Case Studies Prepared In Conjunction With A Report To The Government Activities Subcommittee, Committee On Government Operations, House Of Representatives, On Need For Improved Controls For Identifying And Correcting Safety Defects On Light Aircraft B-164497(1)

Federal Aviation Administration
Department of Transportation

BY THE COMPTROLLER GENERAL OF THE UNITED STATES

JUNE 15, 1973

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON D C 20548

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B-164497(1)

The Honorable Jack Brooks, Chairman
Government Activities Subcommittee
Committee on Government Operations
House of Representatives

Dear Mr Chairman

Here are the case studies on light aircraft design weaknesses which you requested that we furnish in conjunction with our report on the need for the Federal Aviation Administration, Department of Transportation, to improve controls for identifying and correcting safety defects in light aircraft. The case studies include the comments we obtained from the aircraft manufacturers and our evaluation thereof As discussed with the Subcommittee, the case studies are not necessary to understand the findings and conclusions in our report which was prepared in answer to your request.

The case studies illustrate that several models of light aircraft had experienced design weaknesses which affected flight safety. Several of the aircraft discussed in the case studies already have been the subject of product liability lawsuits against the manufacturers Disclosure of the material in the case studies could involve additional legal actions against the manufacturers and the Government.

As agreed with your office, we will provide copies of the case studies to these aircraft manufacturers.

Sincerely yours,

Elmer B. Staats

Comptroller General
of the United States

Contents

ABBREVIATIONS

DOA	Delegation Option Authorization
FAA	Federal Aviation Administration
NTSB	National Transportation Safety Board

CASE STUDY 1

REGULATION OF BEECH AIRCRAFT CORPORATION ACTIVITIES

The Beech Aircraft Corporation has headquarters at Wichita, Kansas, and divisions in Boulder, Colorado, and Salina and Liberal, Kansas The consolidated financial statements of Beech and its subsidiaries for the year ended September 30, 1971, showed sales and other revenues of about $146 million

In 1969 and 1970 Beech's production lines included 21 single-engine and twin-engine Beechcraft models, ranging in size from a two-place trainer to a 17-place, twin-turboprop corporate transport In 1970 Beech delivered to dealers and new owners 793 aircraft with a sales value of about $81 million and in 1971 delivered 519 aircraft with a sales value of about $52 million

DELEGATION AUTHORIZATION

In December 1951 Beech was authorized to employ designated manufacturer's certification representatives under Government procedures for aircraft certification, and in May 1953 Beech began to use the new procedures On November 5, 1965, Beech was authorized to operate under FAA's revised DOA procedures

In March 1971 FAA central region officials were considering withdrawing Beech's DOA to flight-test aircraft for certification because they concluded that Beech (1) concealed known certification problems, (2) engaged in prolonged and unresponsive discussions with FAA concerning FAA's stated requirements, (3) was reluctant to disclose certification-relevant material, (4) followed unconventional flight-test techniques, and (5) did not properly evaluate technical references to earlier designs and design updates

The Deputy Director of the Flight Standards Service in FAA's headquarters suggested that the cited conditions be discussed with Beech officials before any withdrawal action was taken In May 1971 the regional office advised Beech of its concern over Beech's performance in the flight-test phases and arranged for a meeting of FAA and Beech officials to discuss the specific problems Beech officials told us that they were never informed that FAA was considering withdrawing its DOA flight-test authority Following this

discussion, in December 1971 the regional office notified Beech that the matters of concern to FAA had been satisfactorily resolved FAA central region officials told us that the relationship between Beech and FAA had significantly improved and that FAA had not further pursued the possible withdrawal of Beech's DOA to carry out certification flight-testing

DOA AUDITS

In accordance with FAA's practice of auditing manufacturers authorized to use DOA procedures, the central region audited Beech in June 1966, April and May 1968, and May 1970 The audits resulted in the following findings of noncompliance with applicable FAA regulations.

Beech audits	Noncompliance findings
1966	41
1968	18
1970	49

The findings related primarily to the need for additional or corrected certification documentation, revisions in DOA procedural directions and a few aircraft design changes. For the most part, findings were resolved by Beech with additional data documenting Beech's compliance position, revisions to flight manuals and DOA procedures manuals and production design changes. The audits of Beech activities also included findings of compliance in a number of areas considered by FAA investigators and included 42 recommended improvements that did not involve noncompliance

DESIGN WEAKNESSES

Certain Beech aircraft had experienced design weaknesses in two areas FAA noted the existence of these design weaknesses, however, extended periods of time passed before Beech and FAA agreed that the deficiencies required design corrections. The corrections involved the need to design (1) a fuel system that would provide a continuous flow during various flight maneuvers and (2) a trim control system that would enable a pilot to maintain a stable attitude without applying extra force for normal flight control Before making the design corrections, Beech notified aircraft owners of flight maneuvers which would be avoided to

maintain continuous fuel flow and FAA issued an airworthiness directive restricting operating range of the trim control system to maintain stable flight attitude

Fuel system

When Beech's single-engine models Bonanza and Debonair and twin-engine models Travel Air and Baron were certified under delegation procedures between 1957 and 1960, applicable Federal regulations provided for manufacturers to establish prescribed fuel minimums on the basis of flight tests conducted for several critical maneuvers specified in the regulations The fuel system originally designed by Beech for these aircraft permitted fuel interruption when fuel was low in tanks and when the aircraft were engaged in certain movements that forced fuel to extremes of the tanks and away from fuel intake ports (See illustration on p 5) Regulations in effect at that time did not provide for flight tests in the specific movements that resulted in fuel interruption on these aircraft Beech said that its tests demonstrated compliance with Government regulations in effect at that time

Beech became aware of the problem in 1961 during early sales of one of the models and issued a service letter to aircraft owners Beech stated that a copy of the service letter was also furnished to FAA Later, in connection with investigations of an accident, FAA and CAB conducted flight tests which disclosed that fast taxi turns on the ground before takeoff and in-flight slip-and-skid maneuvers (maneuvers connected with turning or banking) caused fuel interruption and, in some cases, engine failure for all four models which had the same basic fuel system Also FAA and NTSB identified 16 accidents--involving 15 fatalities, 6 serious injuries, and 8 minor injuries--which occurred between 1965 and 1971 in which fuel interruption was a probable or suspected cause

Between 1958 and 1969 Beech produced approximately 7,800 aircraft with the apparent defect in the fuel system Beginning in 1969, at FAA's direction, Beech placed placards in aircraft in service or under construction that warned against maneuvers that critically affected fuel flow Late in 1969 Beech began incorporating on all new aircraft a

product improvement in the fuel tanks that would prevent fuel interruption during critical flight maneuvers

Beech offered a fuel tank modification kit which owners of inservice aircraft could purchase Installation was not made mandatory by FAA, and Beech officials indicated that less than 8 percent of the aircraft owners installed the device

Regulations governing fuel minimums when the aircraft were type certified provided for flight-testing in slip-and-skid maneuvers but not in taxi maneuvers. In September 1969 FAA modified its regulations to require that the minimum fuel supply be determined under the most adverse fuel-feed conditions for each intended operation and flight maneuver Subsequently, FAA promulgated specific test procedures for use by manufacturers in complying with the regulations governing fuel minimums The sequence of events leading to these corrective measures is set forth below

Early recognition of fuel interruption

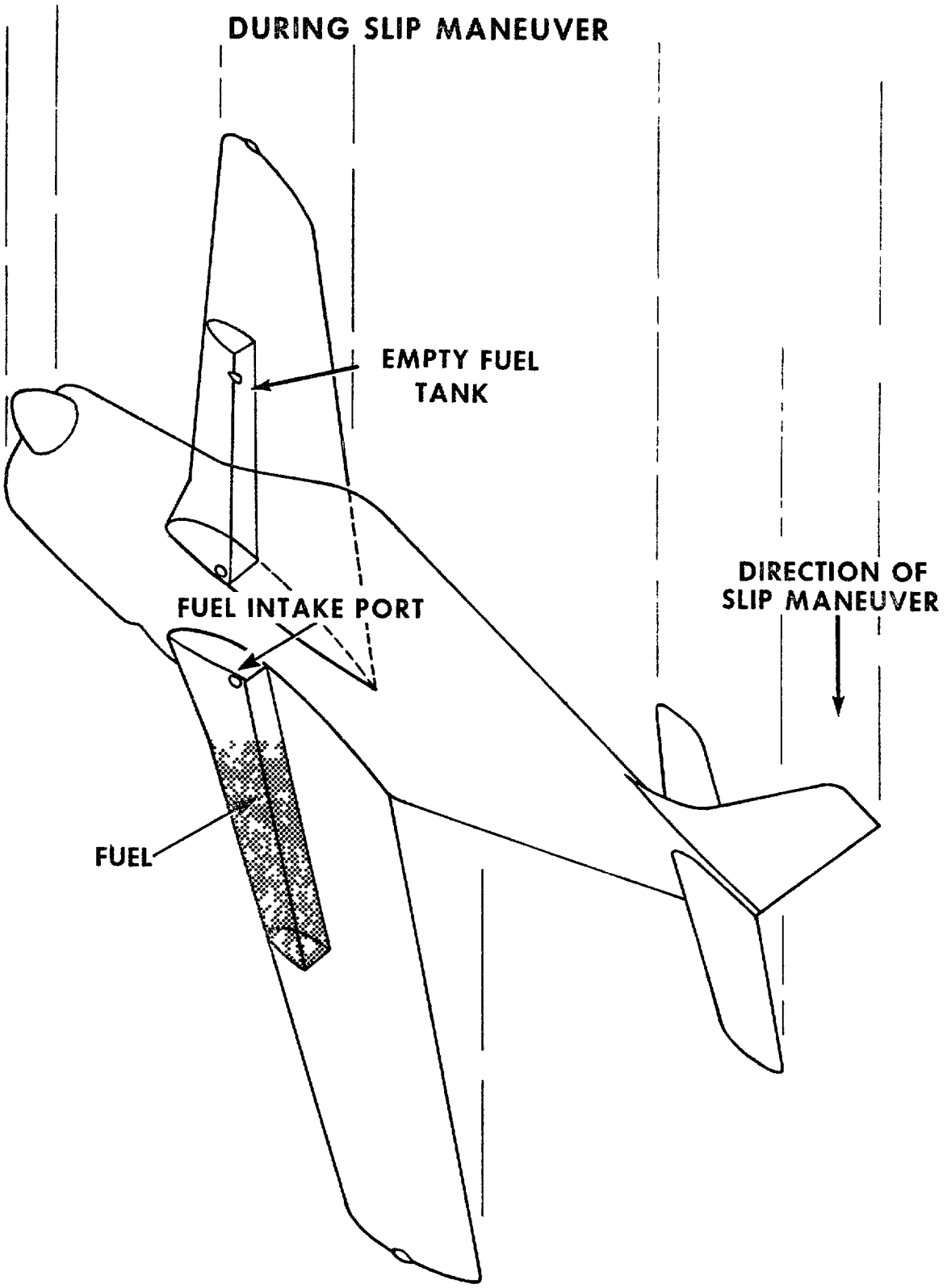
In January 1961 Beech's regional manager for the Pacific States notified the Beech home office in Wichita that a sales representative's flight test of a new Beech Bonanza had disclosed an extremely dangerous condition needing immediate corrective action He stated that

> "When making a rolling takeoff when the tanks register half full, the centrifugal force throws the gas to the outside of the tanks and the engine quits dead after the airplane is airborne * * * [a sales representative] tried this several times and found it to happen each and every time that he experimented with the rolling takeoff "

Shortly thereafter Beech initiated a design program to develop a fuel tank baffle[1] that would retain fuel over tank intake ports during taxi and abrupt flight maneuvers In November 1961 Beech decided to dispense with its design program because efforts to develop an effective modification had been unsuccessful

[1] A device, such as a screen, to prevent uneven movements of fuel

ILLUSTRATION OF FUEL INTERRUPTION DURING SLIP MANEUVER



Beech determined that, in lieu of the baffles, warnings to owners of the Bonanza and Debonair aircraft would be sufficient to rectify the potential safety hazard Beech issued a service letter in December 1961, advising owners of the condition and stating that it did not constitute a hazard but could be disconcerting Beech officials stated that the rate of fuel interruption incidents, compared to the number of aircraft in service, was such that it did not appear necessary to implement design changes

Beech representatives said that the service letter did not cover the Travel Air and Baron aircraft because at that time fuel interruption had not been experienced on these models and that the capability of both the single- and twin-engine aircraft to perform under normal flight operating conditions did not require modification of the fuel system

Receipt of this service letter constituted FAA's first official notice of the fuel interruption condition FAA regional officials indicated that they considered Beech's action to be sufficient at that time, in view of the limited incidents of fuel interruption evidenced in available reports of aircraft malfunctions, defects, and accidents

Subsequent cases of malfunctions

In October 1965 a fatal accident occurred near Salinas, California, in which the pilot of a Baron aircraft lost control of the aircraft after experiencing a power loss FAA and CAB investigators flight-tested the same model aircraft, simulating flight maneuvers and fuel conditions that might have been experienced by the pilot In reporting these tests in February 1966, the investigators stated that they considered it significant that a slight skid in a turn or a slip in straight flight had caused fuel interruption and engine failure

In January 1967 the Chairman of CAB (then responsible for NTSB functions) brought the test results to the attention of the FAA Administrator. He advised the Administrator that the fuel system might not fully comply with the regulations for type certification governing minimum-fuel requirements and recommended that FAA reevaluate the fuel system to determine the necessary corrective actions He

further recommended that FAA advise aircraft owners of the potential for fuel interruption during uncoordinated maneuvers with minimum fuel

FAA's central region asked Beech to investigate compliance with regulations governing fuel minimums, and in February 1967 Beech replied that, in the original flight tests, compliance had been demonstrated Beech stated that it could offer no explanation for differences between its own and FAA's and CAB's test results FAA's Washington headquarters directed the central region to reconsider this matter On July 25, 1967, the central region advised Washington that it had completed a review and had found no areas of noncompliance The central region attributed the different test results obtained by FAA and CAB investigators to their use of procedures differing from those normally followed when compliance was demonstrated At that time, according to the central region, the Baron aircraft did not have a service history of in-flight fuel interruptions

However, on July 31, 1967, the central region told Beech that taxi-turn tests had disclosed that engine failure could be induced with tanks slightly over one-quarter full The central region advised Beech that inserting appropriate information in the normal-procedures section of the flight manual would be sufficient corrective action for inservice airplanes The central region recommended that this condition be corrected in designing future models

In February 1968 the Acting Administrator of FAA advised the Chairman of NTSB that investigations of minimum-fuel requirements had revealed no areas of Beech's noncompliance with applicable regulations and that the regulations had proved to be adequate He stated that, since the October 1965 accident was the only time that fuel interruption was suspected to have caused power failure, FAA was proposing no corrective measures for modifying the aircraft

FAA and Beech continued to evaluate the fuel system problem and to consider possible corrective actions In December 1968 the Chairman of NTSB wrote to the Acting Administrator of FAA in reference to CAB's January 1967 recommendation for a reevaluation of the Beech fuel system Although the Acting Administrator had replied that no corrective action was required, the Chairman stated that experience with Beech fuel systems had caused NTSB to conclude

that the fuel system did have a basic deficiency which, irrespective of general compliance with the regulations, constituted an undue hazard to general aviation

In his letter the Chairman of NTSB outlined five accidents (affecting four Barons and one Debonair) involving suspected fuel interruption, which he said indicated that FAA should require Beech to incorporate a suitable production change, such as tank baffles, in all affected Beech aircraft He stated that this design change should provide a dependable fuel supply from each tank in use throughout the declared usable-fuel range The Chairman also recommended that the cockpits of all inservice aircraft be placarded with appropriate warnings

In conclusion, the Chairman made the following general recommendation

> "* * * general aviation certification criteria be made more stringent, by regulations and/or implementing interpretation thereof, so that basic design deficiencies, such as exemplified in this letter, are not allowed to be perpetuated over many years of otherwise tremendous technical advance in state of the art The case in point here is a fine example where a design fix, making the difference between the fuel system's being marginally or interpretatively airworthy and completely airworthy, is obvious and comparatively inexpensive. The economic argument competitively from one manufacturer to another becomes invalid if appropriate safety design requirements are enforced across the board."

Corrective action

From April 1965 through June 1968, Beech issued additional service instructions or cautionary notes in flight manuals for new and inservice aircraft. In June 1968 Beech began to install warning placards on production aircraft and FAA issued two airworthiness directives, effective December 1968 and February 1970, respectively, which required placarding the inservice aircraft Beech developed a baffled tank which FAA approved in June 1969 for use on new production models of these inservice aircraft

In September 1969 FAA modified its regulations for determining minimum-fuel supply The amended regulations, which are more comprehensive than their predecessors, require that the determination be made under the most adverse fuel-feed conditions for each intended operation and flight maneuver involving each fuel tank Also, FAA made a number of other major changes to general aviation certification regulations which NTSB accepted as meeting its overall recommendation

In May 1972 Beech announced availability of fuel-system modification kits to provide uninterrupted fuel supply to engines during uncoordinated maneuvers FAA tested the kits and approved them as an alternate method of complying with airworthiness directives requiring placards However, FAA did not require installation of the kits on affected inservice aircraft

Labor and materials to modify the 7,800 affected in-service aircraft would cost about $1 8 million on the basis of Beech estimates Beech offered to pay estimated labor charges amounting to about 21 percent of these costs to reimburse aircraft service companies for installing parts sold to aircraft owners during the first 6 months after May 1972 when modification kits were made available Beech officials indicated that, to date, only 625 owners have installed the kits which Beech interprets as an expression of confidence by aircraft owners that their aircraft are safe when handled in a normal manner

Trim system

The Beech 99 is a twin-turboprop engine, 17-seat-capacity aircraft certified by FAA in May 1968 and used by commuter airline operators and by charter and corporate services FAA amended the Beech 99 type certification on July 24, 1969, to include the Beech 100, which has similar design characteristics The model 100 is a twin-turboprop engine, eight-seat-capacity aircraft used for business service As of June 1972 Beech had produced 148 model 99 and 126 model 100 aircraft

