Exemption No. 6867

UNITED STATES OF AMERICA
DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
RENTON, WASHINGTON 98055-4056

In the matter of the petition of

Boeing Commercial Airplane Group

for an exemption from § 25.961(a)(5) of Title 14, Code of Federal Regulations

Regulatory Docket No. 29202

GRANT OF EXEMPTION

By letter dated April 7, 1998, Mr. Norman I. Lee, Manager, Certification, Certification Programs, Boeing Commercial Airplane Group, P.O. Box 3707, Seattle WA 98124-2207, petitioned on behalf of Boeing Commercial Airplane Group for an exemption from the requirements of § 25.961(a)(5) of Title 14, Code of Federal Regulations, to allow a temperature limitation of 85 °F. for JP-4 and Jet B Type fuels on the Boeing Model 757-300/RB211-535 series airplane.

The petitioner requests relief from the following regulations:

> Section § 25.961(a) requires that the fuel system perform satisfactorily in hot weather operation. "This must be shown by showing that the fuel system from the tank outlets to each engine is pressurized, under all intended operations, so as to prevent vapor formation, or must be shown by climbing from the altitude of the airport elected by the applicant to the maximum altitude established as an operating limitation under § 25.1527. If a climb test is elected, there may be no evidence of vapor lock or other malfunctioning during the climb test conducted under the following conditions . . ." Paragraph (5) of this section requires that "the fuel temperature must be at least 110 °F." The petitioner has requested an exemption from this section to allow 85 °F. maximum fuel temperature limitation for JP-4 and Jet B fuels on the Boeing Model 757-300/RB211-535.

ANM-98-021-E

Related Sections of the Federal Aviation Regulations (FAR):

Section 25.1351(d), Operation without normal electrical power.

The petitioner's supportive information is as follows:

"DISCUSSION:

"Introduction:

"An exemption from FAR 25.961(a)(5), Amendment 85, is requested for JP-4 and Jet B fuels on the following basis:

"(1) Existing 757-200/RB211-535 certification data demonstrates satisfactory JP-4 performance with an 85 °F fuel temperature limitation.

"(2) Similarity between the 757-300/RB211-535 and 757-200/RB211-535 airplane and engine fuel systems demonstrates that the existing 85 °F fuel temperature limit is applicable to the 757-300.

"(3) The significant operational and economic implications of not having JP-4* fuel capability demonstrate that this exemption is in the public interest.

"(4) The proposed temperature and additional limitations for JP-4* fuel usage demonstrate a level of safety equal to the requirements of FAR 25.961(a)(5).

"* It should be noted that JP-4 is a military designation for a Jet B type commercial grade fuel with additives. In the discussions presented, the limitations associated with JP-4 fuels are intended to apply to Jet B type commercial grade fuels as well.

"757-200/RB211-535 Fuel System Certification Data:

"Fuel system performance has been satisfactorily demonstrated on the 757-200/RB211-535 with JP-4 fuel. Certification test results are documented in the reference (a) through (d) 757-200 Flight Test Reports. A maximum fuel temperature limitation of 85 °F for JP-4 and Jet-B fuels was established based on 757-200/RB211-535C suction feed flight test results. During the 757-200/RB211-535C testing, engine flameout at service ceiling could not be achieved with heated JP-4 fuel and, consequently, engine restart capability following a flameout could not be demonstrated. As a result, a maximum fuel temperature limitation was imposed based on the temperature of the fuel during testing at service ceiling. This limitation is incorporated in the 757 Airplane Flight Manual (AFM) (Reference e). JP-4 fuel was re-certified on the 757-200 when the RB211-535E4 and E4B engine installations were introduced. During the 757-200/RB211-535E4 testing, a suction feed climb was performed with 86 °F JP-4 fuel at takeoff. Thrust deterioration was observed at 32,000 ft and boost pumps were turned on at 35,000 ft. The climb was continued to service ceiling where the test engine boost pumps were shut off to simulate

an all AC power loss. The test engine subsequently flamed out and a windmill relight was successfully conducted on suction feed with the ignitors operating off battery power during descent at 10,300 ft. This test demonstrated compliance with the requirements of FAR 25.1351(d) for operations without normal electrical power. Based on these test results, the 85 °F maximum fuel temperature limitation for JP-4 and Jet-B fuels was maintained for the RB211-535E4 and E4B engine installations.

