U.S. Department
of Transportation

Federal Aviation Administration

Memorandum

Subject: **ACTION**: Equivalent Level of Safety, Raytheon Model 3000, 14CFR, Part 23, Section 23.777(d), Power Control Lever; Finding No. ACE-97-3

Date: DEC 09 1997

From: Manager, Project Support Branch

Reply to Attn. of: Robert Alpiser (816) 426-6934

To: Manager, Standards Office, ACE-110
Manager, Small Airplane Directorate, ACE-100

This memorandum is to document concurrence with an equivalent level of safety to the power control lever requirements of 14 CFR, Part 23, Section 23.777(d).

Background: See attached Issue Paper P-5.

Applicable Regulations: 14 CFR, Part 23, Section 23.777(d).

Applicant's Position: See attached Raytheon letter of September 11, 1997.

FAA's Position: See attached Issue Paper P-5.

Compensating Features: See attached Raytheon letter of September 11, 1997.

Recommendation: We concur with Raytheon's position as stated in their letter of September 11, 1997. The single power control lever provides an equivalent level of safety to the requirements of Section 23.777(d). The certification basis for the Model 3000 will include an equivalent safety finding for Section 23.777(d).

Larry D. Malir

Concurred by:

for John R. Colomy
Manager, Standards Office, ACE-110

12/5/97
Date

for Michael Gallagher
Manager, Small Airplane Directorate, ACE-100

12-8-97
Date

Attachment

ISSUE PAPER

PROJECT: Raytheon Aircraft Company Model 3000 TC0005WI-A

ITEM: P-5
STAGE: 2

REG.REF.: FARs §21.21(b), 21.261, 23.777(d)

DATE: November 19, 1997

NATIONAL POLICY REF.: None

ISSUE STATUS: Closed

SUBJECT: Single Power Control Lever in Place of Separate Throttle, Propeller, and Condition and Fuel Cutoff Levers

BRANCH ACTION: ACE-116W, ACE-117W

COMPLIANCE TARGET: Pre-TC

EQUIVALENT LEVEL OF SAFETY

STATEMENT OF ISSUE:

The Raytheon Aircraft Company Model 3000 is a single engine, turboprop aircraft with an electronic integrated engine/propeller control system which uses input from a single power control lever (PCL) to control power with no separate propeller and condition/fuel cutoff levers. Literal compliance with FAR §23.777(d) requires separate power, propeller, and condition and fuel cutoff levers.

DISCUSSION:

With the Model 3000, the PCL is a single lever which has a mechanical and electrical interface to the electronic engine/propeller control system in order to produce "jet-like" thrust characteristics during rapid power changes and at low power conditions. PCL movement is transmitted to the power management unit (PMU), which in turn controls fuel flow, gas generator speed, and propeller speed. Propeller pitch is not pilot controllable; therefore, a separate propeller control lever is not supplied. During normal operation, propeller pitch is governed at 100% Np. Low airspeed and power combinations result in propeller pitch going to the mechanical low pitch stop (when the propeller is against the mechanical low pitch stop, it performs as a fixed pitch propeller). During large power transitions below 100% Np (i.e., from idle to takeoff power), the PMU will control propeller pitch. Condition (ground or flight idle setting) is not pilot controllable with the condition function performed automatically by the PMU using weight-on-wheels (WOW) input; therefore, a separate condition lever is not provided. The fuel cutoff function has been incorporated into the PCL with engine shut down performed by pulling the PCL to the idle gate

and then raising a locking lever in order to pull the PCL further to activate the fuel cutoff function.

FAA POSITION:

The Model 3000 single PCL performs the equivalent functions of separate power, propeller, and condition and fuel cutoff levers. The PCL governs fuel flow, and therefore, engine power as a traditional individual power lever would. Propeller pitch control is managed and controlled by use of the PMU with no direct pilot input on propeller pitch. Engine condition (ground or flight idle) is managed automatically by the PMU using WOW input. Fuel cutoff is performed by the PCL using the double action, as required by FAR §23.1143(f), of pulling the PCL to the idle stop and then raising a locking lever that will allow the PCL to be placed in the cutoff position.

APPLICANT'S POSITION:

See attached Raytheon Aircraft Company letter 940-97-09-234 dated September 11, 1997.

CONCLUSION:

The FAA has reviewed Raytheon's request for an Equivalent Level of Safety for the Model 3000 submitted in Raytheon Aircraft Company letter 940-97-09-234 dated September 11, 1997 and agrees that the single PCL in place of separate throttle, propeller, and condition and fuel cutoff levers meets the safety intent of FAR §23.777(d). The certification basis for the Model 3000 will include an Equivalent Level of Safety finding for FAR §23.777(d).

This Issue Paper is closed at Stage 2.