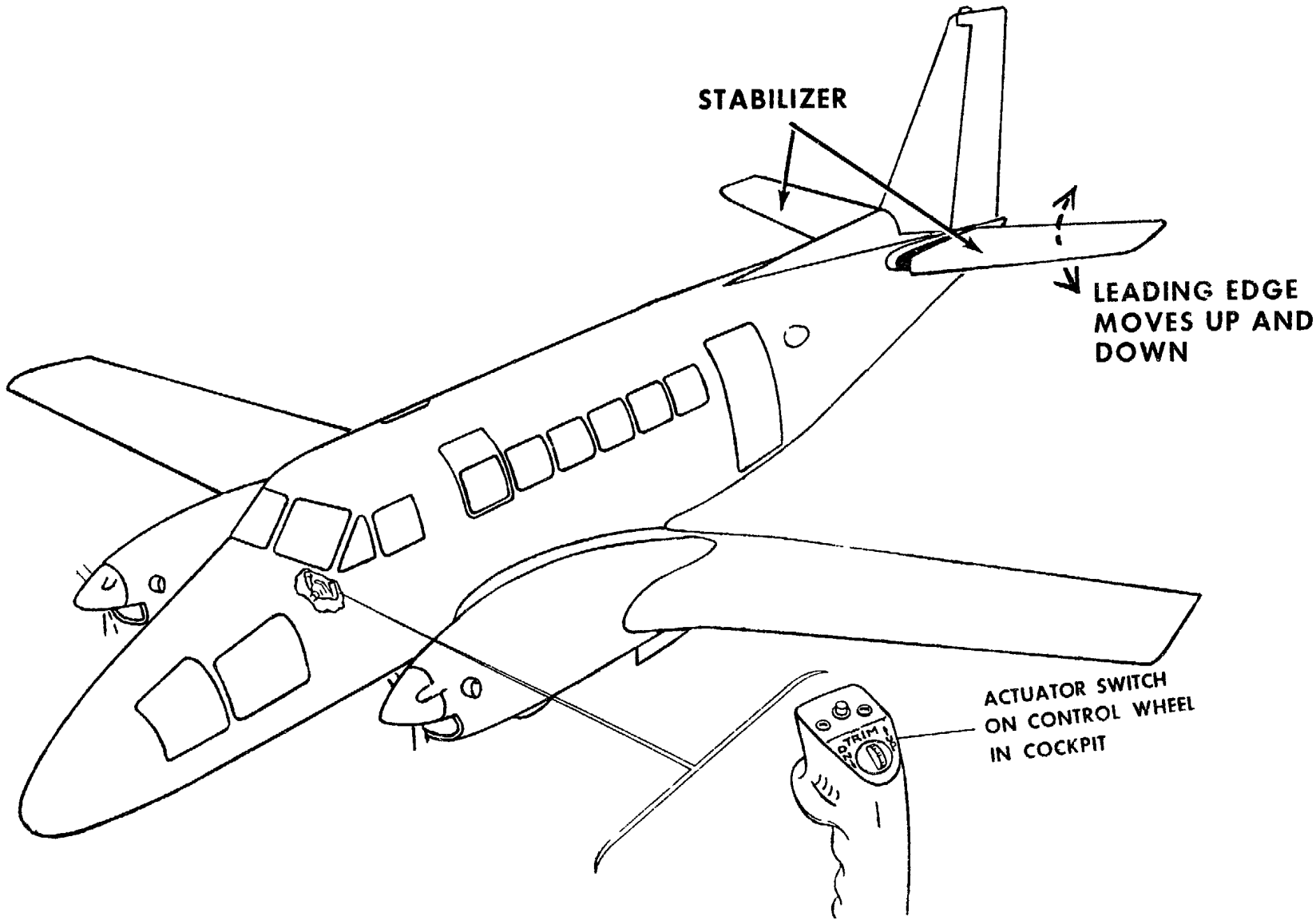
Model 99 experienced hazardous operating difficulties associated with the movable stabilizer, a new design feature incorporated into the aircraft's trim system Between January and March 1969, difficulties in aircraft handling attributable to the trim system were reported to Beech by a commuter airline operator FAA conducted flight tests and reported to Beech in May 1969 that the aircraft's trim system was unsafe During June and July 1969, 2 aircraft accidents occurred involving 16 fatalities and NTSB determined that the trim system was the probable cause of one accident and a possible cause of the other Subsequently, the aircraft were modified to correct the problem NTSB reported that FAA had not participated in flight-testing the stabilizer, even though it was a new design feature, and recommended that in the future FAA participate directly in certifying all new design features

Recognition of trim system problem

An aircraft's trim system, part of its secondary flight controls, produces minor changes in direction and compensates for changes in weight distribution due to use of fuel and certain other factors affecting flight The movable horizontal stabilizer, a part of the trim system, is operated electrically by an actuator switch on the control wheel in the cockpit (See illustration on p 11)

Beech officials indicated that the new trim control system was patterned after similar devices used on commercial transport aircraft During prototype testing of the model 99, Beech recognized the possibility of inadvertent movements of the stabilizer (referred to as runaway) and incorporated in the aircraft a dual trim system to render

ILLUSTRATION OF MOVABLE HORIZONTAL STABILIZER



runaways improbable and to comply with special conditions imposed by FAA to improve the safety of commuter-type aircraft Before certifying the model 99, FAA imposed a special certification condition which Beech adopted requiring that

> "The airplane must be safely controllable and the pilot must be able to perform all the maneuvers and operations necessary to effect a safe landing following any probable electric trim tab runaway which might be reasonably expected in service allowing for appropriate time delay after pilot recognition of runaway "

When FAA imposed this special condition, Beech and FAA understood that, if the electric trim design precluded runaway, flight tests to determine the possibility of runaways would not be considered necessary but that an informal assessment by Beech would be accepted as compliance

Between January and March 1969, Cal-State Airlines, a west coast commuter airline, reported to Beech three instances in which the model 99 had pitched up and down excessively in moderate turbulence On April 21 and 22, 1969, FAA flight-tested a model 99 to evaluate a modification installed by Beech to solve these problems FAA notified Beech on May 26, 1969, that its test showed a reduced but not fully eliminated instability and an unsafe condition in the plane's trim capability at takeoff which should be corrected to comply with FAA regulations Beech conducted tests similar to those conducted by FAA and notified FAA on June 18, 1969, that it did not agree with FAA's findings Beech representatives examined the commuter operator's aircraft and concluded that poor maintenance was a cause of the problems experienced

On the same day an FAA central region test pilot flight-tested a model 100, which is similar to the model 99 with respect to the movable horizontal stabilizer, and found the model 100 unsafe The test pilot recommended that a type certificate on the model 100 be deferred until the unsafe features were corrected

On June 20 a model 99 had an accident in which FAA considered the horizontal stabilizer to have been a possible contributing factor The carrier involved was Cascade

Airways, Inc The crash occurred at Tri-Cities Airport, Pasco, Washington, and caused two fatalities

The findings disclosed by the test pilot on the model 100 were reported to Beech on June 26 Beech officials disagreed with FAA's finding and requested that FAA form a Multiple Expert Opinion Team [1] The team evaluation began on June 30 and included a July 1 flight test of both a model 99 and a model 100 The team concluded for both aircraft that (1) the possibility of takeoff with stabilizer trim positioned at the extremes of travel created an unsafe condition according to applicable Federal Aviation Regulations and (2) the longitudinal control forces observed during the flight evaluation were excessive and prevented the smooth transition from one flight condition to another, a requirement under applicable regulations

The team recommended that (1) mistrim forces on takeoff be reduced or, alternatively, takeoff warning systems be installed to warn the pilots that the systems are beyond safe limits for takeoff and (2) the longitudinal forces be lowered or, alternatively, FAA require that pilots demonstrate their ability to fly the aircraft as designed Beech disagreed with the team findings and said it would appeal to higher FAA authority

On July 6, 1969, another model 99 had an accident The carrier involved was Air South, Inc This accident near Monroe, Georgia, caused 14 fatalities NTSB concluded that the probable cause of the accident was an unwanted change in longitudinal trim which resulted in a nosedown, high-speed flight condition that the pilots were not physically capable of overcoming Although NTSB could not specifically determine the initiating element in the accident sequence, it considered the design of the aircraft flight control system conducive to malfunctions which, if undetected by the crew, could lead to a loss of control

Following the two accidents, FAA headquarters ordered a special evaluation of the models 99 and 100 An

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[1] A group of FAA specialists selected to determine compliance of controversial, qualitative, flight-test-certification design and operational features

evaluation team headed by the Deputy Director of the Flight Standards Service was assembled to prescribe appropriate corrective actions The evaluation, completed on July 31, generally confirmed the findings by the central region's test pilot and by the Multiple Expert Opinion Team The evaluation team concluded, however, that the models 99 and 100 had compensating featuies and could be safely controlled

The evaluation team made 17 recommendations generally consistent with the expert team's recommendations and suggested that Beech undertake a long-range design program to improve the trim system Between July 1969 and November 1970, FAA issued several airworthiness directives requiring Beech to install sounding devices to warn pilots of faulty trim conditions and to make some alterations to correct the trim system

While FAA evaluated the models 99 and 100, Beech requested certification of the model 100 FAA approved this certification on July 24, 1969 In a memorandum dated July 18, 1969, a central region official explained the rationale for the approval The memorandum stated that FAA, knowing that the trim system had to be redesigned, would prefer not to certify the model 100, but that FAA had concluded that its failure to ground or operationally restrict the model 99, which used an identical trim system, had prevented FAA from dealing differently with the model 100

NTSB investigation

On August 1, 1969, NTSB notified FAA that it was investigating the two accidents and several incidents involving the model 99, all of which involved the loss of longitudinal control during flight NTSB was aware of FAA's efforts to preclude further accidents involving the aircraft but stated that, in view of the potentially serious consequences of such accidents, it recommended that the following interim actions be taken immediately

1 Establish emergency procedures for recovery from unwanted and/or adverse longitudinal trim conditions

2 Provide a stabilizer intransit warning system to alert the flight crews of movement of the trim system

3 Consider restricting the stabilizer trim range

Some of the above recommendations were among those included in the FAA evaluation report of July 31, 1969

In its final accident report of August 26, 1970, NTSB pointed out that the horizontal stabilizer in the model 99 was a new design feature which should call for FAA to participate in flight tests but that FAA had not participated The NTSB report further pointed out that this stabilizer had been in use for a long period on various commercial and military aircraft and that the stabilizer problems, as well as various devices to eliminate some of the known problems, should have been well known throughout the industry

NTSB concluded that Beech's informal assessment of the longitudinal trim system of the model 99 was inadequate NTSB therefore recommended that FAA review the existing system for permitting informal assessments and consider establishing a requirement that safety analyses be completed for all aircraft offered for certification that can be used for carrying passengers

NTSB further recommended that

--FAA personnel participate directly in the certification of all newly designed aircraft components, and

--FAA apply experience gained in investigating large aircraft accidents and incidents, when appropriate, to the certification of small aircraft

NTSB noted in its August 1970 accident report that FAA was implementing recommendations made as a result of the FAA special evaluation of the model 99 and that these included some of the actions recommended by NTSB

Beech officials said their evaluations and simulation tests produced no positive evidence to indicate that the trim system was the cause in the two fatal accidents investigated by NTSB Beech officials indicated that FAA test pilots participated in Beech flight checks of longitudinal stability before type certification of the Beech 99 and that these tests would have required significant use of the new trim controls. Although the tests conducted were not for

establishing compliance with the special conditions for trim performance, Beech officials said it was significant that FAA test pilots observed no hazards with the trim control during the tests

BEECH AIRCRAFT CORPORATION COMMENTS AND GAO EVALUATORY REMARKS

A draft of the information presented in the case study was furnished to Beech on March 8, 1973 Beech's comments dated March 20, 1973, and our evaluatory remarks follow

Beech Aircraft Corporation
Wichita, Kansas 67201
U S A

PRESIDENT

March 20, 1973

United States General Accounting Office
Washington, D.C. 20548

Attention Richard W. Kelly
Associate Director

Gentlemen

Upon receipt of the draft of your report forwarded with your letter of March 8, we sent the material to our Engineering Department for review. I have attached to my letter a copy of the memorandum I have now received from our James N Lew, Vice President - Engineering. As we know it is your desire to report objectively, we are certain that you will incorporate our comments in the final draft of your report.

In any consideration of matters such as those covered by your report, it is our conviction that full recognition must be given to the fact that the pilot of an airplane is a professional and is expected to perform his function with requisite skill. It has always been necessary for a pilot to demonstrate a certain level of proficiency before he is granted a license enabling him to fly. At the same time he is required to fly the airplane in accordance with the instructions, directions and within the parameters allowed by the operating manual and placards. Beech manuals since 1965 have contained warnings against abrupt or uncoordinated maneuvers that could cause fuel interruption.

Our company prides itself on the reputation our products hold in the eyes of the airplane owner This is a reputation gained over the past 40 years by producing a safe, quality product We think it significant that those who own and fly our airplanes do not share the concern over the fuel system evidenced in other quarters. When an inexpensive modification kit was offered to over 8,000 owners of unbaffled tank airplanes, less than 8% made the installation. They know their airplanes are safe when handled in the normal manner

One of the great challenges in our business is to resist the temptation to generalize from the particular. The individual occurrence must be evaluated in the light of the mass of statistical information that identifies the occurrence as isolated, unique

To immediately generalize from a particular occurrence is an easy way to avoid being second guessed in the future, but is taking the easy way out. It can result in unfair imposition on the legions of owners who would constantly be beset with the burden of modifying their airplanes primarily to protect the manufacturer, not themselves and it may also result in a more complex but less reliable aircraft. In the end this produces more rather than less hazards in flight.

Thank you for giving us this opportunity to express our views on the material pertaining to our company that you submitted in your March 8 letter. Our views on the Delegated Option Authority system will be a part of an industry position that will be submitted by our industry association, the General Aviation Manufacturers Association.

Sincerely,

Frank E. Hedrick

FEH mw81

Attachment

81 3 324

Beech Aircraft Corporation

INTER-OFFICE COMMUNICATION

FROM James N. Lew DATE March 20, 1973

TO Frank E. Hedrick CC

SUBJECT General Accounting Office Report

As you have requested, the GAO Report, Chapter 3,[1] titled Regulation of Beech Aircraft Corporation Activities has been reviewed. Based on this review, it is deemed appropriate that comments be made to correct some of the information contained therein and to clarify and amplify much of the other information to prevent conclusions being drawn on incomplete or inaccurate information.

While the Beech Aircraft Corporation was authorized to use Delegation Option Procedures on the 4th of December 1951, actual utilization of this authorization was not started until 18 May 1953. This delay in the initiation of our activities under this option was considered advisable to permit personnel of Beech Aircraft Corporation to study the procedures of another manufacturer who had already started an operation under this system.

GAO note *Beech's initial use of delegation procedures from May 1953 is discussed in the case study*

The Beech Aircraft Corporation did not know, nor was it ever informed, that consideration was being given to withdrawing the Delegation Option Authority as it related to Flight Test certification prior to the investigation initiated by the GAO. A letter was received in May of 1971 from the FAA which was our first indication of any dissatisfaction in the accomplishment of our Flight Test Delegation Option work by the FAA Even this letter made no reference to the possible withdrawal of the flight test authority.

Immediately upon receipt of the letter from the FAA, a meeting was scheduled to discuss specific areas about which the FAA expressed concern. The meeting was held with FAA on 10 June 1971, and the following is quoted from a letter received from the FAA on the 7th of December, 1971.

> The working relationship between the Beech Flight Personnel and the FAA Flight Test Personnel improved to the desired level immediately following the meeting on 10 June 1971, and has continued to be satisfactory. The working relationship with the Beech DOA Representative has been commendable."

GAO footnote Case study 1

GAO note *Recognition is given in the case study that Beech was not aware that FAA was considering the withdrawal of Beech's Delegation Option Authorization Also FAA's later decision to continue the Delegation Option Authorization based on improved working relationships with Beech is discussed*

DOA AUDITS

The listing in the GAO Report of the results of the findings of FAA Audits needs to be presented in proper perspective. Attention must be called to the fact that a vast majority of the items listed during these various audits were of a type where only variations in existing procedures as they relate to documentation, correction of documentation, correction of procedural directions, etc., was required to rectify the situation. Only a small minority of the items involved affected actual aircraft hardware in any way

To add credence to this position, the following is quoted from an FAA letter dated 22 June 1966, from the FAA, which forwarded a copy of the findings of the 1966 audit.

> Based on this audit the Board has determined that the Beech Aircraft Corporation is technically qualified and has demonstrated a satisfactory level of competence in all areas of responsibility for operation in accordance with the Delegation Option Authorization Procedures of FAR 21, SubPart J.

It must also be pointed out that a significant number of the items listed as discrepancies during the audit, had no relationship to whether or not Delegation Option Authority was being used.

GAO note *Discussion of FAA audits in the case study includes an explanation of the nature of findings and the corrective action taken by Beech*

DESIGN DEFICIENCIES

The Beech Aircraft Corporation takes issue with the GAO Report in this category of two design deficiencies. Both of the areas referred to were thoroughly tested and reviewed with and by certification representatives of the FAA in accordance with procedures and practices acceptable at the time the reviews were conducted. It is recognized that the FAA requested certain design changes, but it must also be recognized that these requests were concurrent with changes in personnel, practices and procedures of the FAA at dates later than the original certification activity in each of these two cases

GAO note *Our review of FAA records and discussions with FAA personnel disclosed no evidence of FAA participation in critical precertification tests that might have disclosed the two design problems In the case of the fuel interruption problem, the FAA regulations did not require testing for adverse fuel feed conditions for each intended operation and therefore precertification flight tests might not have disclosed the problem In the trim system case, FAA imposed special conditions and Beech designed the system to preclude inadvertent movement or runaways On the basis of this design, FAA allowed Beech to meet type certification and special condition requirements without fully flight-testing the trim system NTSB, in reporting on its investigation of a Beech 99 accident, noted that the horizontal stabilizer in the aircraft was a new design feature which should call for FAA to participate in flight tests but that FAA had not participated NTSB recommended that FAA in the future participate directly in certification of all newly designed features*

Relative to the GAO statement contained on Page 23 that The corrections involved the need to design (1) a fuel system that would provide a continuous flow during various flight maneuvers and (2) a trim (control) system that would enable a pilot to maintain a stable attitude without applying extra force for normal flight control , the following is offered

EVOLUTION OF UNUSABLE FUEL TESTING

To evaluate properly the circumstances surrounding the fuel system, a discussion of testing requirements and procedures is necessary. At the time of original certification Cival Air Regulations Section 3.437 and Federal Aviation Regulations Section 23.959 (prior to Amendment 23-7), stipulated the conditions for determination of unusable fuel. These conditions were

(1) Level flight at maximum continuous power or the power required for level flight at V_c, whichever is less.

(2) Climb at maximum continuous power at the calculated best angle of climb at minimum weight.

(3) Rapid application of power and subsequent transition to best rate of climb following a power-off glide at 1.3 V_{S_O}

(4) Sideslips and skids in level flight, climb, and glide under the conditions specified in SubParagraphs (1), (2) and (3) of this Paragraph, of the greatest severity likely to be encountered in normal service or in turbulent air.

Flight testing on original certification established compliance with these requirements

Amendment 23-7 was effective on 14 September 1969. Previous testing was based on the above four conditions required by the FAA Regulations and reported in the format provided by the Flight Test Report Guide, FAA Special Appendix to CAM 3, Page 75 This was the practice followed by Beech Engineering Test Pilots and FAA Test Pilots until the amendment

After Amendment 23-7 was adopted considerable effort was expended by the FAA and Beech in determining a test procedure which would meet the intent of the rewritten FAR 23.959. On 21 September 1971, unusable fuel test procedures to demonstrate compliance with FAR 23.959, Amendment 7, were received from the FAA. These conditions were as follows

1. Level flight in turbulence
2 Climb
3. Transition to V_Y from a glide
   NOTE The first three conditions essentially cover the four specific conditions of the old requirement.
4. Yaw (multi-engine airplanes)
5. Uncoordinated turns
6. Sideslips
7. Descent
8. Taxi turns, turning takeoffs and short field takeoffs.

Currently Engineering Flight Test is using procedures dated 21 December 1971, which supersedes the procedure dated 21 September 1971. In addition, the FAA Flight Test Report has been revised and FAA Order 8110.7 dated 20 June 1972, has been published. FAA Order 8110.7 is joint industry/FAA effort to provide methods and procedures for certification of small airplanes.

In summary, we have passed through a period of change both in fuel system design and aircraft operation. This change has been met with new evaluation techniques which insure safe fuel system performance over a much greater range of operations.