"757-300/RB211-535 Fuel System Design Similarity:

"Differences between the 757-300 and 757-200 airplane configurations will not affect hot weather fuel system operations. Changes to the fuel system are outlined in the reference (f) 757-300 Fuels System Certification Plan. They include longer wiring between the Fuel Quantity Indicating System processor and in-tank capacitance probes, a slightly increased allowable fuel volume for all three fuel tanks, and a longer fuel feed hose to the Auxiliary Power Unit. None of these 757-300 fuel system changes will affect the airplane's ability to operate with JP-4 fuels. Likewise, none of the on-going 757-200 modifications that will be incorporated into the 757-300 will affect JP-4 performance. These changes are described in the reference (g) 757-200 Letter of Definition. Of particular note is a modification to relocate the forward main tank fuel pump from the forward to the aft wing spar. An analysis of the system indicates that relocating the fuel pump increases the inlet pressure to the pump during climb. This increase, though minor, actually improves fuel feed performance.

"Engine installation differences between the 757-300 and 757-200 also will not affect fuel system operations. The 757-300 will be certified for operations with the RB211-535E4 and E4B engine configurations. These are the same engines certified for use on the 757-200. None of the engine installation differences (i.e. changes to the nacelle or strut) between the 757-200 and 757-300 involve airplane or engine fuel systems. The 757-300 changes are described in the reference (h) 757-300 Propulsion Systems Certification Plan.

"The 757-300/RB211-535 will be certified for operations with two different engine combustor configurations: the Phase II and Phase V combustors. The Phase II combustor is the current RB211-535 configuration. The Phase V combustor is a Low Emission Combustor being certified initially on the 757-200/RB211-535. A description of the RB211-535 Low Emission Combustor and its certification plan is provided in the reference (i) Boeing letter. The Phase V combustor incorporates modifications to the engine fuel manifold and fuel nozzles that are based on the combustor design currently used on the Trent 700 and 800 engines. These modifications will not affect engine fuel feed performance since they are downstream of the engine fuel pumps, and the engine fuel pumps have not been modified. In addition, the fuel pressure exiting the high pressure engine fuel pump is high enough to alleviate any fuel vaporization concerns due to differences in the fuel manifold.

"The following discussion addresses the requirements of FAR 11.25 as stated below:

'11.25 Petitions for rule making or exemptions.
'(5) Contain any information, views, or arguments available to the petitioner to support the action sought, the reasons why the granting of the request would be in the public interest and, if appropriate, in the case of an exemption, the reason why the exemption would not adversely affect safety or the action to be taken by the petitioner to provide a level of safety equal to that provided by the rule from which the exemption is sought.'

"Public Interest:

"Boeing believes it is in the public interest for airlines to have the continued ability to operate their airplanes with JP-4 and Jet B fuels. Although the availability of these fuels is decreasing, they are still used in certain parts of the world and are sometimes the only fuel available at military airfields designated as alternate destinations. The operational and economical impact of not being able to rely on these airfields as alternates is significant, particularly to non-scheduled airlines (e.g., Airline A). The following information was provided to Boeing by 757-300 and 757-200 customers.

"From Airline A:

'The usage of JP-4 fuel is very rare, but in a few occasions it was necessary a couple of times due to diversions to military airfields. Restricting the use of JP-4 fuel would heavily impact the operation of Airline A as several enroute alternates or destination alternates could no longer be chosen for flight planning. This is especially true for the areas of Alaska, Canada, Caribbean, Iran/Persia and Turkey.'

"From Airline B (in response to a query sent by Boeing Customer Services):

'Q1. Do you use JP-4 or Jet B fuel in your 757 airplanes?

'Al. Yes.