CONTACTS:

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DO NOT REMOVE FROM ISSUE PAPERS (ATTACHED)
ISSUE PAPER
COORDINATION GRID

PROJECT: Raytheon Aircraft Company Model 3000		**FAA PROJECT NUMBER**: TC0005WI-A
ISSUE PAPER ITEM: P-5	**ISSUE PAPER DATE**: November 19, 1997	**ISSUE PAPER STAGE**: 2
SUBJECT: Single Power Control Lever in Place of Separate Throttle, Propeller, and Condition and Fuel Cutoff Levers		
PROGRAM MANAGER:	Jim Schueler 316-946-4111	*J Schueler 11/19/97*
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Raytheon Aircraft

Beech
Hawker

Model: 3000

September 11, 1997

In Reply Please
Refer To: 940-97-09-234

DOT Federal Aviation Administration
Mr. James A. Schueler, Program Manager
Wichita Aircraft Certification Office
Room 100, 1801 Airport Road
Mid-Continent Airport
Wichita, Ks. 67209

Reference: Project No. TC0005WI-T

Subject: Equivalent Level of Safety Finding to FAR 23.777(d)

Dear Mr. Schueler:

As provided in FAR 21.261, and in accordance with DOA Procedures Specification BS 23073 Revision E Paragraph 5.6, we are enclosing our staff study regarding a conclusion that an Equivalent Level of Safety exists to FAR 23.777(d) through Amendment 23-47 on the Model 3000.

This staff study is forwarded for your written concurrence and/or comments. When FAA's concurrence and/or comments have been received and incorporated, the finding will be DOA approved by proper completion of Form 90-31429 (including reference to all appropriate data) and deposited into the Record Of Compliance file in accordance with established procedures. In addition, the program Check-Off list will identify this Equivalent Level of Safety Finding as granted and the Type Certificate Data Sheet will identify such in the Certification Basis section.

Very truly yours,

RAYTHEON AIRCRAFT COMPANY

A. C. Jackson, Group Manager
Product Design Assurance
& FAA Liaison

ACJ:dsp

Attachment

STAFF STUDY - SINGLE POWER LEVER
MODEL 3000 (JPATS)
FAA PROJECT NO. TC0005WI-A
ATTACHMENT TO LETTER # 940-97-09-234 DATED 9/4/97

SCOPE

This study is in response to the preflight type certification board meeting and subsequent meetings with the FAA concerning the Model 3000 aircraft. The issue concerned the use of a single power control lever which is used on the Model 3000 in place of the generally accepted throttle, propeller control and condition levers.

The Model 3000 is a single engine, tandem seating turboprop aircraft with an electronic integrated engine/propeller control system which uses input from a single Power Control Lever (PCL) to control power. PCL movement is transmitted to the Power Management Unit (PMU) which in turn controls fuel flow, gas generator speed (N_G,) and propeller speed (N_P) in order to produce "Jet-like" thrust characteristics during rapid power changes and at low power conditions. During all other flight regimes the propeller is acting as either a constant speed propeller operating at 100% N_P or a fix pitch propeller when sufficient power or airspeed is not present to maintain 100% N_P. This staff study will find the single PCL configuration used in the Model 3000 provides an equivalent-level-of-safety to that of FAR §23.777(d) though amendment 23-47.

FAA COMMENTS

The FAA ACO concurs that there are no safety issues involved with using the single power control lever, but has requested additional information related to the operation of the single power lever to verify that FAR §23.777(d) can be satisfied via an equivalent-level-of-safety finding.

BACKGROUND

§23.777 Cockpit controls.

(d) The control location order from left to right must be power (thrust) lever, propeller (rpm control), and mixture control (condition lever and fuel cutoff for turbine powered airplanes). Power (thrust) levers must be at least one inch higher or longer to make them more prominent than propeller (rpm control) or mixture controls. Carburetor heat or alternate air control must be to the left of the throttle or at least eight inches from the mixture control when located other than on a pedestal. Carburetor heat or alternate air control, when located on a pedestal must be aft or below the power (thrust) lever. Supercharger controls must be located below or aft of the propeller controls. Airplanes with tandem seating or single place airplanes may utilize control locations on the left side of the cabin compartment; however, location order from left to right must be power (thrust) lever, propeller (rpm control) and mixture control.

§23.1143 Engine controls.

(f) If a power, thrust, or a fuel control (other than a mixture control) incorporates a fuel shutoff feature, the control must have a means to prevent the inadvertent movement of the control into the off position. The means must -

(1) Have a positive lock or stop at the idle position; and

(2) Require a separate and distinct operation to place the control in the shutoff position.