GAO note *Recognition is given in the case study to the fact that the FAA regulations were in a state of change during the period when fuel interruption incidents were noted on Beech aircraft However, aircraft movements that caused the problem were first brought to Beech's attention in 1961 and a modification kit was not made available to improve design until 1972*

FUEL SYSTEM

In the GAO Report, Page 24, it is stated Beech became aware of the possible problem in 1961 during early sales of one of the models - - - At this point, it is suggested that the report show that action was taken in 1961 to notify users of the possible hazard in high speed turning takeoffs with small amounts of fuel in the tank. The incident rate, when compared to the aircraft produced and being flown was such that it did not appear necessary to implement design changes.

GAO note *Recognition is given in the case study to Beech's actions to notify pilots of the possible hazard and its views on the incident rate*

We also take issue with the statement that between 1958 and 1969 Beech produced approximately 7800 aircraft with the apparent defect in the fuel system. We take this position because of our complete compliance with existing requirements and certification procedures in effect at the time of certification. It should also be pointed out that copies of these Service Instructions were sent to the FAA in February, 1962. This Service Bulletin was reissued as part of an updating of Bulletins in April of 1965, again with a copy going to the FAA.

It is recognized that this is spoken to later on in the report, but we think the reader must be made aware of corrective action taken immediately by Beech at the same time he is being made aware of the fact that 'Beech has been aware of the possible problem' It should also be pointed out on Page 24 of the report, that slip and skid maneuvers of the type used in these tests were by no means considered nominal. With the type of aircraft being considered when flaps are standard, the use of prolonged slips and skids is open to question on several grounds. It should be pointed out that such a maneuver is an uncoordinated one and not a normal maneuver when practiced to the extent now being used in certification procedures.

GAO note *The discussion in the case study was clarified to show the actions taken by Beech when it became aware of the fuel interruption problem Also the case study points out that both Beech and FAA were satisfied that compliance with the regulations existed at the time of certification and that FAA, in view of the problems being encountered, later made the required compliance test procedures more stringent*

In June, 1965, with the certification of the S35 Bonanza, the following note was included in the Owner's Manual.

"NOTE When making tight turning type takeoffs under minimum fuel conditions, it is best to have the fuel selector valve positioned to select the tank on the inside of

the turn. This way centrifugal force brings fuel to the tank outlet instead of taking fuel away from the outlet."

In 1965, the C33 Owner's Manual was revised to include the following statement.

NOTE. When making tight turning type takeoffs under minimum fuel conditions, it is best to have the fuel selector valve positioned to select the tank on the inside of the turn, e.g., right turn, right tank. Since the tank fuel outlets are at the inboard ends of the tanks, selecting the inboard tank lets centrifugal force bring the fuel inboard to the active tank."

Again in 1965, when the original V35 Owner's Manual was issued, it contained the following statement.

"NOTE· When making a tight turning type takeoff with minumum fuel, it is advisable to select fuel from the cell on the inside of the turn (left turn - left hand cell, right turn - right hand cell). Since the cell outlets are at the inboard ends of the cell, this procedure causes centrifugal force to convey fuel toward the outlets of the cell being used rather than away from the outlet.

In 1966, the C33A Owner's Manual had the same statement contained in it that was in the V35 Bonanza Owner's Manual.

In 1967 (October), Beech added the following note in the normal procedures section of the Airplane Flight Manual.

"CAUTION When taking off with minimum fuel do not make a tight turning type takeoff. The fuel may be conveyed away from the outlet during the turn causing an interruption in engine operation."

Copies of this Manual were sent to the FAA in October of 1967. The FAA requested that the Caution Note include minimum fuel quantity. In February of 1968, Beech suggested tests to determine safe fuel levels for the new tests being required and that the Manual Note would then be based on the test results.

In May of 1968, the Model 36 Bonanza was published with the following contained caution.

"CAUTION· To prevent fuel flow interruption due to gravity or centrifugal force, select high wing tank in sustained slips and inside tank during takeoff."

In June of 1963, a placard was installed in production aircraft. The placard contained the following information.

CAUTION To prevent fuel flow interruption due to gravity or centrifugal force, select the high wing tank in slips and inside tank during turning takeoffs.

In June of 1968, the Beech Travel Air and Baron Flight Manuals were issued with the following information.

CAUTION Do not make a turning type takeoff or take off immediately following a fast taxi turn.

a. If either 25-gallon main tank contains less than 5-gallons of fuel, or,

b. If either 40-gallon main tank contains less than 25-gallons of fuel.

CAUTION To prevent fuel flow interruption avoid prolonged operation in a slip or skid attitude under low fuel condition.

GAO note. Corrective actions taken by Beech are summarized in the case study

Criticism is suggested in the GAO report based on the fact that Beech did not apply similar comments and warnings to Baron and Travel Air Aircraft at the time it published the material quoted above for the Bonanza. The Baron and Travel Air aircraft are larger and heavier twin engine models, normally subjected to different use patterns and less erratic maneuvers. Experience with so-called fuel interruption in single engine aircraft had indicated only a momentary interruption in power of a few seconds duration which would not represent a hazard in the operation of twin engine aircraft, even if they were subjected to the extraordinary maneuvers and attitude conditions believed necessary to interfere with adequate fuel flow.

GAO note. Beech comments are recognized in the case study.

There is a tendency in considering this question to assume that the Bonanza, Baron and Travel Air were the first and the only aircraft to be designed and produced without so-called baffled tanks. This assumption is incorrect. The state of the art permitted the use of unbaffled tanks and at that time there were and are now a number of aircraft produced and flown without baffled tanks.

It must also be understood that almost any conceivable tank design including current models of the baffled fuel cell, have limitations

which if exceeded in terms of aircraft attitude or motion will permit exposure of the fuel intake port. The most elaborate system designed to minimize unporting in a wide range of flight conditions will sacrifice simplicity and reliability. At the time in question it was believed that the normal flight operating conditions of twin engine aircraft did not require a modification of the fuel system.

Much has been said and written about the so-called "defective fuel system" in these aircraft, chiefly as the result of wide publicity which has been given to certain civil litigation in which, unfortunately, the facts in relation to the operating limitations of the fuel system have not been properly presented. Despite the fact that we have modified the fuel system, Beech has continued detailed research and testing in this area. The results of this work support the conclusion that the actual incidents of fuel interruption from unporting have been few indeed and that the aircraft must be subject to the most severe and unusual use conditions and even abuse in order to induce fuel interruption.

As indicated in the report, a modification kit was made available in May of 1972, to the users of approximately 8,000 aircraft to bring these aircraft up to the higher standard established for new design. It is interesting to observe that since that time, only 625 owners installed this kit. This is less than 8% of the users.

GAO note. The case study recognizes that Beech originally did not consider modification of the fuel system necessary in its twin engine aircraft The case study also discusses Beech's efforts to modify the fuel system, the incidence of fuel interruption, and the fact that Beech made a modification kit available to owners on a voluntary cost-sharing basis

TRIM SYSTEM

Prior to the decision to design, develop and produce the Model 99 aircraft, a significant study effort was made to determine the needed characteristics of an aircraft to service Commuter Airline operators. During this period of study, several meetings were held with the FAA. At the time of the study, there existed two sets of requirements defining design requirements for fixed wing aircraft certificated in the U. S. One set of these requirements covered aircraft up to and including those which had a gross weight of 12,500 pounds or less, and a second set of requirements covering those aircraft especially designed for airline use and for small jet aircraft.

During the discussions with the FAA, it was recognized that for aircraft designed for use by the Commuter industry, special requirements should be developed to provide equipment of the type which would fulfill their needs. The Beech Aircraft Corporation formally negotiated with the FAA

for special design conditions which would be incorporated into their design. These special design conditions were over and above the requirements set at that time. There was no law or requirement that we do this. The FAA indicated there was no requirement that we do so, but offered Beech an alternative to design to a set of negotiated special conditions as a prelude to forthcoming changes in rules which they anticipated would cover the Commuter design type aircraft before a five-year period had elapsed, and, therefore, our aircraft would already be covered. Beech volunteered to utilize these higher standards which have since become the basis for new regulations for aircraft design and for use in the Commuter industry

GAO note *Beech's adoption of special conditions imposed by FAA for certification of the new aircraft is described in the case study*

On Page 31 of the GAO Report, there is a statement that the Model 99 experienced hazardous operating difficulties associated with the stabilizer. A new design stabilizer was incorporated into the design system.

It should be noted that the statement in the GAO Report, Page 31,[1] "During June and July 1969, two aircraft accidents occurred, involving 16 fatalities, and the aircraft were subsequently modified to correct the problem. and their later discussion wherein on Page 34, they indicated the 'FAA considered the horizontal stabilizer to have been a possible contributing factor" and the statement contained on Page 35 wherein it is stated 'although NTSB could not specifically determine the initiating elements in the accident sequence, it is considered the design of the aircraft flight control system conducive to malfunction which, if undetected by the crew, could lead to the loss of control.

GAO note. The case study was clarified to show that NTSB identified the stabilizer as the probable cause of one accident and a possible cause of a second accident

The GAO Report refers to the movable stabilizer as a new design feature incorporated into the aircraft's trim system. It should be pointed out that from the beginning, because of the design requirements of this type of aircraft, where the c.g. travel is significant, a new tail design was needed. This tail design and its control including its trim capabilities were established and patterned after similar devices used on larger transport aircraft. It is true they were new to Beech, but they were well within the existing state-of-the-art at the time of certification.

GAO note. Beech's views were recognized in this case study.

GAO footnote Now on page 10 of the case study.

On Page 33 of the GAO Report, reference is made to difficulties experienced by Cal-State. At that time, the Beech Aircraft Corporation dispatched a team of specialists to California to investigate this matter. It was found that the aircraft were grossly lacking in proper maintenance, especially on such maintenance related to the flap control system. The detent system had been allowed to deteriorate significantly, allowing uncalled for small deflection of the flaps to result in airplane pitching acceleration. The team rectified this situation without recourse to design changes.

GAO note. Beech's determination that poor maintenance was a cause of problems is noted in the case study

Relative to the two accidents referred to in the GAO Report, an inference is made that the trim system was the cause of these accidents. This inference cannot be collaborated. One accident was considered to have been a training maneuver wherein the aircraft stalled during a turn after an engine-out maneuver.

An investigation of the other accident referred to also failed to produce positive evidence that the trim system was the cause of the accident. In this accident, eye witnesses testified to the presence of loud engine noises or bangs before the aircraft entered into a vertical dive into the ground. It was demonstrated during simulation tests run after the accident in cooperation with the NTSB that had the upset been caused by a trim system and had the pilots been physically capable of doing so, the airplane attitude could have been recovered had the pilots recognized the existence of and reacted to a trim-induced upset within ten seconds. Since a normal pilot will recognize and react to attitude changes in less than three seconds, the apparent failure of their pilots to institute any observable steps to recover the aircraft is a fact of the utmost importance and tends to indicate that they may have been injured or unconscious as the result of some unknown occurrence on board the aircraft.

While several operational difficulties were reported, the FAA, during formal testimony at an NTSB Hearing in Atlanta, Georgia, testified to the fact that as of that time, they had been unable to identify with any certainty, a single case of run-away trim conditions, which we believe is the hazardous operating difficulty referred to within the report. Investigation generally established other reasons for such reported difficulty. In the case of one report that a run-away trim had been experienced and it was determined in the investigation that the co-pilot had inadvertently actuated the flaps when he let a hard book cover of a flight manual depress the flap lever.

GAO note. Beech's comments that its evaluations and simulation tests produced no evidence that the trim system caused the two fatal accidents investigated by NTSB and NTSB's findings are noted in the case study

GAO Report, on Page 31, indicated the NTSB reported the FAA had not participated in the flight testing of the stabilizer. This is contrary to the fact and to the written documentation which exists in our certification records.

On 16 April 1968, three FAA Test Pilots accompanied a Beech Aircraft Corporation Test Pilot on a 2½ hour flight check to study the longitudinal stability of the aircraft during which a number of landings and takeoffs were made. These tests were run at a forward c.g. gross weight condition and would have required significant use of the trim system. It should be noted that this date was well before the certification date of the aircraft. The names of the three pilots who conducted these tests were Mr. Les Melton, Mr. Stu Present and Mr. Frank Stogsdill, all of the FAA Regional Offices in Kansas City, Missouri.

The above indicates a minimum of 3½ hours by four different FAA Test Pilots, none of whom indicated a hazardous condition during the flight test program conducted.

GAO note. The case study was clarified to point out that, prior to type certification, FAA test pilots participated in tests of the aircraft that would have involved use of the trim system It was also noted that the tests performed were not for establishing trim system compliance for type certification

SUMMARY

Today, 95% to 98% of all General Aviation aircraft designed, developed and produced in this country, are produced under the DOA system. Under this system, our industry has grown in size and respect until its products are second to none in the world. No foreign company can approach the record established by the U. S. manufacturers.

Over the years the manufacturers utilizing DOA have worked most diligently with various foreign certification agencies and to this day have justifiably gained the respect and trust for the system being utilized in the U. S. for aircraft certification.

While it is recognized that improvements in any system are possible, it is vital to the industry that the basic system be continued.

James N. Lew
Vice President - Engineering

JNL mw

CASE STUDY 2

REGULATION OF CESSNA AIRCRAFT COMPANY ACTIVITIES

The Cessna Aircraft Company, headquartered in Wichita, Kansas, produces 27 models of single-engine commercial aircraft in its Pawnee Division and 10 models of twin-engine commercial aircraft and 2 models of military aircraft in its Wallace Division These aircraft are produced under three programs administered by Cessna--programs under FAA delegation option procedures, FAA standard procedures, the Department of Defense military specifications

Cessna's consolidated financial statement for the year ended September 30, 1971, showed sales and other revenue of about $172 million In 1970 Cessna delivered to dealers and new owners 3,730 commercial aircraft with a sales value of about $97 million and in 1971 delivered 3,859 commercial aircraft with a sales value of $102 million

DELEGATION AUTHORIZATION AND DOA AUDITS

In October 1951 Cessna was first authorized to use designated manufacturers' certification representatives and in November 1965 it was authorized to use DOA procedures Since November 1965 FAA has made six audits of DOA procedures which resulted in the following findings of noncompliance with applicable FAA regulations

Pawnee Division audits	Noncompliance findings
1966	24
1967	20
1970	35
Wallace Division audits	
1966	28
1968	21
1970	43

FAA's 1970 audit findings on Cessna's activities covered such matters as needed changes in Cessna's DOA procedures manual, revisions in Cessna aircraft engineering data and specifications, and needed improvements in production designs For the most part Cessna corrected noncompliance

findings with procedural changes, additional data documenting its compliance position, production design changes, and service letters to aircraft owners

FAA officials stated that they were satisfied with the corrective actions Cessna had taken in the six DOA audits The audits had also included findings of compliance in a number of areas and 81 recommended improvements that did not involve matters of noncompliance

Cessna officials said that DOA audits have been valuable in providing a detailed review and in-depth critique of Cessna's operations by qualified FAA personnel. Also the audits provide inputs which help update product airworthiness and obtain refinements in interpretations of the Federal Air Regulations

DESIGN WEAKNESSES

Certain Cessna aircraft had experienced design problems in two areas Long periods elapsed before Cessna and FAA determined that design modifications were required The modifications involved (1) correcting a fuel tank design which did not allow continuous fuel flow in steep descents and (2) modifying a flap actuator to prevent uncontrolled slipping Before the modifications Cessna had cautioned pilots on possible fuel interruption in certain maneuvers and issued maintenance instructions for the flap actuators

Wingtip fuel tanks

The Cessna 300 and 400 series aircraft (four-to-eight-seat executive aircraft) are equipped with fuel tanks at the wingtips that were designed in a manner permitting fuel interruption during steep descents when fuel is low in the tanks When most of the aircraft were certified, FAA regulations did not require flight tests to detect fuel interruption during steep descents.

In 1958, Cessna flight tests of a new model revealed a fuel interruption problem in certain flight maneuvers and Cessna issued a cautionary note in aircraft owners' flight manuals In August 1968 an accident occurred, in May 1969 FAA attributed it to the design problem. After conducting tests necessary to make this determination, FAA advised Cessna that the condition was unsafe and required corrective action Subsequently, Cessna developed a design modification which FAA required to be installed on all affected aircraft before January 1970

Recognition and correction of the problem

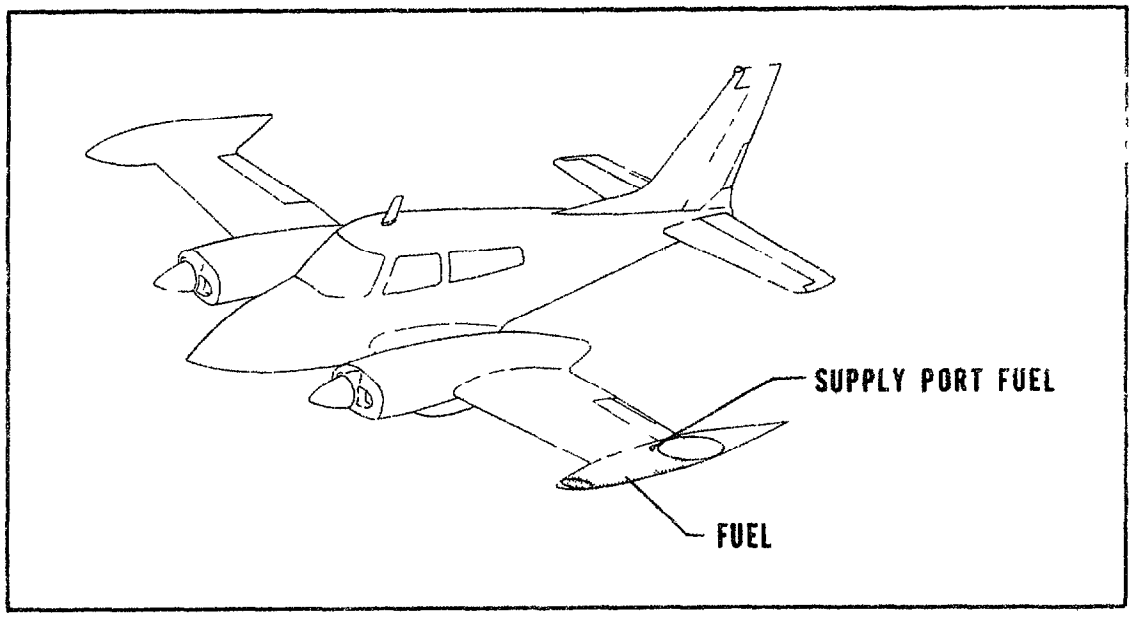
The basic model of the Cessna 300 and 400 series aircraft was certified in March 1954 under FAA direct surveillance procedures Several other models were certified between 1957 and 1970 The Cessna 300 and 400 series aircraft are equipped with external wingtip fuel tanks which are teardrop shaped and which have the fuel outlets approximately midway on the backsides FAA found that potential for fuel interruption occurred when fuel was low and when aircraft were in steep descents, which forced the fuel to the front of the tanks and uncovered the fuel intake ports (See illustrations on p 32 which also shows the modification made later by Cessna to correct this condition)

The fuel interruption problem first came to Cessna's attention in 1958 during precertification flight tests of a new model Cessna found that an unexpected fuel flow delay occurred if a steep descent was prolonged more than 30 seconds and with only 12 to 13 gallons of fuel remaining in each wingtip tank Cessna believed that a cautionary note in the aircraft owners' flight manuals was advisable, although it considered steep descents as abnormal flight maneuvers, and that such maneuvers were beyond the scope of existing Government regulations It is not clear whether FAA received this cautionary note which was issued by Cessna in 1958