'Q2. If so, how often (on a daily, weekly, monthly, or annual basis) and under what conditions (diversion, scheduled route, charter route, etc.) is the JP-4 or Jet B fuel used?

'A2. Normally only on an annual basis (perhaps only once per year for the entire fleet). This would occur either on a charter or diversion only.

'Q3. What are the cost implications of not having JP-4 or Jet B fuel capability for your 757 fleet operations? Please try to quantify your response in terms of US Dollars per year.

'A3. This is a very difficult figure to estimate, as Airline B's 'emergency only' use would normally come about due to a diversion on a scheduled operation due to a medical emergency or a charter to a station where Jet A/A-1 is not available which could be an

aid relief mission. A delayed return waiting road delivery of approved fuel (of at least 24 hours) would mean a financial loss of up to one million US Dollars per occasion. If it were known that only JP-4/Jet B would be available, then Airline B would be unable to operate a charter if refueling would be required, if the aircraft was not certificated accordingly.

'Q4. Would inability to use JP-4 or Jet B fuel cause you to change any of your planned airplane revenue routes?

'A4. If the aircraft were not certificated to use JP-4/Jet B then each sector would need to be re-evaluated with respect to approved diversionary airfields and reserve fuel carried, so it is quite possible that there would be many routes which would cost more to operate and others where a decision would be made not to operate because of the capability of the aircraft.

'Q5. Please provide any other pertinent information which would help us describe to the FAA/JAA possible operator hardships (adverse economic impact) resulting from the inability to use JP-4 or Jet B fuel for your 757 fleet.

'A5. The aircraft would possess the inability to operate into northern Canada or divert in the event of a medical emergency in order to render immediate hospitalization for the patient. There will be a restriction on the potential use of any aircraft without certification to use widecut fuel in an emergency situation, particularly in the event of a world jet fuel shortage. . . Non certification of widecut fuels in a new aircraft type . . . may result in severe operational disadvantages to that aircraft after entering airline service. It is essential that aircraft have the ability to use JP-4/Jet B fuels, even if this use has operational restrictions for maximum temperature and altitude on its use, to enable the aircraft to be operated in emergency or abnormal circumstances.'

"From Boeing's perspective, the economic impact of full compliance with FAR 25.961(a)(5) as written would be debilitating. Because of the physical properties of JP-4 and Jet B fuels, the current 757-200/RB2ll-535 and 757-300/RB211-535 configurations cannot demonstrate the capability of operating on suction feed with 110 °F JP-4 fuel to maximum altitude. A major redesign to the airplane fuel feed system, fuel tanks and possibly the airplane electrical system (to place the fuel pumps on battery power) would likely be required to develop this capability. Each of these changes would involve a costly redesign and certification effort of the 757 fuel feed system, which has had proven service experience with JP-4 usage allowed for the past 15 years.

"Equal Safety:

"Boeing believes that incorporating a maximum fuel temperature limitation for JP-4 and Jet B fuels provides a level of safety equal to the provisions of FAR 25.961(a)(5). We believe the intent of FAR 25.961(a)(5) is to insure that an airplane will be capable of operating in most parts of the world without being limited by fuel temperature. Limiting

operations with a maximum fuel temperature will not affect public safety since the airplane has demonstrated the ability to operate in the proposed temperature range. The temperature limitation will only affect operators by preventing them from taking off under certain hot weather conditions (i.e. when the fuel tank temperature is greater than 85 °F). To maintain an equal level of safety however, Boeing proposes to incorporate additional limitations for JP-4 and Jet B fuel usage. The following limitations package is being proposed for the 757-300 Airplane Flight Manual:

"Operational Limits:

"(1) The maximum allowable fuel temperature for JP-4 or Jet B fuel is 85 °F.