DISCUSSION

The following discussion describes the operation of the single PCL used in the Model 3000 aircraft as applicable to FAR §23.777(d) which states in part "The control location order from left to right must be power (thrust) lever, propeller (rpm control), and mixture control (condition lever and fuel cutoff for turbine powered airplanes)". The classical interpretation from the FAA is that if a function such as a variable pitch propeller exists, it must have a control lever or it does not meet the regulation. This discussion clarifies the

STAFF STUDY - SINGLE POWER LEVER
MODEL 3000 (JPATS)
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operation of the PCL in the Model 3000 with respect to engine power, fuel flow and propeller speed and demonstrates that the Model 3000 provides an equivalent-level-of-safety to FAR §23.777(d). It should be noted that control location is on the left side of the cockpit and order of the power, propeller, and mixture controls are the only issue.

Below is a list of each control referenced in FAR §23.777(d) and a description of its operation on the Model 3000.

Power Lever

The PCL is a single lever which has a mechanical and electrical interface to the electronic integrated engine/propeller control system. Movement of the PCL controls fuel flow only, which in turn controls power output of the engine. Power lever order of 23.777(d) is complied with.

Propeller Control

The propeller pitch is not pilot controllable on the Model 3000 and therefore does not require a control lever. FAR 23.777(d) does not envision a system not pilot controllable, therefore airworthiness provisions not complied with are compensated for by factors that provide an equivalent level of safety.

During normal operation an electrical signal relays the position of the PCL to the PMU, which then commands the fuel flow. The propeller pitch is governed at 100% N_p once sufficient power and/or airspeed (approximately 140 KIAS) are obtained. Low airspeed and power combinations result in the propeller blade angle falling to a minimum pitch set by a mechanical low pitch stop in the propeller hub. When the propeller is against the low pitch stop it acts as a fixed pitch propeller. During large power changes (i.e. powering up from idle to takeoff) the PMU will modify the propeller pitch to provide smooth power application until the power stabilizes. This transition only occurs when the propeller is below 100% N_p.

During manual operation or with a failed PMU the propeller speed is governed at 100% N_p by a mechanical flyball governor. Insufficient power or airspeed will allow the propeller blade angle to fall to a minimum angle set by the mechanical low pitch stop. The propeller blade angle remains against the low pitch stop until N_p reached 100%, then the flyball governor adjusts the pitch to maintain 100% N_p.

Mixture Control (condition lever and fuel cutoff for turbine powered airplanes)

The Model 3000 is a turbine powered airplane therefore uses condition and fuel cutoff functions.

Condition lever

The condition function is not pilot controllable on the Model 3000 and therefore does not require a control lever. FAR 23.777(d) does not envision a system not pilot controllable, therefore airworthiness provisions not complied with are compensated for by factors that provide an equivalent level of safety.

The condition function is controlled automatically through the PMU via input from the Weight on Wheels (WOW) switch. The aircraft has two WOW switches, one on each main landing gear. When both switches indicate flight for 0.5 seconds, flight mode is activated. When either switch indicates ground operation for 2 seconds, ground mode is activated. If a discrepancy between switches exists for more than 1 minute, a fault is annunciated.

STAFF STUDY - SINGLE POWER LEVER
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Ground idle is 60% N_G and flight idle is 67% N_G minimum. Ground idle power is set to provide low thrust to avoid excessive braking. Flight idle power is set low enough to satisfy aircraft handling criteria, but high enough to ensure that the maximum acceleration time from flight idle to maximum power is met.

Fuel cutoff

The fuel cutoff function has been incorporated into the PCL. To shut down the engine the PCL must be pulled to the idle gate where a locking lever must be raised in order to pull the PCL further aft to activate the fuel cutoff function. This double action provides a positive stop at the idle position and a separate and distinct operation to place the control in the cutoff position as required by FAR §23.1143(f).

The use of a single power control lever in the Model 3000 without a propeller, condition, or fuel cutoff lever provides a simpler system to that specified in the airworthiness regulations and meets the equivalent-level-of-safety requirements for compliance with FAR §23.777(d) becausc:

1. Propeller speed is not a pilot-controlled function, the propeller acts as either a constant speed prop fixed at 100% N_P or as a fixed pitch prop.
2. Condition is not a pilot-controlled function. The pilot commands idle by moving the PCL to the idle gate, then the PMU determines idle power based on the WOW input.
3. The fuel cutoff has been integrated into the PCL and complies with §23.1143(f)

Equivalent methods of controlling the items listed in §23.777(d) have been addressed by the FARs as is evident in §23.1143(f) which acknowledges that the fuel cutoff lever may exist in a configuration other than stated in FAR §23.777(d).

CONCLUSION

The single power lever in the Model 3000 has been analyzed and determined to be airworthy and in compliance with §23.1143 and RAC finds that an equivalent level of safety finding exists to the requirements of §23.777(d).