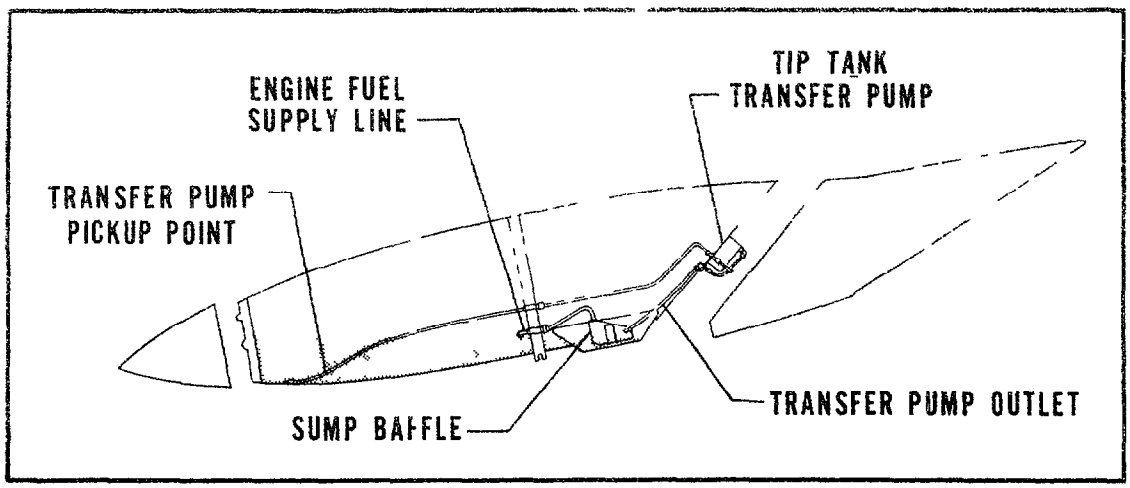
FAA first indicated interest in the matter in August 1968 when a Cessna crashed at Pine Mountain, Georgia, and seriously injured all six occupants Initially, FAA investigated the possibility that the aircraft had run out of fuel

FAA conducted flight tests of an aircraft of the same type in April 1969 FAA advised Cessna on May 15, 1969, that its tests were conducted as prescribed in Cessna's Owner's Manual and that they showed that an engine or engines would quit during the test descent with up to 5 gallons of fuel remaining Therefore FAA advised Cessna that it considered engine stoppage due to fuel starvation at the recommended approach speeds and configurations an unsafe condition that could occur under normal flight conditions and that immediate corrective action was needed FAA told Cessna that, until more suitable action could be taken, an airworthiness directive would be issued to require placards prohibiting flight with less than 10 gallons of fuel in the main tank On the basis of its tests, Cessna considered that encounters with

ILLUSTRATION OF FUEL INTERRUPTION DURING DEEP DESCENTS



SUBSEQUENT MODIFICATION OF FUEL SUPPLY TANK



fuel difficulties were of an inconsistent nature and occurred in aircraft operations, such as prolonged power off steep descents, which Cessna considered abnormal

After further tests and discussions, FAA issued an airworthiness directive dated June 4, 1969, requiring that owners of post-1962 models of Cessna 300 and 400 aircraft (most of the operating fleet) install placards reading "Operation with less than 10 gallons of fuel in each main tank is prohibited "

On June 27, 1969, Cessna advised owners about certain Cessna-developed modifications to the fuel system that would allow the safe operation of the aircraft without the restrictions imposed by FAA's directive (See illustrations on p 32) The modifications were acceptable to FAA On June 30, 1969, FAA amended the airworthiness directive of June 4, 1969, to exempt those aircraft which had been modified The owners of the unmodified aircraft were required to have them modified on or before January 1, 1970, in accordance with Cessna's service letter of June 27, 1969, or by an equivalent method approved by FAA Cessna officials stated that, at a cost of over $500,000, they provided the required parts and labor to make the modifications on affected aircraft

An additional airworthiness directive was issued by FAA on July 9, 1969, and was amended July 15, 1969, to make the required placards applicable to a small number of models of the 300 series produced before 1962 and still in service and to prohibit operation of these aircraft with less than 5 gallons of fuel in each main tank In September 1969, FAA amended its regulations for type certification to require flight tests to detect fuel interruption during steep descents

Wing-flap mechanism

The Cessna 182 E, which was type certified in June 1961 under delegation procedures, included a new flap actuator mechanism Cessna conducted both ground and flight tests of the actuator Cessna stated that its testing exceeded the minimum FAA requirements for certification and that the results of the tests indicated that the device would function satisfactorily

In 1966 and 1967 a number of incidents of unexpected flap retractions were reported due to malfunction of the actuator on the Cessna 182 and other Cessna aircraft Cessna conducted tests of actuators which had been in use on aircraft and determined that improved maintenance techniques would increase reliability of the mechanism Subsequently, Cessna issued service letters to aircraft owners advising them of the new maintenance technique

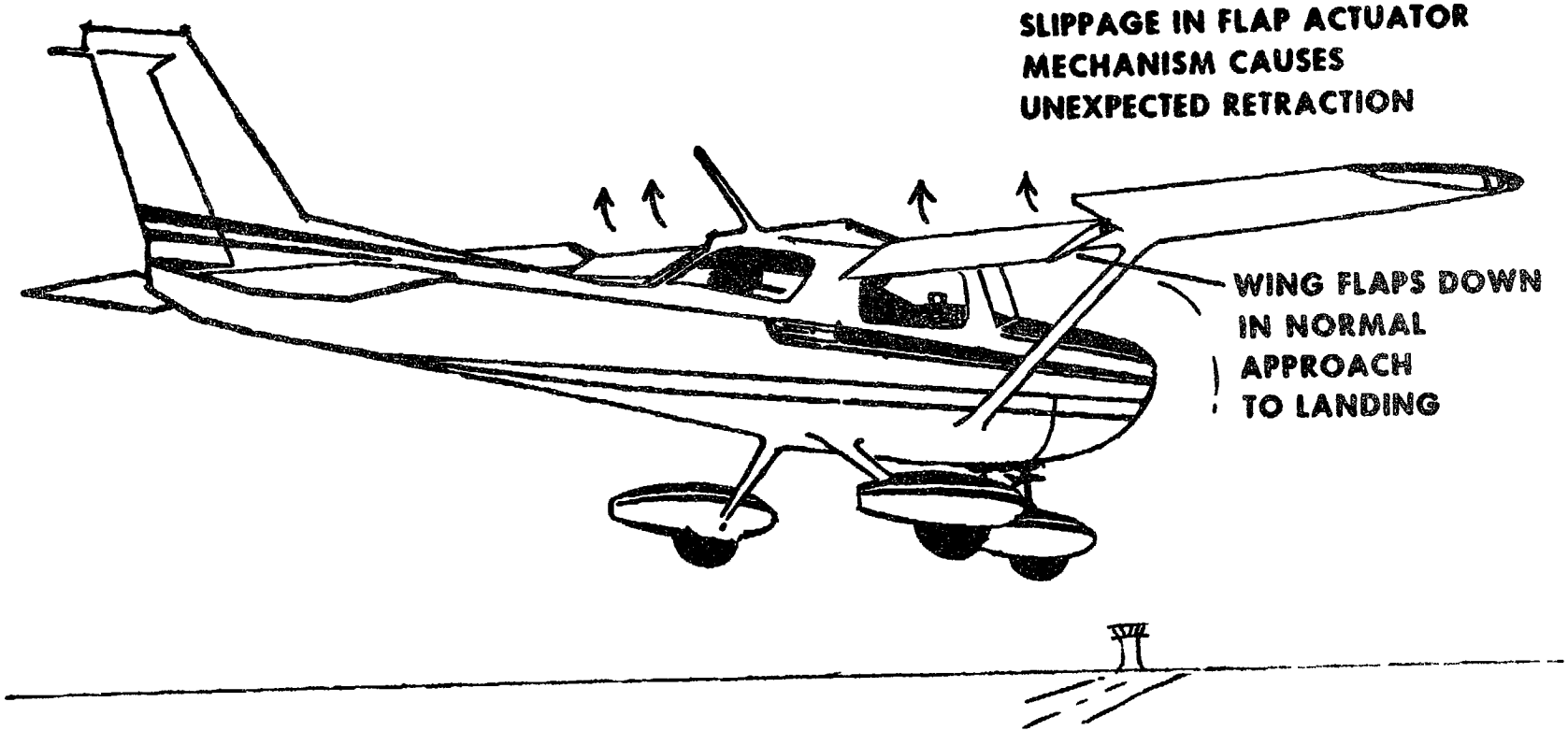
In May 1971, an NTSB investigator, after discussing the actuator problem with the National Bureau of Standards and with a representative of the manufacturer of the actuator component determined that the mechanism could be induced to retract under buffeting-type forces experienced in aircraft applications (See illustration on p 35) NTSB and FAA identified the flap actuator as the suspected cause in a number of fatal accidents between 1968 and 1971

Cessna did not agree with the FAA and NTSB findings but at a cost of about $352,000 Cessna made modification kits available to aircraft owners (about 35,600) to prevent the flap actuators from slipping An FAA airworthiness directive made installation mandatory

Recognition of the design problem

Aircraft wing flaps are extended during landings to cause the aircraft to lose altitude at a controllable airspeed and should remain stable against airflow after being placed in position Electric flap actuators were first introduced on the Cessna 182 E certified under delegation procedures in June 1961 and were later incorporated in several other Cessna aircraft FAA was not directly involved in Cessna's precertification ground testing or inspection of this new design feature However, Federal regulations governing the design and construction of wing flaps, in effect

ILLUSTRATION OF UNCONTROLLED WING FLAP RETRACTION ON APPROACH TO LANDING



at the time these aircraft were certified, clearly stated that flaps had to be designed so that they would not slip. Records of Cessna-type certification ground and flight tests indicated no problem with the flap actuator.

In December 1966 FAA notified Cessna that two instances of unexpected flap retractions had occurred in less than a month Cessna tested the malfunctioning parts and stated that it was unable to duplicate the slippage and advised FAA on February 24, 1967, that the parts had withstood design load tests, and that the flaps may have been used when the aircraft were being operated above manufacturer-recommended speeds. In 1967 Cessna received a number of flap retraction reports and, as a result, issued two service letters during 1968 notifying aircraft owners that experience had shown that the extension devices on all Cessna single-engine aircraft with electric flap actuators should be cleaned and lubricated to increase operational reliability

In March 1970 the pilot of a Cessna aircraft reported to FAA that he had experienced flap retractions in about 50 percent of his simulated landing approaches. FAA then discussed the flap retractions with Cessna, and Cessna tested an aircraft with manually operated flaps to determine the effect of rapid flap retractions The flight test showed that altitude losses from 32 to 79 feet were experienced during simulated unexpected retractions Cessna tests were generally conducted in level or descending attitudes Cessna stated that these tests were conducted under all reasonable conditions and that its test pilots agreed that no significant safety hazard was involved in sudden unexpected flap retraction.

In May 1970 the FAA central region flight-tested a Cessna aircraft to determine the effects of unexpected flap retractions FAA tests went beyond the scope of Cessna tests to include turning and missed approaches to landings and other in-flight conditions which FAA believed could be experienced using the flaps. Altitude losses up to 500 feet were recorded during FAA tests and FAA concluded that the aircraft demonstrated a characteristic which could be dangerous. Also in May 1970 the Chairman of NTSB advised the FAA Administrator that flap retractions on certain Cessna single-engine aircraft with electric flap actuators were strongly suspected as a cause factor in a number of fatal aircraft accidents. Pending complete preventive action, NTSB

recommended that all operators of affected Cessna aircraft be advised immediately of the potential hazard and of the appropriate piloting techniques needed to insure adequate control of the aircraft

During the Government investigations, NTSB identified the flap actuator as the suspected cause in 6 accidents between 1968 and 1970 involving 11 fatalities and FAA identified the flap actuator as the suspected cause in 3 other accidents between 1969 and 1971 involving 5 fatalities Cessna officials stated that they reviewed the complete accident records when they became available and that they considered that flap retraction was a remote possible cause in only two accidents

In June 1970 FAA advised NTSB that a telegraphic alert on the flap actuator problem was being processed for dissemination to pilots of affected Cessna aircraft Also Cessna issued a service letter recommending periodic inspections and lubrications of the flap actuators. An FAA airworthiness directive issued in July 1970 made these actions mandatory

In May 1971 an NTSB investigator furnished the actuator to the National Bureau of Standards officials who demonstrated that the mechanism could be made to retract under vibration The Bureau offered to conduct further tests to measure and evaluate the impact of vibration on the mechanism, but NTSB did not elect to fund further evaluations at that time On the basis of the Bureau's findings and of discussions with the actuator manufacturer, the NTSB investigator concluded that the actuator could retract under buffeting-type forces experienced in aircraft applications

On May 20, 1971, NTSB and FAA officials met with Cessna officials to discuss the NTSB's findings and the need for corrective design action Cessna stated that in all of its laboratory and flight-testing, it could not establish that a serious safety problem did exist, but in June 1971 Cessna began to install newly designed flap actuators in 1972 model production aircraft FAA, NTSB, and Cessna met again in August 1971 and agreed that devices to prevent uncontrolled actuator reversals would be made available for all affected inservice aircraft

Cessna issued a service letter on January 21, 1972, advising owners of all affected aircraft that free modification kits to prevent the uncontrolled retractions of wing flaps

were being made available FAA issued an airworthiness directive on January 25, 1972, which required owners to install the kits on or before January 1, 1973 The modifications affected about 35,600 aircraft and cost Cessna about $352,000

CESSNA AIRCRAFT COMPANY COMMENTS AND GAO EVALUATORY REMARKS

A draft of the information presented in the case study was furnished to Cessna for comment on March 8, 1973 Shortly thereafter we met with Cessna officials and discussed the case study As a result of this meeting we made changes to the case study to clarify certain material and to set forth Cessna's views Cessna's comments dated March 30, 1973, and our evaluatory remarks, follow

CESSNA AIRCRAFT COMPANY
WICHITA KANSAS 67201
March 30, 1973

DEL ROSKAM
PRESIDENT

Mr Richard W. Kelley
United States General Accounting Office
Associate Director, Resources and
Economic Development Division
Washington, D C. 20548

Dear Mr. Kelley.

Thank you for the opportunity to comment upon your Report to the Congressional Subcommittee examining FAA Regulatory activities

Although we could make many comments with respect to details, we believe it will save the Subcommittee's time if we limit ourselves to the two areas of your Report as it applies to Cessna Flaps and Fuel Tanks.

It is our understanding that your basic purpose has been examination of the merits of the FAA's Delegation Option Authorization The significant point is that the two major

criticisms of DOA at Cessna in all probability would have been handled no differently even if Cessna had not been operating under DOA. As stated in your Report, the basic model using the tanks in question was certified by the FAA before DOA was authorized.

Therefore, there is nothing in your Report that shows the DOA procedure is any less reliable than FAA standard procedures.

GAO EVALUATORY REMARKS

The fuel interruption problem was first noted by Cessna during precertification flight tests of a new model in 1958 before DOA procedures were instituted, however, other types of delegation procedures were in effect at that time and FAA did not participate in these flight tests Cessna initially responded to the problem by issuing a cautionary note in aircraft owners' flight manuals to avoid steep descents and, subsequently, developed a design modification to correct the problem We cannot speculate on what may have occurred if FAA had been directly involved in precertification flight tests but, such involvement at least would have afforded Cessna and FAA with opportunities for clarification of FAA rules and early recognition of the need for modification in aircraft designs

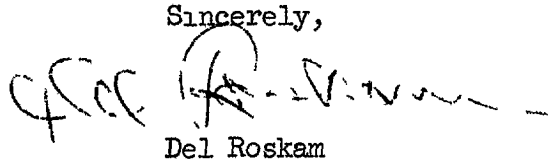
We believe that today the Delegation Option Authorization places the responsibility in proper sequence for the best results and cost savings accrue to government, industry and the customer.

The U S general aviation industry, operating under DOA procedure, today builds well over 80% of the world's general aviation aircraft. More industries like this might solve the U.S. Balance of Payments problem Certainly, it is important to our country's transportation system to have a strong aviation industry.

Any review of procedures should recognize the 150,000 general aviation aircraft that are successfully flying more than ten million miles per day in the U S. transporting people and cargo.

We sincerely believe that operations under Delegation Option Authority represent the best regulatory system in use today, and that continuation of DOA will enable the U.S. to maintain its world leadership in general aviation, with well-designed, well-built, safe aircraft.

Sincerely,



Del Roskam

DLR•mdm

CASE STUDY 3

REGULATION OF PIPER AIRCRAFT CORPORATION ACTIVITIES

Piper Aircraft Corporation currently produces 14 models of light aircraft ranging from a low-cost, one-seat agricultural aircraft to an eight-seat, twin-turboprop corporate aircraft. Piper manufacturing facilities are located in Lock Haven, Pennsylvania, and Vero Beach, Florida In 1970 Piper delivered to dealers and new owners 1,675 aircraft with a sales value of about $49 million and in 1971 delivered 2,055 aircraft with a sales value of about $57 million.

DELEGATION AUTHORIZATION

In October 1951 Piper was first authorized to participate in Government procedures using designated manufacturer's certification representatives Piper was authorized to operate under DOA procedures at its Lock Haven facility in November 1965 and at its Vero Beach facility in July 1968.

In October 1968 FAA officials made a DOA audit of Piper operations at Lock Haven and found two major certification problem areas involving noncompliance with flight-handling characteristics of the Piper 31-300 aircraft that had been type certificated in June 1967.

The areas of noncompliance indicated to FAA's eastern region that Piper's flight-test capability was not sufficient to determine compliance with regulations, therefore, in December 1968 FAA restricted Piper's DOA to require that all flight tests conducted by Piper be reviewed, flight evaluated, and approved by the eastern region Piper officials believe that the increased FAA participation has been beneficial in that it has served as a doublecheck on Piper flight-test engineers in verifying FAA rule interpretations.

DOA AUDITS

The eastern region made three DOA audits of the Piper operations at the Lock Haven plant between 1966 and 1971

In addition to disclosing numerous instances of compliance, each of these audits resulted in the following FAA findings of noncompliance.

Piper audits	Noncompliance findings
1966	19
1968	2
1970	7

These findings showed a need for corrective actions or desirable improvements in aircraft design or aircraft flight-operating procedures. The specific areas of noncompliance generally were resolved through revising the flight manuals, issuing service bulletins or airworthiness directives, and making some design changes in production aircraft. Piper officials said that generally the noncompliance findings related to differences in Piper and FAA interpretation of applicable Government rules In addition to the above findings FAA suggested a number of improvements in areas that did not involve matters of compliance. The results of a fourth DOA audit made by the eastern region in December 1972 were not discussed above.

DESIGN WEAKNESSES

Certain Piper aircraft have experienced design problems After the design problems were recognized, extended periods of time passed before Piper and FAA agreed that the problems were serious and arranged for corrective actions satisfactory to FAA. The problems were (1) adverse stall-and-spin characteristics, (2) abnormal control forces, and (3) aircraft explosions and fire hazards due to fuel leakage.