"(2) When operating with JP-4 or Jet B fuels, the maximum allowable altitude for the first two hours of cruise operation shall be limited to:

"Dispatch Fuel Temperature (°F)	Altitude Limit (Feet)
65 to 85	32,000
45 to 65	36,000
25 to 45	39,000
15 to 25	41,000
15 or Lower	42,000

"(3) The fuel tanks must be defueled to sump level (i.e. the level at which fuel pump low pressure lights illuminate) following operations with JP-4 or Jet B fuel. If the fuel tanks are not defueled, the JP-4 fuel usage limitations shall continue to apply.

"The intent of these restrictions is to insure an equal level of safety when using these fuels. An airplane's ability to operate with JP-4 and Jet B fuel is a function of the vapor pressure of the fuel. The vapor pressures of wide cut fuels, like JP-4 and Jet B, are considerably higher than narrow cut fuels (i.e. Jet A and Jet A-1). Vapor pressure will also increase with temperature. At higher temperatures, the fuel is more likely to vaporize during suction feed operations which can result in an engine flameout. This concern is addressed by limiting JP-4 and Jet B fuel temperatures (and thus vapor pressure) to a level that has been successfully demonstrated in flight testing.

"In addition to fuel temperature, altitude is a concern with higher fuel vapor pressures. At higher altitudes, ambient pressures are lower which increases the chance of fuel vaporization during suction feed operations. Limiting the maximum altitude based on JP-4 fuel temperature at dispatch insures that the airplane will operate below any potential engine flame out altitude. An altitude limitation is only required for the first 2 hours of flight at cruise because the fuel temperature cools sufficiently below the temperature at takeoff during the first 120 minutes. An analysis of the predicted fuel tank temperatures for the 757-200 was provided in the reference (j) 757-200 Fuel System Analysis document. The same analysis is applicable to the 757-300. For reference purposes, the main and center fuel tank temperature predictions are also provided on

Attachments 1 and 2. Boeing believes the combination of a temperature and altitude limitation for JP-4 and Jet B fuel usage on the 757-300/RB211-535 is very conservative, but together the limitations maintain a level of safety equivalent to the intent of FAR 25.961(a)(5).

"It is important to note as well, that there is an inherent margin of safety associated with limiting JP-4 fuel usage based on the suction fuel feed capability of the engines. Under normal conditions, the airplane fuel boost pumps will be functioning. There are two AC powered boost pumps in each of the main fuel tanks, and two AC powered boost pumps in the center wing fuel tank. The center tank boost pumps have sufficient performance to feed the engines with the main tank boost pumps deadheaded. Under pressure feed conditions, the airplane can operate normally with JP-4 fuel at a dispatch temperature of 110 °F up to maximum altitude. This capability was demonstrated by analysis as presented in the reference (j) 757-200 Fuel System Analysis document. The same analysis is applicable to the 757-300. For the airplane to have to rely on suction fuel feed, an all AC power loss would have to occur. Due to numerous redundancies in the airplane electrical system, the probability of an all AC power loss is extremely low."

The following additional information was provided by the petitioner in a letter to the FAA dated September 15, 1998.

"In the reference (a) letter, the FAA also requested Boeing to provide information that addresses the hot center tank fuel concerns raised in reference (b). Data is currently being collected to address the reference (b) FAA concerns [references (a) and (b) are in the Docket]. This information will be provided to the FAA for all Boeing airplane models at a later date. Until a collective response can be provided, Boeing proposes to incorporate an additional AFM operational limitation for the 757-300/RB211-535 that prohibits the use of JP-4 or Jet B fuel in the center tank. This limitation would be incorporated in addition to the operational limitation already proposed in the reference (c) Boeing letter. Following resolution of the issues/concerns raised in the reference (b) FAA letter, Boeing may request to remove this interim limitation."

"An exemption from FAR 25.961(a)(5), Amendment 85, is being requested for JP-4 and Jet B fuels on the basis of existing 757-200/RB211-535 certification data and similarity between the 757-300/RB211-535 and 757-200/RB211-535 airplane and engine fuel systems. While similarity between the 757-300 and 757-200 fuel systems was addressed in reference (c), the FAA has requested additional information regarding fuel system changes that have occurred on the 757-200 since the certification test was conducted in 1984.

