since by compliance with the requirements as stated above, the BAe ATP would offer a considerably improved level of safety compared with that of the majority of large turbopropeller airplanes currently operated in the U.S.

Finally, the petitioner asserts that the requested exemption is in the U.S. public interest due to job creation and export revenue. In this regard, it should be noted that a significant portion of the airplane systems, equipment, and materials will be supplied by U.S. manufacturers. The petitioner estimates the potential value of such export products to be in the region of $100 million based on a conservative estimate of 50 airplane sales in the U.S.

A summary of the petition was published in the Federal Register on December 29, 1986 (51 FR 248), and interested persons were afforded the opportunity to participate in the rulemaking process by providing comments on the petition. No comments were received.

The FAA's analysis/summary is as follows:

In consideration of the earlier Saab-Scania petition, the FAA reviewed the available data concerning 69 propeller and propeller blade release incidents and accidents that were known at that time to have occurred with civil transport type airplanes worldwide over the preceding 35 years. Although the details of some were somewhat limited, the data supported the petitioner's contention that it would be practically impossible to comply literally with § 25.571(e)(2). In this regard, the forward fuselage of a twin-engine turbopropeller airplane was completely severed due to impact of the released propeller blade in an accident in 1967. These data also support the petitioner's contention that structural failure due to blade impact is only a limited part of the problem. Of the 69 propeller or propeller blade releases, only two--a 1959 DC-3 wing failure and the 1967 accident noted above--involved structural failure due to blade impact as addressed by § 25.571(e)(2). At least 30 of the 69 incidents and accidents resulted in no further significant damage to the airplane. Of those that did result in further damage, the more predominant failure modes were

structural failure due to extreme propeller unbalance and the loss of vital control systems due to blade penetration, neither of which is addressed by § 25.571(e)(2), although such control failures are now considered under §§ 25.671 and 25.1309.

It was noted that the majority (53) of the 69 propeller or propeller blade releases involved airplanes with reciprocating engines. This appeared to be due primarily to the torsional vibratory stresses experienced by propellers used with reciprocating engines. Secondarily, the propellers used with most reciprocating powered transport airplanes were designed and manufactured more than 3 decades ago, whereas the propellers and associated control systems used with turbopropeller airplanes utilize much later design and fabrication technology. In this regard, there was no accident and/or fatality caused by a propeller or propeller blade failure on a civil turbopropeller transport in the preceding decade. The only fatal transport accident caused by a propeller failure during that period involved a reciprocating powered airplane with mid-1940's vintage propellers. This accident did not involve structural damage due to blade impact as addressed in § 25.571(e)(2).

In view of these incidents and accidents, the FAA concluded that it would, as asserted, be virtually impossible to assure literal compliance with § 25.571(e)(2) with any economically viable, propeller-driven airplane, and that structural damage due to propeller blade impact is a failure mode that presents relatively low risk, as this was the failure mode in only two accidents in 37 years. It was also noted that the risk of propeller blade failure has, in itself, been considerably reduced in the past decade. Accordingly, after carefully considering these factors, the FAA determined that requiring literal compliance of the Saab-Scania Model 340 with § 25.571(e)(2) would impose an extreme burden without providing a commensurate improvement in safety. On the other hand, compliance with the alternative proposed by the petitioner would assure that all practical measures to preclude structural failure due to blade impact would be taken.

It was also noted that engine rotor failure presents a hazard to the airplane that is similar to that of the impact of a failed propeller blade. Compliance with the proposed alternative was considered to be consistent with the philosophy of § 25.903(d)(1), which specifies that "Design precautions must be taken to minimize the hazards of the airplane in the event of an engine-rotor failure...."

In consideration of the above review and analysis, the requested exemption was granted to Saab-Scania. Embraer subsequently petitioned for and was granted a similar exemption based on this same review and analysis.

Since the time the above review and analysis were completed, the FAA obtained data concerning 40 additional propeller and propeller blade release incidents and accidents that occurred with civil transport type airplanes. These additional data support the conclusions reached as a result of the earlier review and analysis. The majority occurred during the early post-World War II period and involved reciprocating powered airplanes. There was one fatality in 1981 involving a propeller failure on

a Russian-built turbopropeller transport airplane; however, structural failure due to blade impact is not believed to have been the failure mode. Subsequent to receipt of the additional data, Transport Canada, acting on behalf of de Havilland of Canada, and CASA petitioned for similar exemptions. In consideration of these additional data, as well as those considered for the earlier Saab-Scania and Embraer petitions, the requested exemptions were granted to de Havilland of Canada and CASA.

The conclusions concerning propeller and propeller blade release that were reached in consideration of the Saab-Scania, Embraer, de Havilland of Canada, and CASA petitions are considered equally applicable to the British Aerospace petition. In this regard, it is noted that the SF-340, EMB-120, DHC-8, CN-235, and BAe ATP are similar in size, configuration (albeit two are high-wing and three are low-wing airplanes), and basic construction. In addition, each of the five models is competing in the same U.S. market.

In consideration of the foregoing, I find a grant of exemption would not adversely affect safety and is in the public interest. Therefore, pursuant to the authority contained in Sections 313(a) and 601(c) of the Federal Aviation Act of 1958, delegated to me by the Administrator (14 CFR 11.53), British Aerospace is hereby granted an exemption from § 25.571(e)(2) of the Federal Aviation Regulations to the extent required to permit type certification of the Model BAe ATP without showing that the airplane is capable of successfully completing flight during which likely structural damage occurs as a result of propeller blade impact, provided the petitioner shows compliance with the following in lieu thereof:

All practicable precautions must be taken in the design of the airplane, taking into account the design features of the propeller and its control system, to reduce the hazard which might arise from failure of a propeller hub or blade.

Issued in Seattle, Washington, on June 11, 1987.

Robert E. Waiblinger, Acting Director
Northwest Mountain Region