Stall-and-spin characteristics

FAA type certified the Piper 30 Twin Comanche on February 5, 1963, under procedures using designated manufacturer's certification representatives. Piper introduced the aircraft as a high-performance, low-cost, twin-engine aircraft for general aviation The aircraft seats from four to six occupants. About 2,000 aircraft were produced between 1963 and 1970 when the model was replaced by the Piper 39 Twin Comanche aircraft. As of May 1972 there were 1,846 registered Piper 30 aircraft--1,367 in the United States and 479 in foreign countries

According to NTSB statistics for the period 1964 through 1970, Piper 30 aircraft were involved in at least 42 stall-and-spin accidents that caused 78 fatalities and 11 serious injuries Stalls occur at speeds too slow to sustain flight Spins can occur on twin-engine aircraft when an engine becomes inoperative Before type certification, Piper became aware that a developmental prototype of the aircraft had a design characteristic that could cause the problem and made some modifications to the final prototype to correct the problem Piper officials indicated that they were unaware that the final prototype which was type certified had any flight characteristic problems

In June 1964 one FAA regional office questioned whether the Piper 30 was in compliance with FAA regulations concerning stall characteristics During the ensuing years, the question of Piper 30 compliance and the method of demonstrating compliance became a subject of considerable debate in FAA. Finally Piper developed a modification to improve flight characteristics, which FAA approved in June 1970 Installation of the modification is being made voluntarily by aircraft owners and is being paid for by Piper. Piper records showed that by May 1972 over 90 percent of the in-service Piper 30s had been modified.

Recognition of the problem

Before type certifying the Piper 30 aircraft, Piper officials were aware that a developmental prototype of the aircraft had flight characteristic problems A Piper preliminary test report dated April 2, 1962, of the prototype disclosed a number of problems, including difficulty in recovery from power-on stalls with one engine inoperative because the rudder exerted insufficient influence to maintain directional stability

On April 10, 1962, Piper's aerodynamics section recommended a 50-percent increase in the vertical tail surface to correct flight characteristic deficiencies On May 17 the aerodynamics section issued a report recommending an increase in the vertical tail surface to 19 square feet compared with 13.4 square feet on the prototype.

Although Piper designed, and considered using, a tail-tip extension increasing the tail surface to 20 square

feet, it did not use the extension on production aircraft. Piper management raised objections to increasing the tail surface to the extent suggested because it would alter the basic appearance of the aircraft. The vertical tail surface was increased to 14.9 square feet on the final prototype used for type certification and on subsequent production models Piper officials indicated that this determination was made after many different aircraft configurations were tested in flight. Piper also made other design changes in the final prototype intended to improve control in power-on stall conditions. Piper officials also indicated that FAA agreed with the determination of the tail size at the time of certification.

FAA first became involved in the design of the aircraft in May 1962 when FAA officials visited Piper to become familiar with the Piper 30 project and to determine the extent they should participate in type certification of the aircraft On June 4, 1962, the eastern region notified Piper that it planned to verify compliance with Federal requirements on certain areas for type certification Following this notification FAA participated in a number of pre-certification tests of the Piper 30.

Piper started pre-type-certification flight tests on the Piper 30 prototype in November 1962 and completed them on February 1, 1963. Piper's type inspection report dated February 5, 1963, showed that all flight-test handling characteristics, including stalls and spins, complied with FAA regulations

From January 31 to February 4, 1963, an FAA flight-test pilot conducted tests of the flight characteristics of the Piper 30. He flight-tested selected stall characteristics and found that they complied with FAA regulations. He did not determine spin characteristics but concluded that the Piper 30 complied with FAA regulations on the basis of his review of Piper's tests and flight spot checks.

On February 5, 1963, a panel of FAA and Piper technicians met to discuss Piper's completed test data, Piper's statement of compliance, and other information relevant to certification. On the same day, FAA provided Piper with the type certificate for the aircraft.

Actions after type certification

The FAA western region reported to the FAA eastern region on June 23, 1964, that flight tests of the Piper 30 with a modified fuel tank had disclosed that the aircraft did not comply with FAA regulations relating to stall characteristics and lateral stability In response to the western region letter, three eastern region pilots flight-tested the Piper 30 aircraft in August 1964 and found that the aircraft did not comply with stall requirements

On September 3, 1964, the eastern region established a Multiple Expert Opinion Evaluation Team to evaluate the Piper 30's stall characteristics. The team flight-tested the aircraft on September 10, 1964, and by majority opinion found that its stall characteristics and lateral stability did not comply with FAA regulations The team chairman reported that stall characteristics did not comply because exceptional piloting skill was required during the recovery portion of FAA testing criteria for power-on, gear-and-flaps-down stall maneuvers The team chairman believed that the extremely marginal rudder effectiveness close to the stall contributed greatly to the difficulty of the maneuver. The team believed that, to meet the requirements of the regulations, pilots with average piloting skills should be able to recover from these maneuvers Piper made a mechanical modification as a result of the team findings, but Piper flight tests showed that the modification did not correct the problem.

An FAA headquarters official telephoned the eastern region on September 14, 1964, and questioned the propriety of applying average pilot skill criteria in conducting stall characteristics tests. He contended that the stall was an abnormal flight maneuver and that exceptional, not average, pilot skills should be the criteria for type certification As a result, on September 15 the eastern region verbally advised Piper to disregard the team findings.

The determination that judgments on the airworthiness of the aircraft should be based on exceptional pilot skills appears at variance with the fact that the aircraft was likely to be flown by less skilled pilots since it was used extensively for instructing students who are required to demonstrate their ability to recover from the stall maneuver

Of the 42 Piper 30 stall-and-spin accidents identified by NTSB, 18 occurred during training or practice flights.

Piper officials said that all pilots, both skilled and unskilled, are taught that if they inadvertently stall an airplane they can recover easily and quickly by merely lowering the nose and recovering air speed. It is Piper's view that the inability of an unskilled pilot to fly the Piper 30 through the maneuver required by FAA regulations does not imply that the unskilled pilot would have any difficulty in recovering from a stall or a spin. Piper officials believe that the accidents that have occurred during training flights may have been associated, in part, to past FAA requirements for stalls to be practiced at altitudes too low for recovery and to the competency of the pilot or instructor.

In January 1965, at the Third Annual Flight Test Symposium, National Aeronautics and Space Administration and FAA personnel discussed the pilot skill criteria used in determining compliance with regulations The consensus at the symposium was that the level of safety had been unjustifiably reduced by using exceptional pilot skill for determining compliance with stall requirements Piper officials stated that they were not aware of the symposium consensus and that FAA did not then adopt the symposium position.

The National Aeronautics and Space Administration informed FAA in a November 1966 report, "An Evaluation of the Handling Qualities of Seven General Aviation Aircraft," that the Piper 30 had unacceptable power-on stall characteristics Piper officials stated that the Piper 30 tested by the National Aeronautics and Space Administration for this evaluation had characteristics that could reduce effectiveness of the test results.

NTSB was concerned about the high accident rate of the Piper 30 aircraft. An NTSB study, released in July 1967, of fatal aircraft accidents for 1964 showed that the stall accident rate for the Piper 30 was three times greater than the rate for comparable aircraft. Between 1967 and 1970 NTSB repeatedly requested FAA officials to investigate the aircraft's stall-and-spin characteristics As a result of preliminary work on the 1967 study, FAA headquarters advised eastern region officials in May 1967 that the overall

characteristics of the aircraft could be improved and requested them to take corrective actions

During July 1967 the Chairman of NTSB informed the Administrator of FAA that the Piper 30 had been involved in 13 spin-type accidents that caused 30 fatalities The Chairman recommended that FAA determine (1) the pilot actions required to precipitate the spins and (2) whether adequate recovery control is available to check inadvertent spin entries and any specialized procedures necessary to effect recoveries

In October 1967 FAA headquarters notified NTSB that it (1) had met with Piper to discuss the problem, (2) had issued an advisory circular on September 14, 1967, relating to the performance of stalls and engine-out maneuvers during pilot flight tests, and (3) planned to conduct additional flight tests to reaffirm handling qualities and operational aspects of the aircraft.

Four FAA flight-test pilots evaluated the aircraft in October 1967 and found it performed acceptably when flown in accordance with the advisory circular and current flight-test guides As in previous FAA flight tests, exceptional pilot skill criteria were used to determine compliance

As part of a continuing investigation of general aviation aircraft, the National Aeronautics and Space Administration made full-scale wind-tunnel tests on the Piper 30 and concluded in September 1968 that

> "The behavior of the airplane at the stall seems to be the result of the rolling and yawing movements produced by the asymmetric stall These movements are greater than the corrective movements produced by the control "

According to Piper officials, the National Aeronautics and Space Administration wind-tunnel test results are not indicative of free flight at extremes of operation and that the aircraft used in the test had the equivalent of 25 percent more horsepower than Piper 30 production models Piper officials indicated that the latter condition can seriously affect the controllability of the aircraft throughout the stall.

On October 7, 1968, the eastern region recommended that FAA headquarters require that, in any present and future type certification flight-test programs, average--instead of exceptional--pilot skill criteria be used in demonstrating compliance with the controllability and flight characteristics requirements during the stall evaluation. About 1 week later the Deputy Director of the Flight Standards Service notified the eastern region that the average pilot skill criteria should be used in future flight tests This modification was based on an FAA General Counsel ruling that safety should be the deciding factor in interpreting regulations.

On August 29, 1969, Piper issued a service bulletin (1) requiring placarding of all Piper 30 aircraft advising pilots to use 85, rather than 80, miles per hour as the minimum control speed,[1] (2) prohibiting single-engine, power-on stalls, and (3) prohibiting twin-engine, power-on or power-off stalls below 5,000 feet Piper officials said that their action sought to minimize the potential for accidents

After Piper issued the bulletin, FAA investigated the Piper 30 aircraft minimum control speed beginning in September 1969 The Deputy Director of the Flight Standards Service directed the eastern region not to include a reevaluation of the stall characteristics of the Piper 30 in the investigation, because of the controversial nature of FAA's role in evaluating this subject

The eastern region completed its investigation of minimum control speed on October 24, 1969, and concluded that Piper's flight tests had not been conducted correctly As a result of its investigation and Piper's request, the eastern region issued an airworthiness directive on November 5, 1969, increasing the minimum control speed to 90 miles per hour

An FAA memorandum of a meeting with Piper officials at FAA headquarters on September 4, 1969, states that a history of Piper 30 accidents was worse than that of comparable aircraft and that corrective actions for pilots, such as prohibiting power-on stalls and increasing the

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[1]Normally the airspeed at which an aircraft with one engine inoperative can be safety controlled

minimum control speed, were unacceptable to FAA. Another FAA headquarters official said, according to the memorandum, that the only solution to the problem was to change the flight characteristics of the aircraft Piper officials said that they had obtained different understandings from this meeting

On January 7, 1970, the FAA southwest region advised the eastern region that flight tests of a standard Piper 30 which was to be modified and certified under an FAA supplemental-type certificate had disclosed that the unmodified aircraft did not comply with FAA lateral stability requirements and requested that it be evaluated The southwest region noted that the aircraft was directionally stable, except that the response to rudder inputs in one flight maneuver was very poor. On January 19, 1970, the eastern region replied to the southwest region by presenting a chronology of FAA and Piper actions in regard to tne Piper 30's stability problem.

Corrective action

In a meeting with FAA on April 29, 1970, Piper proposed improving the Piper 30 flight characteristics during slow-speed maneuvers by installing airflow modification kits on the aircraft. At the meeting the Deputy Director of the Flight Standards Service furnished the eastern region with guidelines for evaluating the Piper 30 modification program The guidelines provided that (1) the project not be a team evaluation, (2) the test for lateral stability be handled on a comparative basis to insure the modification provides an aircraft comparable to or better than the basic Piper 30, and (3) the test for stall characteristics use exceptional pilot skill. FAA justified using exceptional pilot skill as a criterion to obtain results comparable with the 1964 tests.

In May 1970 the eastern region flight-tested a Piper 30 on which Piper had installed an airflow modification kit Piper further modified the Piper 30, and on June 2, 1970, the eastern region retested the aircraft and found it complied with FAA regulations The modifications included airflow strips installed on wing leading edges, the aileron-rudder interconnect, and other changes illustrated on page 51

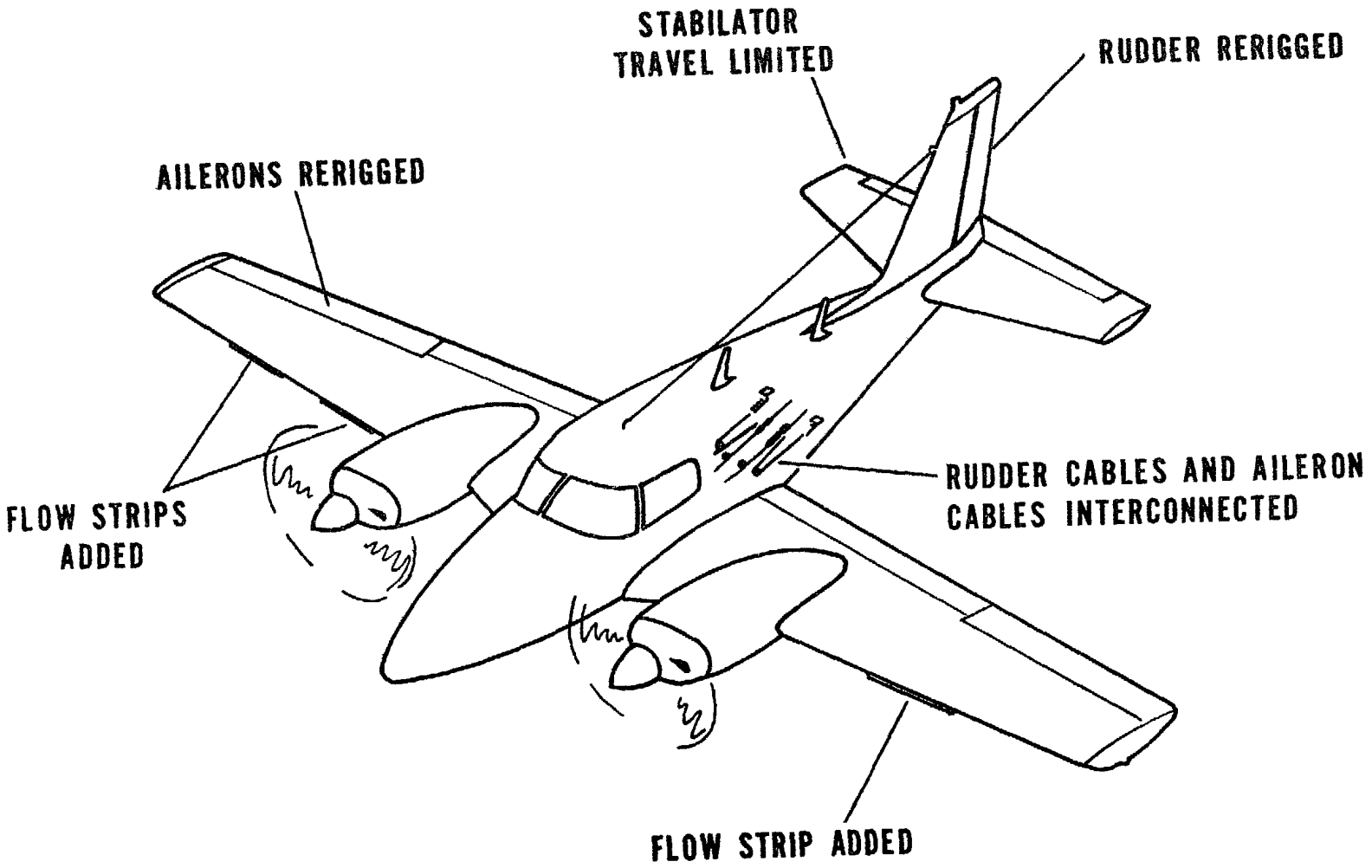
On August 18, 1971, NTSB recommended that FAA issue an airworthiness directive requiring that airflow kits be installed on all affected Piper 30 aircraft Piper officials stated that, at that time, approximately 62 percent of the owners and operators of Piper 30 aircraft had installed airflow kits and that Piper had been actively encouraging the installations for more than 1 year After considering recent accident records and flight-test data, FAA concluded that continuing to offer the kits on a voluntary basis was preferable to issuing a directive

A May 1, 1972, Piper status report on the modification of the Piper 30 showed that 1,264 of the 1,356 Piper 30 aircraft registered in the United States and eligible for airflow kits had been modified

Regulatory agencies in foreign countries have required installation of the airflow kits on Piper 30 aircraft registered in their countries The French Government required installation of the kits by July 1, 1971 On October 12, 1971, the Canadian Government required installation of the kits The Civil Aviation Authority in England also was preparing an airworthiness directive in April 1972 which would require installation of the kits

According to Piper officials, there were a number of factors that contributed to the accident record experienced by this aircraft. Piper believes that many of the stall-spin accidents occurred through aircraft overloading or mishandling near the ground when recovery is difficult if not impossible Piper officials also indicated that the British have had an excellent safety record with the Piper 30 and that more closely controlled British training programs and the discouragement of stall maneuvers near the ground contributed to this record Piper indicated that FAA, in contrast, has required new pilots to demonstrate slow-speed, single-engine control competence at low altitudes.