"There have been no airplane level fuel system changes incorporated on the 757-200 since 1984 that adversely effect airplane fuel system performance. The only change to the 757-200 airplane fuel systems is a modification to relocate the forward main tank fuel pump from the forward to the aft wing spar. As discussed in reference (c), this modification is also incorporated on the 757-300 airplane, and analysis has shown that

relocating the pump actually improves fuel feed performance by increasing the inlet pressure to the pump during climb.

"There have been no RB211-535E4/E4B engine modifications incorporated since 1984 that have any significant effect on the hot fuel performance of the engine. An extensive review of all the engine fuel system modifications was conducted by Rolls Royce. In addition to engine fuel system modifications, oil system changes were also reviewed to ensure that indirect effects on fuel heating had been considered. Most of the modifications reviewed could be classified as 'Misc. Minor Alterations.' 'Misc. Minor Alterations' are described as a collection of unrelated very minor changes which do not require a change of part number or quantity adjustment and by their definition do not effect interchangeability, safety, performance, reliability, weight, maintainability or customer cost. Those modifications that could not be categorized as 'Misc. Minor Alterations' were reviewed for their effect on either pumping capability or fuel temperature, and were confirmed as having 'no effect on hot fuel performance' by technical assessment."

A summary of the petitioner's request for exemption appeared in the Federal Register on November 30, 1998 (63 FR 29202). No comments were received.

The FAA's analysis/summary is as follows:

The regulation regarding fuel system performance with hot fuel is intended to assure an uninterrupted fuel supply is provided to the engines. Section 25.961(a)(5) specifically requires that this capability be demonstrated with fuel at a temperature of at least 110 °F. The Boeing Model 757-200 was shown by testing of components and fuel system analysis to directly comply with § 25.961(a)(5). As discussed by the applicant, the 85 °F. fuel temperature limitation imposed on the Boeing Model 757-200 during original certification resulted from certification testing intended to show compliance with § 25.1351. This testing showed that engine power interruption could not be induced with the airplane at the service ceiling altitude with JP-4 fuel at 85 °F. Therefore, demonstration of the capability to relight the engines following an all AC power loss could not be demonstrated.

Since the original finding of compliance with § 25.961(a)(5) on the Boeing Model 757-200, the FAA has determined that a flight test of the airplane with hot fuel is necessary to show compliance with this section. Analysis and component testing alone are no longer accepted by the FAA as an adequate demonstration of compliance because of unexpected fuel flow interruption to the engines during certification flight testing on an airplane utilizing these methods. However, in this exemption, the applicant has proposed operational limitations on dispatch fuel temperatures and altitude that assure satisfactory fuel system performance will be achieved. These limitations are consistent with flight test performance previously demonstrated by the aircraft and engines.

The petitioner has requested that the Boeing Model 757-300 derivative airplane be granted an exemption to § 25.961(a)(5). The information provided by the petitioner indicates that granting of the exemption to allow use of JP-4 and Jet B fuel would be in the public interest because granting of the exemption will allow use of alternate airports for planning flights where these fuels are the only fuel available. Public safety would not be adversely affected because of the temperature and fuel loading limitations placed on the airplane will limit operation of the airplane to fuel temperatures where satisfactory fuel system performance has been demonstrated.

In consideration of the foregoing, I find that a grant of exemption is in the public interest and will not adversely affect he level of safety provided by the regulations. Therefore, pursuant to the authority contained in 49 U.S.C. §§ 40113 and 44701, delegated to me by the Administrator (14 CFR § 11.53), the petition of the Boeing Commercial Airplane Group for an exemption from the fuel system hot weather operation requirements of § 25.961(a)(5), for the fuel system of the Boeing Model 757-300 airplane, is hereby granted, with the operational limitations incorporated into the Airplane Flight Manual as proposed by the petitioner in the previous discussion.

Issued in Renton, Washington, on February 24, 1999.

/s/ Donald E. Gonder
Donald E. Gonder
Acting Manager
Transport Airplane Directorate
Aircraft Certification Service, ANM-100