ILLUSTRATION OF AIR FLOW MODIFICATION KIT INSTALLED TO IMPROVE HANDLING CHARACTERISTICS



Abnormal control forces

In November 1969 Piper notified FAA's eastern region that it intended to relocate the landing light and the heater inlet on future models of the Piper 23-250 (a six-seat aircraft) but did not advise FAA that it was extending the nose of the aircraft. Since FAA had limited the flight-test portion of Piper's DOA in December 1968, Piper requested the eastern region to advise whether they would participate in testing the Piper aircraft modifications The eastern region advised Piper 4 days later that FAA participation would not be required to obtain FAA approval Piper officials stated that they did not measure the control forces associated with the nose modification in flight tests because they were confident that the slight change in configuration would not affect these forces

Adverse aircraft-handling qualities associated with the aircraft nose modifications were not disclosed until after a DOA audit in 1970 In October 1971 Piper made a design modification available to aircraft owners In June 1972, 52 of the 115 aircraft in service had not been modified, Piper requested FAA to issue an airworthiness directive making installation mandatory In October 1972 FAA issued the airworthiness directive requiring installation of the modification within 30 days of the effective date of the directive

Recognition of abnormal control force

During the 1970 DOA audit, the eastern region found that Piper, in addition to making the changes reported to FAA, had modified the existing Piper 23-250 by increasing the nose section by 1 foot Also the eastern region found that Piper had not flight-tested the new model to determine whether the modifications had affected aircraft-handling characteristics The eastern region requested Piper to make handling-qualities tests before FAA made flight tests to determine the aircraft's compliance with FAA regulations Piper completed the flight tests for the modified Piper 23-250 on April 9, 1971, and concluded that the aircraft conformed to the existing type certification and would operate safely

Flight tests made by the eastern region several days later disclosed noncompliance with FAA regulations dealing with the aircraft's handling characteristics An FAA test pilot concluded that the lengthened nose section designed to increase luggage capacity had changed the aerodynamic design of the aircraft, which had caused the control mechanism to experience abnormal forces during the power-on stall maneuver Piper's test report also disclosed the abnormal forces, but Piper believed that it (1) did not constitute noncompliance, (2) was not related to the increased nose length, and (3) was based on an FAA change in rule interpretation

In one of the maneuvers to determine whether an aircraft complies with FAA regulations, the pilot pulls back the control wheel, which moves the stabilator trailing edge to an up position and which places the aircraft in a steep-climbing attitude The pull force exerted by the pilot on the control wheel is opposed by a resistant pull force created by the airflow against the stabilator In a steep ascent the pilot ordinarily must exert an increasingly stronger pull force for the aircraft to continue to climb while losing airspeed The aircraft will stall when it no longer can sustain flight due to insufficient flying speed

In performing the same maneuver, FAA found that the forward or pull force on the Piper 23-250 control wheel created by the airflow against the stabilator decreased before it attained the stall speed and that the pull force reversed and became a push force Consequently, the pilot had to exert a push force, an abnormal characteristic, on the control wheel to keep the aircraft climbing in a consistent attitude before reaching the stall speed An FAA test pilot indicated that, if the pilot did not push the control wheel forward, the aircraft would immediately nose upward and stall

Piper officials stated that FAA regulations require that positive control wheel pressures be exerted until the aircraft enters unsteady flight conditions and that Piper engineers and test pilots had always thought that earlier models of the Piper 23 entered unsteady flight conditions when the buffeting normally associated with a stall was experienced They said that the Piper 23-250 could be flown through buffeting conditions and on to a stall They said

also that, since FAA's test pilot determined that positive stick pressures must be maintained on the Piper 23-250 through buffeting to the stall, Piper believed this to be a change in rule interpretation

Corrective action

Piper proposed a design modification in May 1971 to overcome the reversal condition by installing a spring mechanism Eastern region flight tests in June 1971 showed that the aircraft with the mechanism met all FAA requirements The modification was incorporated during production of the Piper 23-250 starting in June 1971 At that time 116 Piper 23-250 aircraft had been produced In October 1971 Piper issued a service bulletin providing for modifying all affected aircraft without charge to the owners However, complying with the service bulletin was at the option of aircraft owners and, as of June 1972, 52 of the affected aircraft had not been modified In June 1972 Piper requested the eastern region to prepare an airworthiness directive which would require owners of the 52 aircraft to comply with the service bulletin The proposed directive was issued in October 1972

Piper officials said that to their knowledge there had never been any safety hazard associated with the Piper 23-250 nor any accidents attributed to the condition noted by FAA

Fuel system

Two models of the Piper 23 aircraft have experienced fuel leakage and fuel vapor accumulation near the engine exhausts, which create fire and explosion hazards The fuel tanks are constructed of a material that tends to become dry and porous if they are not kept full when the aircraft are not in operation The hazards exist because of the arrangement of the engine exhausts and their proximity to the fuel drain holes in the wings, which can permit the engine exhaust to ignite accumulated fuel vapors and cause a fire or an explosion in the wings (See illustration on p 56)

Fuel tank leakage reports led FAA to request in January 1964 that Piper correct the problem Between 1964 and 1971 FAA and Piper attempted to resolve the problem by imposing

additional maintenance and service requirements on pilots. These measures proved to be ineffective, Piper therefore developed a design improvement which was incorporated on all new aircraft FAA did not require it to be incorporated on inservice aircraft

As of May 31, 1972, five explosions and one fire incident involving the Piper 23-250 had occurred, FAA attributed them to the fuel system problem No fatalities or injuries occurred in any of these incidents

Early recognition of fuel leakage

The Piper 23-250 and Piper 23-235 are twin-engine aircraft which were type certified under delegation procedures on September 18, 1959, and January 22, 1962, respectively

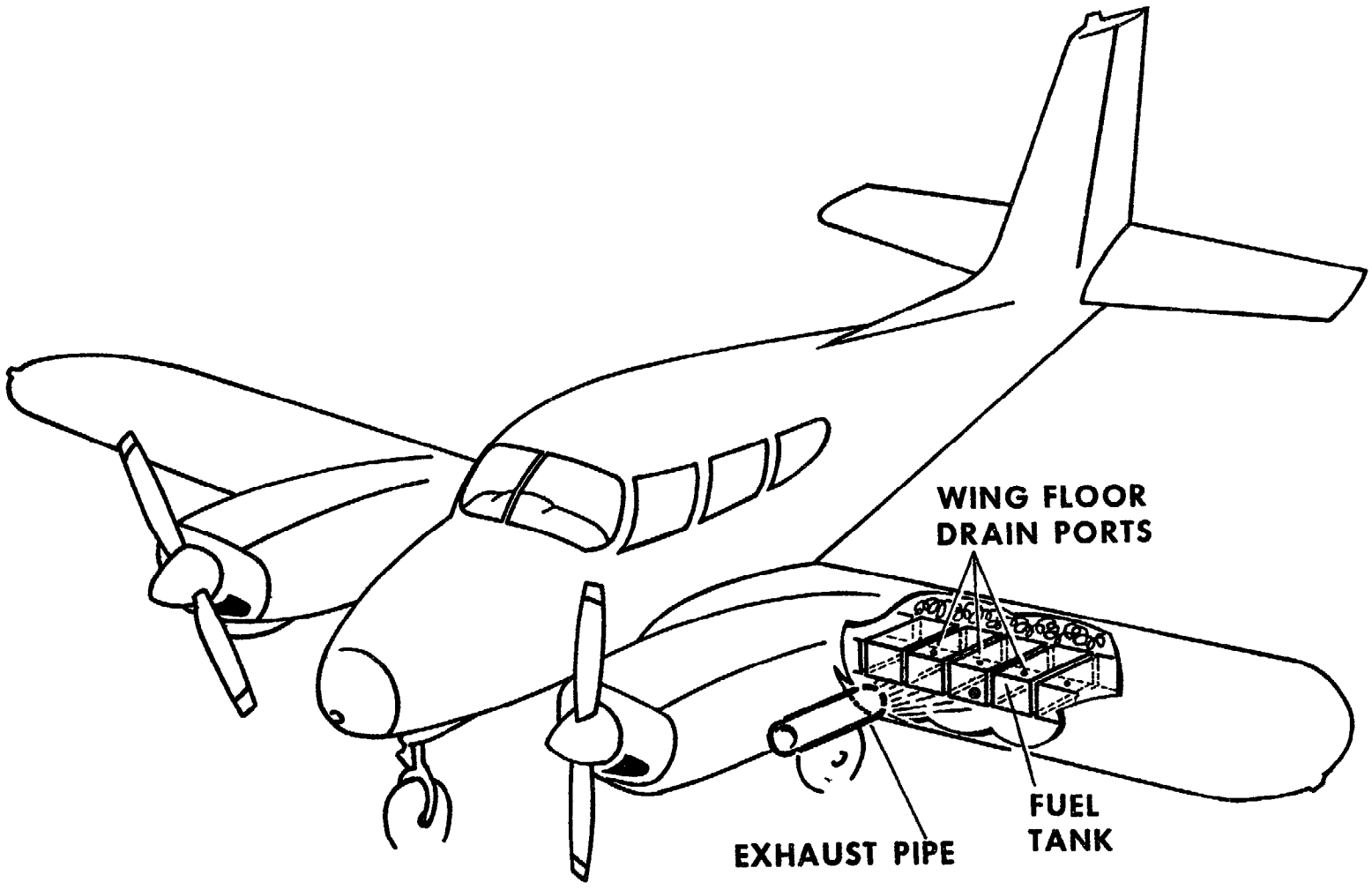
In January 1964, after receiving reports of fuel leakage on one of these aircraft, FAA requested Piper to investigate and propose corrective action Piper advised FAA in April 1964 that, after 1 or 2 years, the fuel tanks developed pinholes which allowed fuel to seep out Piper considered the problem a nuisance rather than a hazard, but, in the interest of improving safety, Piper used a new fuel tank constructed of another material for aircraft produced beginning in September 1964

Attempted corrective action

FAA continued to receive reports of fuel leakage, and in November 1964 FAA told Piper that the leakage was a hazard and requested Piper to furnish information necessary for an airworthiness directive Piper replied in February 1965 that it did not consider a directive necessary, however, Piper issued a service letter in April 1965 recommending that preflight inspections be made of the lower wing surfaces for fuel stains and that corrective action be taken, including replacing fuel tanks

As the result of an April 1967 report indicating that a fire had occurred around the fuel tank of a Piper 23-250,

ILLUSTRATION OF FIRE-EXPLOSION HAZARD FROM FUEL CELL LEAKAGE



FAA issued General Aviation Inspection Aids[1] which cited the fuel leakage problem and which recommended that fuel tanks be kept full when the aircraft were not in operation.

In March 1968 FAA forwarded data to Piper on two Piper 23-250 aircraft explosions and fire incidents caused by fuel leakage. FAA stated that the leakage was a distinct hazard which apparently could not be effectively controlled or eliminated by conducting preflight inspections or by keeping the fuel tanks full when the aircraft was not in use FAA requested Piper to investigate and propose corrective measures Piper replied in May that it recognized fuel leakage could be a hazard but that (1) the fuel tanks could not be expected to last forever, (2) proper maintenance and good preflight inspections should avoid similar incidents, and (3) the drainage provided should normally allow leaking fuel to escape

The eastern region's report on its 1968 DOA audit sent to Piper in February 1969 cited the fuel leakage problem and suggested that action more detailed than the service letter be taken Piper agreed to investigate further and later revised its service letter Piper believed that fuel leakage incidents would cease because very few of the deficient tanks were in service and because owners had been advised of the problem.

In October 1969, after another Piper 23-250 explosion and fire incident, FAA advised Piper that, on the basis of past experience, the leaking fuel tanks and exhaust system arrangement contributed to the fires and explosions

Because of continuing incidents, FAA requested Piper to reevaluate the problem to determine corrective actions and suggested that design changes to the drainage, ventilation, or exhaust systems might be required. FAA issued an airworthiness directive in February 1970 and revised it in May to require inspections of the lower wing surfaces for evidence of fuel leakage or stains. If such evidence was found, corrective actions or repairs were required Piper

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[1]Monthly publications prepared by FAA from information supplied by persons who operate and maintain aircraft The publication is available on a subscription basis

stated that three or four incidents of the thousands of aircraft in service were not sufficient to justify design changes

During October 1970 the FAA Aeronautical Center at Oklahoma City was requested to make a safety investigation of fuel leakage in the wing areas of Piper 23-250 and 23-235 aircraft In April 1971 the Center reported that it had investigated 440 of 1,947 inservice aircraft and had determined statistically that from 14 to 22 percent of the inservice aircraft were subject to fuel leakage in the wing areas--mostly from the fuel tanks--due to porosity of the material used in constructing the tanks. The Center recommended that, if improved fuel tanks were available, owners should be encouraged to use them as replacements and that FAA should revise the airworthiness directive to require inspections of the wing surfaces for fuel stains prior to all flights until improved tanks are installed

Piper established a design modification in November 1971 to eliminate the hazard principally by making the wing drain holes smaller This modification was incorporated on Piper 23-250 aircraft produced starting about February 1972. The Piper 23-235 aircraft were no longer in production. At the time of the modification, 3,270 Piper 23-250 aircraft and 118 Piper 23-235 aircraft had been produced. FAA did not make the modification mandatory for these aircraft but authorized discontinuing certain periodic inspections on those inservice aircraft which had been modified. Information as to how many of these aircraft had been modified was not available

PIPER AIRCRAFT CORPORATION COMMENTS AND GAO EVALUATORY REMARKS

A draft of the information presented in the case study was furnished to Piper for comment on March 8, 1973. Piper's comments dated March 26, 1973, and our evaluatory remarks follow

Piper Aircraft Corporation
Lock Haven, Pennsylvania, U S A 17745
TELEX 841412 AREA CODE 717 748 6711

CABLE ADDRESS CUB

March 26, 1973

Mr Richard W Kelley
Associate Director
United States General Accounting Office
Resources and Economic Development Division
Washington, D C 20548

Dear Mr Kelley

We are grateful for the opportunity extended to us in your letter of March 8, 1973 to review and comment upon the section of the draft report being prepared by the General Accounting Office (GAO) discussing FAA Delegation Option Authorization (DOA) granted to our company

In our view, the basic approach of the draft of the section of the GAO report dealing with our company and its products is fallacious. The fault lies in attempting to evaluate the effectiveness of the DOA procedure by concentrating on three areas, characterizing those areas as "problem areas" and inferring that because those "problem areas" exist, the DOA procedure has not worked effectively.

We think this fallacy was not initiated by the General Accounting Office but by those who requested the study who may have assumed that this approach would bring out the required facts with which to study the effectiveness of the DOA. We are informed that the staff of the Government Activities Sub-Committee of the House Government Operations Committee instructed the GAO to take the approach which was taken. Certainly, when we expressed our objections previously it was explained that the GAO is powerless to take any other approach because of its instructions.

In our view, the draft of the GAO report dealing with Piper is designed to prove an assumption, namely that the DOA procedure has not operated effectively to protect the public interest because three "problem areas" have existed in Piper.

GAO EVALUATORY REMARKS

Our review was directed to evaluating the adequacy of FAA actions to identify and correct safety defects on light aircraft. Although the delegation process was an important consideration in making our review, it was apparent that limiting our work to the procedural aspects of the delegation process would not give us sufficient insight into how the Government and the manufacturers handled recognized design problems of specific inservice aircraft. Moreover, demonstrating the significance of varying interpretations of FAA's regulations and of the processes and time involved in developing corrective actions required historical analyses of the cases reviewed

We did plan to limit our work to DOA procedures, however, when we noted safety problems which appeared to go beyond the DOA process, we modified our approach to more fully analyze the history of specific aircraft design weaknesses Also we examined the results of comprehensive FAA audits of the operation of the delegation procedures at the various light aircraft manufacturers, and we obtained the views of FAA and the manufacturers on DOA. This approach was discussed with the Subcommittee.

We think an analysis of the so-called "problem areas" will demonstrate that there was a close monitoring by the FAA of Piper in all of these areas, that the FAA has not been hoodwinked; that Piper has not been slow to comply with FAA directives; that there has been no default by Piper in the exercise of its DOA; and that problems which have arisen have, for the most part, been difficulties in coping with changing rule interpretations.

The three so-called "problem areas" were as follows:

1. DOA certification of the Piper PA-30 Twin Comanche.

The history of this aircraft was studied by the GAO team because it has been a controversial aircraft. The controversy has hinged on whether the aircraft meets the requirements of Section 3.120 of the Federal Air Regulations. The FAA has repeatedly tested the aircraft and has found that it does comply with Section 3.120 and all other Federal Air Regulations.

There is some implication in the GAO study that since this aircraft was certificated under DOA procedures, that the FAA did not have an opportunity to evaluate the aircraft before it was certificated. This implication is false.

The record shows that the FAA was intimately involved in the certification of this aircraft for a period of eleven months prior to its certification. The aircraft type certificate was actually issued by an FAA official on February 5, 1963 after a large panel of FAA and Piper technicians had jointly reviewed all of the test data pertaining to the aircraft.

We believe that the facts of this case clearly demonstrate that FAA and Piper technicians co-operatively evaluated the aircraft and all design and test data and joined in the decision to certificate it. No impartial body has found their judgment was in any way erroneous.

GAO EVALUATORY REMARKS

The Piper 30 was selected for study because it had exhibited unsatisfactory stall-and-spin performance, a characteristic that has been experienced by a number of light aircraft

FAA was periodically involved with Piper in reviewing the design development and testing of the Piper 30 FAA performed or participated in some Piper flight tests of the Piper 30 before type certification of the aircraft Most of FAA efforts, however, were limited to reviewing the tests performed by Piper FAA approved the Piper 30 compliance with FAA regulations governing spin recovery performance on the basis of Piper test results which indicated that compliance had been achieved.

After type certification, however, FAA regional officials flight-tested the Piper 30 in connection with a request for a supplemental-type certificate and questioned the aircraft's compliance with FAA regulations for stall characteristics and lateral stability characteristics that can lead to spin conditions. As discussed in the case study, the question of Piper 30 compliance and the method of demonstrating compliance was the subject of considerable debate for a number of years. FAA never formally found the

Piper 30 in noncompliance with its regulations. Eventually, Piper developed an aircraft modification to improve flight characteristics which FAA approved in June 1970.

2. Piper Service Bulletin No. 345 requiring a Modification of the Aztec "E".

After certification of the Aztec "E", a periodic FAA audit of Piper's DOA procedures indicated that the Aztec "E" flight tests for certification did not include a review of handling qualities Piper explained that the Aztec "E" was merely a minor modification of the Aztec D which had been extensively flight tested. Therefore, there was no need to conduct flight tests to determine its handling qualities. At the request of the FAA, Piper pilots flight tested the Aztec "E" and found it in compliance with Federal Air Regulations. Immediately thereafter, FAA test pilots flight tested the Aztec "E" and objected that after the aircraft was flown into the buffeting usually associated with a stall, there was a mild reversal of stick pressures. The FAA deemed this characteristic to be in non-compliance with a certain Federal Air Regulation which had not been interpreted in the same way before.

There was no apparent safety hazard and no accidents had resulted or were likely to result from this characteristic. After discussion between the FAA and Piper, Piper agreed to FAA insistence that a modification be made. The modification was to connect a spring device to the control system to maintain a positive stick pressure even after unsteady flight conditions were experienced. Piper offered the modification by a Service Bulletin in which it agreed to pay for labor and material costs.

Piper later asked the FAA to issue an AD to require compliance with its Service Bulletin although no safety hazard was known.

The GAO study implies that there was some flaw in DOA procedures because Piper personnel did not interpret the rule the same as FAA personnel did.

GAO EVALUATORY REMARKS

The essence of this case study is that Piper did not advise FAA of changes in the nose section of a new model of the PA 23-250 before type certification, and FAA did not flight-test the new model because there appeared to be no substantive changes in the aircraft Subsequently, FAA found the change in a DOA audit and concluded that this change could affect the aircraft's flight performance. FAA officials flight-tested the aircraft and found that the new model aircraft experienced abnormal control forces which they deemed in noncompliance with regulations

Piper views on the difficulties in interpretation are considered in this case study. Had FAA flight-tested the aircraft before type certification, these difficulties might have been resolved with the appropriate design corrections before Piper placed the aircraft in service

3. Fuel Tank leakage on PA-23-235 and PA-23-250 Aircraft

These aircraft are both versions of the twin engine Aztec. The GAO study outlines the difficulties that Piper experienced when it was found that the fuel cells on early models had become porous and permitted leakage of fuel into the wings.

In the years 1968 to 1971 five PA-23-250 aircraft caught fire while on the ground as a result of fuel leakage being ignited by engine exhaust. No fatalities or injuries occurred and no such incidents have been reported on PA-23-235 aircraft Piper has manufactured 3,517 of these aircraft up to December 31, 1972

The GAO study outlines the extensive efforts by the FAA and Piper to eliminate this condition Piper improved the material used in the fuel cells on new production models and later provided smaller wing drain holes to prevent any problems on outstanding models.

In 1970 the FAA issued an airworthiness directive for inspection of wing areas for fuel stains prior to each flight and repairs as necessary

With FAA approval, Piper issued Service Letter 606 dated February 1, 1972 setting forth the inspection procedures which, if followed by aircraft owners, would eliminate the need for further compliance with the airworthiness directive

There is no question but the fuel tanks were a problem which has occupied both Piper and the FAA but there should be no implication that somehow the fuel leakage problem has resulted from some malfunction of DOA procedures This is simply a case in which the material selected for fuel cells proved in service to be unreliable and corrective action was taken.

GAO EVALUATORY REMARKS

The fuel cell problem was first observed in 1964 but, as discussed in the case study, was not corrected with a design modification until 1971 During the interim, Piper attempted unsuccessfully to correct the problem by calling for additional service inspection requirements by aircraft owners

Although no fatalities or injuries from explosions and fires were attributed to this condition, the safety hazards were apparent for a number of years before a design correction was considered necessary on the aircraft.

In summary, the three so-called "problem areas" described in the GAO study prove only that the FAA has been heavily involved with Piper in the certification of aircraft and in the interpretation of Federal Air Regulations. The cases studied do not deal directly with the effectiveness of the DOA procedures nor do they suggest that any other procedures might have changed the results in any way.

In our judgment, the only part of the draft study of the GAO that deals with DOA procedure is that part entitled "DOA Audits" The GAO study leaves the impression that FAA audits reveal serious non-compliance with Federal Air Regulations and the implication is that such non-compliance would not have occurred if standard FAA procedures had been followed.

We believe that a fair study of the FAA audits would show that a team of about 24 FAA experts conducted extensive audits of all procedures followed by Piper in the exercise of its Delegation Option Authorization. These audits were conducted for the years 1966, 1968, 1970 and 1972. In each case the FAA team wrote 30 to 40 pages of comments, suggestions and alleged non-compliances. Through a process of consultations and reports, each of the items were cleared up to the satisfaction of the FAA. The non-compliance items were never serious safety hazards and generally involved rule interpretations or improvements

The GAO's draft study sought only to elicit from FAA audits items described as being in non-compliance with Federal Air Regulations without in any way evaluating the significance of the items or indicating that Piper either quickly complied or satisfied the FAA there was no non-compliance.

It appears that the GAO has paid no attention to the actual DOA certification procedures and to the high degree of participation by the FAA in every stage of aircraft testing and evaluation Indeed, the GAO study indicates no understanding of the DOA procedure as it actually works but merely assumes that Piper is free to certificate any kind of flying machine it chooses to develop. This assumption is false and does a great injustice to the FAA, to Piper and to the industry.

GAO EVALUATORY REMARKS

The aircraft we considered were selected, generally because they had experienced unsatisfactory characteristics which required design modification. Several of the aircraft were selected because, according to NTSB studies, the unsatisfactory characteristics they exhibited were common to other light aircraft and because correcting these characteristics had been of concern to the Government and to the light aircraft industry. The conclusions in our report were based on review of several manufacturers' aircraft, not only those problem areas as indicated by Piper's comments.

Manufacturers are required to maintain detailed records of certification activities conducted under delegated authority, and FAA conducts audits of these records, generally about every 2 years. At the time of our review, FAA had performed a number of audits of the operation of delegation procedures at the Piper Aircraft Corporation These audits were comprehensive, and we did not consider it advisable to duplicate FAA efforts by making a further evaluation of the delegation procedures. We examined the results of the audits and obtained the views of FAA and the manufacturers on the benefits and detriments of delegation procedures.

Some of the DOA audit findings resulted in production changes to Piper aircraft in the interest of improving flight safety As an illustration, the December 1968 audit disclosed the Piper 31-300 was in noncompliance with FAA regulations governing stall characteristics Piper determined that the installation of wing flow strips would correct the problem and took action to appropriately modify production and in-service aircraft

Interpretation of regulations is a problem that is recognized in appropriate areas of the case study. We believe that our work at Piper illustrates the need for closer FAA involvement under delegation procedures in certifying new aircraft and that substantial delays in correcting recognized design weaknesses have been due, in part, to difficulties in interpretation of rules We are aware that FAA participated in the certification process for the aircraft in these case studies, and we believe that the case studies made it sufficiently clear that additional and more timely participation and action by FAA could have provided opportunities for avoiding or lessening certain of the problems encountered

The GAO study seeks to show that DOA procedures might have resulted in aircraft that were not in compliance with Federal Air Regulations and were presumptively unsafe. In our view, there is no evidence that unsafe aircraft have been produced by Piper. Where "non-compliance" has been found on FAA audits, they were either of a technical nature (and were corrected by Piper) or resulted from change in rule interpretations (in which case the FAA either agreed with Piper's interpretation or Piper made the corrections the FAA deemed advisable)

The tentative conclusion of the GAO staff, as explained to Piper, is that the DOA "needs strengthening" because the DOA procedure has not been applied in a manner consistent with the public interest We are at a loss to understand how this conclusion could be reached, since the DOA procedures have not been studied and the so-called "problem areas" merely reveal a high degree of involvement by FAA personnel in Piper's certification procedures Indeed, at the moment, the FAA has assumed the burden of flight testing all of Piper's Lock Haven aircraft prior to certification.

In our view, the only way to explain the approach taken by the GAO study investigating the effectiveness of the DOA procedure at Piper Aircraft is that the GAO study was structured to prove that DOA procedures are not working in the public interes

In conclusion, we would urge the GAO to begin its study of DOA procedures as applied by Piper and to approach the study as professional auditors interested in the procedure and the results obtained rather than to prejudge the matter. We think that the approach which has been used by the GAO is shallow and misleading and does not throw any light at all upon the effectiveness of the DOA procedure. It is obvious that the study has been structured improperly and, therefore, cannot result in a constructive analysis but can only result in prejudice to the FAA, to Piper and to the general aircraft industry.

We respectfully request that the draft study of the GAO be withdrawn and that a fresh, objective approach be taken.

GAO EVALUATORY REMARKS

We have made no general assumptions that any aircraft was unsafe, however, we believe that the case studies adequately demonstrate that there were safety problems with Piper aircraft and that there were serious questions whether certain characteristics of the aircraft were in full compliance with FAA regulations.

We have not depicted our review or our report to the Subcommittee as an evaluation of the effectiveness of DOA The report recognizes that DOA provides benefits to both the Government and the manufacturers. However, we feel that DOA could be strengthened significantly if FAA participated in flight testing and other critical testing leading to type certification We believe also that the case studies demonstrate that FAA needs to take more timely action in determining the significance of safety problems related to aircraft design and in requiring effective corrective action.

Since there appears to be some likelihood that the draft study of the GAO will be submitted to the Congress, we believe that some effort should be made to correct the misstatements and innuendos that are still contained therein To that purpose, we have attached to this letter a critique of the draft report pertaining to Piper Aircraft Corporation that was attached to your letter of March 8, 1973 We respectfully request that good faith efforts be made to clarify and correct the draft report before submission to Congress

Sincerely yours,

Joseph M Mergen
President

JMM rr
encls as stated

GAO EVALUATORY REMARKS

The detailed critique referred to by Piper and GAO notes on the matters discussed follow

Critique of the Draft Report of the General Accounting Office
Entitled Chapter 5 Regulation of Piper Aircraft Corporation Activities

This critique will discuss the sections of Chapter 5 under the headings which appear in the draft report

The First Grammatical Paragraph - Page 48

Piper Aircraft Corporation (Piper) is not a subsidiary of Bangor Punta Corporation Bangor Punta Corporation presently holds approximately 52% of the outstanding common stock of Piper A judgment of the United States Court of Appeals for the Second Circuit has enjoined Bangor Punta Corporation from voting approximately 14% of the outstanding common stock of Piper for a period of at least five years

Piper will produce 14 models of light aircraft during 1973 instead of 17 models These models will range from a one-seat agricultural aircraft to a Twin Turbo Prop corporate aircraft having eight seats.

GAO note The case study was revised in accordance with Piper's comments

Authorization to use DOA

The October 1966 DOA audit of Piper found that the Piper Navajo, PA-31-300, did not comply with federal air regulations in two respects

1 The rate of climb of the aircraft was deemed to be deficient with one engine inoperative

2. The aircraftfailed to meet the test for controllability after entering a stalled condition

These deficiencies were quickly corrected The rate of climb with one engine inoperative was improved by reducing the gross weight of the aircraft The aircraft met the controllability test after installation of a flow strip along the leading edge of its wings

The Piper Twin Comanche, PA-30, had not experienced similar "flight handling problems" as alleged by the report

GAO note. The case study recognizes that Piper took corrective actions on the findings resulting from the October 1968 DOA audit Also the case study was revised to avoid the implication that difficulties in the flight-handling characteristics with the PA-31-300 were similar to those experienced with the PA-30

As an outgrowth of the experience with the Navajo, PA-31-300, the Eastern region of the FAA did restrict Piper's DOA to require that all flight tests conducted by Piper be reviewed, flight evaluated and approved by the Eastern region. Piper has felt that this additional activity by the Eastern region has been beneficial in that it has served as a double check on Piper flight test engineers in verifying FAA interpretation of rules For that reason, Piper has proposed to continue to obtain FAA concurrence in flight test matters should the FAA see fit to lift this restriction

GAO note Piper's observations are included in the case study

DOA Audits

The Eastern region of FAA has conducted four, not three, DOA audits of the Piper Lock Haven plant, the latest in December 1972 The list of noncompliance items given in the report should be understood to mean "alleged" noncompliance items

Generally, they involve differences in interpretation of rules (The experience with the Navajo PA-31-300 being an exception)

The GAO report discusses the stall and spin characteristics of the Piper Twin Comanche PA-30, the reversal of control forces on the Piper Aztec(E), PA-23-250, and fuel tank leakage on early models of the Piper Aztec, PA-23-235 and PA-23-250 The report states that after the design problems were recognized on these aircraft extended periods of time passed before Piper and FAA agreed that the problems were serious and arranged for corrective actions satisfactory to the FAA This is misleading

> *GAO note. The case study recognizes that four DOA audits have been made at Piper and that there has been considerable disagreement as to the meaning of certain FAA regulations and the methods which should be used to show compliance with them With respect to the time involved in making design improvements available, the case study sets forth the actions which took place before design modifications were completed For example, the case study shows that, between June 1964 when FAA's western regional officials first questioned the stall/spin characteristics of the PA-30 and June 1970 when Piper made a modification kit available, a major cause of the delay was the concern within FAA as to the degree of pilot skills appropriate for testing the aircraft to show compliance with the regulations.*

The GAO report itself shows that there were alleged to be adverse stall/spin characteristics of the Twin Comanche, PA-30, but that these allegations were untrue and that the FAA had certificated the aircraft and had participated from the very beginning in reviews of its stall and spin characteristics The FAA never urged Piper to take corrective action regarding the stall/spin characteristics of the PA-30

GAO note. The case study discusses in detail the flight testing and conclusions of the FAA pilots The central question of compliance with FAA's regulations dealt with the degree of skill a pilot should have to follow FAA testing requirements. The FAA record shows that FAA did urge Piper to take corrective action

The GAO report itself shows that the control stick forces of the Piper Aztec, PA-23, were not thought to be "abnormal" by the FAA or by anybody else until the Aztec(E) was tested during a DOA audit and the test pilot decided that the force reversal after buffeting was not in compliance with Federal Air Regulations (FAR) This was simply a difference in rule interpretation There was never any question regarding the safety of the aircraft

GAO note. FAA's flight test of this aircraft occurred after the DOA audit. The case study shows that Piper considered this case a question of rules interpretation and that Piper made a modification available about 10 months after the DOA audit.

The GAO report mentions the fires resulting from the leakage of fuel tanks on early versions of the Aztec, PA-23-235 and PA-23-250 There were no personal injuries although there were five fires which occurred on the ground as a result of fuel leakage being ignited by engine exhaust The problem was ultimately corrected through intensive efforts by Piper and the FAA The delays which occurred were attributable entirely to an identification of the problem and the working out of appropriate corrective measures There were never any fires in the air caused by fuel leakage and there was practically no risk that this could occur since the leakage would evaporate by ventilation in flight

GAO note. Piper observations are contained in the case study

In short, nearly every sentence of this section is inaccurate and prejudicial

GAO note On the basis of the data available in the records and Piper, FAA, and NTSB views and observations, the case study accurately and objectively described the circumstances A primary purpose of providing Piper with an opportunity to comment was to insure that we considered all available facts and circumstances.

Stall and Spin Characteristics

This section of the GAO report deals with the Piper Twin Comanche PA-30 which was certified by the FAA on February 5, 1963 It was not certified by Piper as would have been the case if delegated option procedures had been followed. Therefore, it is not true as stated in the GAO report that "FAA type certified the Piper 30 Twin Comanche on February 5, 1963, under Delegation Option Procedures "

GAO note. At the time the PA-30 was certified, Piper was operating under Government procedures using designated manufacturer's certification representatives--the predecessor program to DOA procedures. The language of the case study was revised accordingly.

The certificated aircraft was not a "Piper 24 single engine Comanche aircraft modified to a twin engine configuration" as stated in the GAO report The first mock-up in the development of the Twin Comanche, PA-30, was a single engine Comanche air frame modified to a twin engine configuration This mock-up was the first step in the evolutionary process of developing the Twin Comanche, PA-30, that was utlimately certificated It is false and misleading to imply that Piper merely added an engine to a single engine aircraft and certificated the result by exercise

of its delegation option authority The fact is that FAA personnel were intimately involved in the development of this aircraft and its certification for a period of 11 months prior to its certification by an FAA official The aircraft was certificated only after a large panel of FAA and Piper technicians had jointly reviewed all the test data and FAA had conducted flight tests pertaining to the aircraft

GAO note. We did not imply that Piper merely added an engine to a single engine aircraft and certified the result, however, to clarify the matter we expanded the case study to distinguish between the original prototype aircraft and the aircraft certified FAA participation in the type certification of the Piper 30 is detailed in the case study.

The GAO report states that "Stalls occur at speeds too slow to sustain flight Spins can occur on twin engine aircraft when one engine becomes inoperative. Prior to type certification, Piper became aware that the aircraft had a design characteristic that could cause the problem and made some modifications in an attempt to correct the problem "

All aircraft will stall and all aircraft will spin It is the responsibility of the pilot to avoid stalls and spins for they can both occur with both engines on, or both engines off, or with one engine inoperative If a pilot inadvertently stalls or spins an aircraft, he can quickly recover if there is sufficient altitude Recovery from a stall of a Twin Comanche can be accomplished easily within 500 feet

It is not correct, as the GAO report states, that Piper was aware prior to type certification that the Twin Comanche had a design characteristic that could

cause the problem (We presume that the problem referred to is the problem referred to under the heading "Recognition of the problem" which speaks about the development of the tail surfaces prior to certification) The implication is that Piper was aware that the Twin Comanche had a design characteristic that would cause stalls and spins and that it certificated the aircraft anyway. This is untrue and an extremely damaging innuendo

GAO note The case study has been revised to show more clearly that Piper made design modifications to the prototype aircraft which was certified to overcome unfavorable flight characteristics which were recognized in the developmental prototype and that Piper was not aware that there might be unfavorable characteristics in the certified aircraft.

The NTSB statistics to the effect that the Twin Comanche was involved in a number of stall and spin accidents require interpretation First, it should be observed that pilots should never stall or spin an aircraft unless they are training and they are at sufficient altitude to recover from these maneuvers Second, it appears that many of the so-called stall and spin accidents have occurred through mishandling near the groundwhen recovery is difficult, if not impossible Third, the British have had an excellent safety record with the Twin Comanche and it is thought that the reason has been that the British have a more closely controlled training program and discourage stall maneuvers near the ground, whereas, the FAA has required demonstrating slow speed single engine control competence at low altitudes

GAO note The case study was revised to include Piper's views on FAA's pilot-testing requirements.

Piper did develop a modification to improve the flight characteristics of the Twin Comanche and this was offered voluntarily by Piper to all owners of the Twin Comanche free of cost to such owners. It is not true as alleged in the GAO report that the improvement was "paid for by Piper's 30 owners "

GAO note. Piper's observation is included in the case study.

Recognition of the Problem

The first paragraph of this section states that prior to type certifying the Twin Comanche, PA-30, Piper officials were aware that the aircraft had flight characteristic problems The report goes on to say that the mock-up disclosed a number of problem areas, including difficulty in recovery from power-on stalls with one engine inoperative

It is false and misleading to say that Piper officials were aware that the aircraft had flight characteristic problems. It is true that the mock-up did not meet Federal Air Regulations in its initial tests, but it is also true that the aircraft which was certificated, namely the Twin Comanche, PA-30, did meet Federal Air Regulations and Piper officials were not aware that this certificated aircraft had any flight characteristic problems

It must be understood that this section of the GAO report is really drawing from information generated during the development stages of the PA-30. Also, it must be understood that mock-ups and models are often built during development of a new airplane to determine those areas in which it does not meet Federal Air

Regulations. They must be modified and perfected so that they will meet all Federal Regulations before the design can be frozen into a production model that can be certificated This was the process that Piper went through in developing the Twin Comanche, PA-30.

> *GAO note. As previously indicated the case study was expanded to more clearly show the distinction between the developmental prototype aircraft and the aircraft certified. The case study also discusses the changes made by Piper to overcome unfavorable characteristics noted in the developmental prototype aircraft and makes it clear that Piper was not aware that the certified aircraft might have unfavorable flight characteristics.*

The discussion in this section of the recommendation made by the aerodynamics section of Piper to increase the area of the vertical tail surface implies that the Piper management did not accept the recommendation of its aerodynamics section because it "would completely alter the basic appearance of the aircraft " In other words Piper sacrificed safety for appearance.

The fact is that the Piper Engineering Department not the Piper management, decided upon the appropriate area for the tail surface of the PA-30 after trying many versions with different configurations and testing a number of them in actual flight It was found from such experimentation that the vertical tail surface of 14 9 square feet was adequate to provide the controllability needed to meet all Federal Air Regulations. The FAA agreed with this determination at the time of certification and continues to do so to this day. Are the GAO auditors willing to substitute their judgment for the judgment of the FAA?

GAO note The case stuay was revised to include the basis for the determination of the appropriate area for the vertical tail surface as described by Piper The case study also shows that FAA certified the aircraft after satisfying itself as to the acceptobility of its flight-handling characteristics

On page 52, the GAO report states that "FAA did not review the adequacy of the tail surfaces prior to type certification " Later on the same page it is stated "From January 31 to February 4, 1963, an FAA flight test pilot reviewed the flight characteristics of the Piper 30 " He " concluded that the Piper 30 complied with FAA regulations " These statements are contradictory We know that a large panel of FAA and Piper technicians reviewed the test data pertaining to the aircraft and that an FAA official actually issued the type certificate over his signature on February 5, 1963 How then can it be said that the FAA did not review the adequacy of the tail surface prior to type certification? We know that in fact the FAA flight test pilot did determine the stall characteristics of the PA-30 and found the aircraft did meet the controllability standards of the FAA regulations.

GAO note The case study was revised to delete any reference to FAA review of the adequacy of the vertical tail surface Also the case study shows that FAA's test pilot determined that the aircraft met FAA regulations with respect to stall characteristics and concluded that the aircraft met FAA regulations with respect to spin characteristics on the basis of his review of Piper tests showing compliance and flight spot checks

Under the heading "Actions After Type Certification" there is a discussion of the formation on September 3, 1964 of a Multiple Expert Opinion Evaluation Team to evaluate the stall characteristic of the Twin Comanche PA-30 The statement is

made that the team determined that the aircraft did not comply with Federal Air Regulations because exceptional piloting skill was required to recover from power-on, gear and flaps down stall maneuvers.

The use of the word "recover" is entirely misleading. The team was established to determine whether the PA-30 complied with FAA regulations. One regulation (CAR 3, Section 3.120) includes a test of the controllability of an aircraft, during the recovery portion of the stall maneuver. The test is to ascertain whether the aircraft can be prevented from rolling or yawing more than 15^{o} after it has stalled. This is a very rigorous test. If the wings of an aircraft dip more than 15^{o} after entering a stall, the solution is simple: simply lower the nose, gain air speed and recover control.

There was never any question about recovering from stalls and there is no question that even inexpert pilots know how to recover from a stall. The question in the minds of the evaluation team was whether the PA-30 could be so controlled that after entering a stall with power on and gear and flaps down, the later attitude could be maintained without allowing the wings to roll more than 15^{o}. This was found to require exceptional pilot technique. The FAA headquarters in Washington ruled, in effect, that because of the artificial nature of the maneuver, compliance with Section 3.120 by the application of exceptional pilot technique would be deemed sufficient.

GAO note. The case study was revised to clarify the Team's findings and FAA headquarters' ruling.

The GAO report takes issue with the determination of the FAA on the ground that the PA-30 is likely to be flown by less skilled pilots and that many accidents involving the aircraft have occurred during training or practice flights This observation by the GAO is apparently based on the assumption that if exceptional pilot skill is required to fly an airplane through the test specified by Section 3 120 that this makes the aircraft hazardous for less skilled pilots This assumption is incorrect All pilots, both skilled and unskilled, are taught that if they inadvertently stall an airplane they can recover easily and quickly by merely lowering the nose and recovering air speed These simple recovery techniques can be applied even if the aircraft wings roll more than 15^{0} after entering a stall In short the inability of an unskilled pilot to fly the Twin Comanche PA-30 through the maneuver required by CAR Section 3 120 does not imply that the unskilled pilot would have any difficulty whatsoever in recovering from a stall or a spin in a PA-30 The accidents that have occurred during training flights involving the PA-30 can be understood if it is realized that

1 The FAA at one time required stalls to be practiced at low altitudes,

2. The more inexpert the instructor or pilot, the greater the accident rate

GAO note *The case study has been expanded to include Piper's views on FAA requirements for pilots demonstrating proficiency*

The GAO report states that there was a consensus at the Third Annual Flight Symposium in January 1965 that the level of safety had been unjustifiably reduced by using exceptional pilot skill for determining compliance with stall requirements Piper was not advised of this consensus and the FAA did not then adopt that position

GAO note *Piper's comments were incorporated into the case study*

The National Aeronautics and Space Administration evaluation of the Twin Comanche PA-30 in a report issued November 1966 does not reveal that the PA-30 used in the test had been in a ground accident and that the rudder travel on the aircraft tested was 19% to 26% less than the design certified by the FAA There is also a serious question whether the rigging tension on the rudder cables was at the proper value

GAO note *Piper reservations concerning the NASA report were incorporated into the case study*

Again, on page 54, the GAO report states "Between 1967 and 1970 NTSB repreatedly requested FAA and Piper officials to investigate the aircraft's stall and spin characteristics " We are unable to find any evidence in the Piper files of any such requests and we have contacted Piper officials who might have received such requests, and they have no knowledge of it This statement is apparently false

GAO note *The records indicate that Piper was present at only one meeting in which NTSB requested an investigation of the aircraft's stall-and-spin characteristics The case study was revised to show that NTSB requests were directed to FAA*

The NASA wind tunnel tests concluded September 1968 did not conclude, as reported by the GAO, that "the apparent cause of the behavior of the PA-30 in the stall was that the lateral forces were greater than the corrective forces produced by the controls " The NASA report states "The behavior of the airplane at the stall seems to be the result of the rolling and yawing moments produced by the

asymmetric stall These moments are greater than the corrective moments produced by the control " Such wind tunnel test results are not indicative of free flight at extremes of operation Furthermore, the PA-30 used in the test had the equivalent of 200 HP engines installed, whereas, Piper has never produced a PA- 30 with engines having in excess of 160 HP The increase of 25% in the HP in an asymmetrical configuration can seriously affect the controllability of the aircraft throughout the stall

GAO note The discussion of this matter in the case study was revised to incorporate NASA's description of its finding and to show Piper's reservations concerning the tests

The discussion on page 56 of the GAO report is a garbled explanation of Piper's efforts to increase the manufacturer's recommended minimum single engine speed for the Twin Comanche, PA-30 Piper did not seek to increase the "minimum control speed"as alleged by the report The minimum control speed determined under Federal Air Regulation is V_{mc} The V_{mc} for an airplane is normally an air speed at which an aircraft with one engine inoperative can be controlled Piper had originally determined the V_{mc} to be 80 miles per hour There is no question but that 80 miles per hour is the correct speed for V_{mc} However, the British had provided an extra margin of safety by specifying a take-off safety speed of 90 miles per hour Since the British have had such an excellent safety record with the PA-30, it occurred to Piper that it might minimize accidents if a placard prohibiting single engine flight below 85 miles per hour was displayed This created a furor with the

FAA which resulted in its retesting the aircraft and increasing the placard V_{mc} to 90 miles per hour It is presumed that the purpose of the FAA was to provide an additional margin of safety

GAO note The discussion in the case study was expanded to incorporate Piper's observations

Piper also sought to minimize accidents by prohibiting single engine power-on stalls and by prohibiting power-on and power-off stalls below 5000 feet The FAA immediately prohibited FAA inspectors and examiners from continuing flight tests on the PA-30 only because the FAA required students to demonstrate ability to control the aircraft at V_{mc} (80 MPH) while the Piper placard prohibited single engine flight below 85 miles per hour. Utlimately, Piper was persuaded to withdraw its prohibition against single engine power-on stalls and to merely restrict the aircraft to the performance of stalls above 5000 feet This compromise allowed FAA inspectors and examiners to conduct all flight tests on the PA-30

The last paragraph, page 56, states erroneously that "the Deputy Director of Flight Standard Services advised Piper officials that the accident history of Piper 30 was worse than that of comparable aircraft " The person referred to stated that the accident history of the PA-30 was no worse than that of comparable aircraft That offical did not state that corrective actions directed at pilots were unacceptable to the FAA Indeed, the FAA did accept the placarding of the PA-30 by Piper Aircraft to increase the V_{mc} and to require that stalls be practiced above 5000 feet

GAO note *It appears that Piper received a different understanding of the discussion than FAA and this difference is noted in the case study*

Piper has no knowledge of the statements in the first paragraph at page 57 of the GAO report However, it questions what the paragraph is doing in the report since it deals with a modified PA-30 and deals with communications between FAA regions to which Piper was not a party

GAO note *The matter referred to above deals with a report from FAA's southwest region to FAA's eastern region concerning PA-30 characteristics We consider the report material to show the continuing discussion within FAA as to whether the PA-30 met FAA regulations*

At the foot of page 57 of the GAO report, it is stated "Although FAA had never notified Piper that the basic Piper 30 did not comply, FAA found the modified aircraft's lateral stability did not meet FAA regulations " The "lateral stability" referred to is not the same thing as the controllability of an aircraft when entering a stall The "lateral stability" test of the CAR requires a plane to show a tendency to return to wings level, using the rudder with ailerons free after having been placed in a 10^{o} coordinated banked turn In the original certification of the PA-30, this demonstration was conducted with wing flaps retracted and in the takeoff position (15^{o}) with power-off and power- on However, at the time the airflow modification kit was flight tested by the FAA, this demonstration was required using full (27^{o}) wing flaps This more severe interpretation of the test condition resulted in the requirement to install a rudder/aileron interconnect in order to cure the problem Prior to this new interpretation there was no question concerning lateral stability, thus, the FAA could not have notified Piper that the PA-30 as originally certificated did not comply

GAO note *The case study was revised to delete reference to the basic PA-30*

On August 18, 1971, the NTSB did recommend that the FAA issue an airworthiness directive requiring that the Piper airflow modification kits be installed on all PA-30 aircraft At that time Piper had been campaigning for more than one year to persuade owners to install the airflow modification kits and had succeeded in obtaining about 62% compliance, not 45% compliance as stated in the GAO study By May 1, 1972, Piper had obtained 94 5% compliance

Regulatory agencies in foreign countries have required installation of the airflow modification kits on PA-30 aircraft registered in their countries as stated in the GAO report. However, it is commonplace for foreign governments to make mandatory improvements which are deemed to be discretionary in the United States

GAO note. The case study was revised to include Piper's reported compliance.

The illustration of the airflow modifications is incorrect in a number of respects Instead of "elevator travel limited" the stabilator up travel was limited Instead of the "rudder modified" the rudder was rerigged to one degree right of neutral Instead of "ailerons modified, " ailerons were rerigged A seal was provided between the fin and rudder Where did the GAO get such an illustration?

GAO note *The illustration was provided by FAA and revised for Piper comments.*

The foregoing comments dealing only with the section entitled "Stall and Spin Characteristics" and dealing only with the Piper Twin Comanche, PA-30, illustrate that the thrust of the GAO study is to condemn the development, design and

testing of the PA-30 and by implication to condemn the DOA procedure The fact is that the PA-30 was certificated by the FAA, not Piper, after extensive cooperative effort on the part of the FAA and Piper The aircraft has not been inherently unsafe and has not been defectively designed Repeated flight tests by the FAA and by Piper have demonstrated that it does meet all applicable Federal Air Regulations The unfortunate accidents involving the PA-30 are largely the result of stalling the airplane at low altitude and from overloading the aircraft We submit that no plane can be safely stalled at low altitude or safely overloaded We think that an objective review of this section of the GAO draft report will demonstrate that it is sufficiently false and misleading to be unfairly prejudicial to the FAA and Piper

GAO note. As previously indicated a primary purpose in our soliciting comments on draft reports is to insure that all relevant facts and observations are brought to light and considered to provide fair and objective reporting Piper's comments have been appropriately incorporated into the case study

Abnormal Control Forces

This section deals with the reversal of stick pressure that occurred after the Aztec(E) had been flown beyond the buffeting usually associated with a stall The GAO report refers to this as "adverse aircraft handling qualities" throughout this section.

In late 1969 Piper modified the nose of the Aztec to change it from a rounded shape to a pointed shape and it designated the new configuration the Aztec(E) Piper did flight test the aircraft, but did not measure the stick forces because it was confident that the slight change in configuration would not alter these forces When

the Aztec (E) was flight tested by the FAA during the 1970 DOA audit the test pilot concluded that the Aztec(E) was not in compliance with a certain FAA regulation (CAR 3.114(a))which requires that positive stick pressures by exerted until aircraft enters unsteady flight conditions Piper engineers and test pilots had always thought that the Aztec entered unsteady flight conditions when it experienced the buffeting normally associated with a stall The FAA test pilot concluded that since the Aztec could be flown through buffeting and on to a stall that positive stick pressure should be maintained until the stall occurs This was, in effect, a change in rule interpretation by the FAA It required Piper to modify the Aztec(E) by connecting a spring device to the control system to maintain a positive stick pressure even after an unsteady flight condition was experience.

GAO note. Piper comments were incorporated into the case study

The implication of the GAO report is that Piper hoodwinked the FAA by not advising it of the change in the configuration of the nose of the Aztec(E) and thereby leading the FAA to forego a flight test of the modified Aztec When the FAA "discovered" that the modified Aztec(E) did not comply, it was actually imposing upon Piper a new interpretation of the Federal Air Regulations Piper has no doubt that the FAA is authorized to reinterpret its own rules, but it does not feel that it should be condemned when this is done

GAO note. We did not imply that Piper "hoodwinked" FAA The case study reports that Piper did not notify FAA of the change in the configuration of the nose of the aircraft and that FAA recognized in its later audit

that the change had been made and, in subsequent tests, determined that the aircraft did not fully comply with FAA regulations Piper's comments on its interpretation of the regulations are contained in the case study

The GAO report on page 60 refers to "adverse aircraft handling qualities associated with the aircraft nose modifications " There was no change in the handling qualities of the Aztec associated with the nose modification It should be pointed out that also there has never been any accident or complaint associated with the reversal of stick pressures on any Aztec model Instead, there have been some complaints about the modifications which Piper was required to make to comply with the FAA interpretation of the Regulations

GAO note The comments in the case study have been clarified to incorporate Piper's observations

In Piper's view, there has never been a safety hazard associated with the reversal of stick pressure on any model of the Aztec To understand this, one should realize that the maneuver which is to be performed by test pilots is to apply back stick pressure at a rate which will reduce the speed of the aircraft by one mile per hour per second until unsteady flight is experienced The object is to see whether this rate of reduction in air speed can be maintained by a positive back pressure until an unsteady condition exists In the Aztec, positive back pressure is required until buffeting occurs. Thereafter, pressure must be released and a slight forward pressure exerted on the stick to maintain this rate of reduction in air speed until the stall If the pressures were not reversed and the stick was held back, the only consequence would be that the rate of reduction in air speed would increase above

one mile per hour per second However, in either condition, the attitude of the nose of the Aztec is exaggeratedly above the horizon and it is inconceivable that any pilot would be fooled or misled by this slight reversal in stick pressures

The language of the GAO report on page 61, in seeking to explain the maneuver for testing stability, states "In a steep ascent the pilot ordinarily must exert an increasingly stronger pull force for the aircraft to continue to climb while losing air speed. The aircraft will stall when it no longer can sustain flight due to insufficient flying speed Unless the aircraft is at a sufficient altitude to regain flying speed, it will crash "

The quoted language is obviously designed to be prejudicial It has nothing to do with the safety of the Aztec(E) or any other Aztec model, but the language implies that the failure of the Aztec(E) to meet the technical standard described above will result in a crash! This is untrue and grossly unfair

GAO note The comments were intended to relate the problem as described to us by FAA personnel. The discussion has been revised to prevent an interpretation similar to that made by Piper.

It is not true as stated in the GAO report that "FAA found that the Piper 23-250 had a tendency to stall prematurely in performing the same maneuver " The Aztec, PA-23-250, has a stall speed which is neither premature nor delayed It is what it is and the FAA has never indicated that the PA-23 has a tendency to stall prematurely (this is a conclusion of the GAO only) The concern of the FAA has been that the stick pressures required to fly the PA-23 after the buffeting point and into

the stall, while reducing speed at the precise rate of one mile per hour per second reverses from a positive back pressure to a slightly forward pressure The aircraft can be flown into the stall by maintenance of positive back pressure throughout the maneuver, but if positive back pressure is maintained, then the reduction of speed will not be at a constant rate of one mile per hour per second In either case, the stall occurs at the same speed

GAO note. The case study was revised to give effect to Piper comments

The foregoing comments regarding the section entitled "Abnormal Control Forces" are intended to illustrate the false and prejudicial statements contained in the GAO report The false statements seem to be designed to prove that Piper "hoodwinked" the FAA when in fact the problem arose because of a difference in the interpretation of a particular Federal Air Regulation designed to test the stability of an aircraft at slow speeds Piper has produced, as of December 31, 1972, 3,517 Aztec models and the aircraft is generally regarded as one of the most docile and stable aircraft ever built

There has never been any safety problem arising from its stability characteristics. Indeed, it is exceptionally easy to fly at low speeds There is no risk whatsoever that the aircraft will "stall prematurely" as stated by the GAO report

GAO note The discussion in the case study on this matter incorporates data available in the records and FAA and Piper views and observations It is not designed to prove that Piper "hoodwinked" FAA, but it does present a historical narrative showing that FAA determined noncompliance with its regulations early in the production of the aircraft and that Piper effected a modification after 116 aircraft had been produced

Fuel System

The section entitled "Fuel System" mentions five fire or explosion incidents arising out of the leakage of fuel tanks on the Piper Aztec, PA-23-250 and PA-23-235 There was only one alleged explosion All incidents occurred on the ground as a result of fuel being ignited by engine exhaust No personal injury occurred as a result of any of these fires

The fuel tanks on early models of the Aztec proved, in service, to develop pin hole leaks Gasoline escaped from these tanks into the trailing parts of the wings and created a hazard It took a considerable amount of time for Piper and the FAA to discover the nature of the problem and to work out a solution As the report shows, a solution has been worked out and no more fires have occurred

The Aztec was certificated under DMCR procedures which were prior to the adoption of DOA procedures The implication of the GAO report is that some other procedure might have obviated the problem The problem in this case was simply that the material selected for the fuel cells proved in service to be unreliable As soon as that was determined, production models were changed and corrective action was taken It would seem that the only purpose of including this section in the GAO report is to embarrass Piper and the FAA by indicating that it took a long time for Piper and the FAA to work out a solution to the problem A number of approaches were attempted, but the final solution was to make the wing drain holes smaller and to seal a portion of the cavity in which the fuel cell is located

It is submitted that this section of the report does not throw any light whatsoever upon DOA procedures or the efficacy of the certification process.

GAO note. The discussion on this subject contains the essential elements of Piper's discussion above. We agree that the problems encountered in this instance do not concern the DOA process The matter is included in the case study as an illustration of the time and difficulties that can be associated with effecting a permanent solution to a design weakness that is not recognized until after an aircraft is certified and produced

CASE STUDY 4

REGULATION OF ROCKWELL INTERNATIONAL CORPORATION

BETHANY AIRCRAFT DIVISION ACTIVITIES

At its manufacturing facilities in Bethany, Oklahoma, the Bethany Aircraft Division of Rockwell International Corporation produces three models of light twin-engine aircraft that seat from seven to nine passengers These aircraft, known commercially as Aero Commanders or Commanders, are used primarily in corporate and air-taxi operations.

In 1970 the Bethany Aircraft Division delivered to dealers and new owners 61 aircraft with a sales value of about $15 million and in 1971 delivered 37 aircraft with a sales value of about $5 million

DELEGATION AUTHORIZATION

On July 1, 1965, Aero Commander Division, recently renamed the Bethany Aircraft Division of Rockwell International, was authorized to design and produce aircraft under DOA

In March 1970 Aero Commander Division curtailed aircraft production because of declining sales and a resulting high inventory To insure that capability to operate under DOA was maintained, FAA's southwest region initiated monitoring procedures over aircraft production activities at the plant during both the shutdown period and the following production buildup period Shortly after adopting monitoring procedures, FAA considered canceling the Division's DOA because its quality control system had deteriorated However, by June 1970, numerous inspections and tests showed that the quality control system had improved to such an extent that FAA permitted the Division's DOA to remain in effect After normal production resumed, FAA discontinued the monitoring procedures in April 1971

DOA AUDITS

The southwest region has conducted two DOA audits of the Division's operations The first audit, conducted in March 1967, was limited because the Division had not type

certified any new aircraft under DOA No substantial discrepancies were noted.

In the second audit, conducted in October 1969, FAA found 78 instances of noncompliance such as insufficient documentation of compliance testing and failure to keep revisions to engineering data current, however, most of the findings related to poor quality workmanship which was due, in part, to incomplete records of production designs and processes and ineffective quality control and inspection procedures over production and components manufactured by suppliers.

Shortly after the audit, FAA instituted direct surveillance procedures over the Division's production activities until FAA determined that the production and quality control procedures had been improved The Division resolved other matters of noncompliance to FAA satisfaction by improving document control procedures, issuing service bulletins, and revising engineering and production designs incorporated in future aircraft The audit also included findings of compliance in a number of areas and included 13 recommended improvements that did not involve matters of noncompliance The results of a third DOA audit conducted in late 1972 were not discussed above.

DESIGN WEAKNESSES

Certain Aero Commander aircraft have experienced design problems in the fuel caps and wing structures of its aircraft. In 1955, FAA became aware of the problems in connection with initial incidents of fuel siphoning and in-flight wing failure. The manufacturer attributed the problems to improper preflight inspection and in-flight maneuvers by the pilots FAA is acting to require correction of the fuel cap problem and NTSB is studying the wing structure problem.

Fuel cap

Since 1955 Aero Commander aircraft have experienced a number of instances of fuel exhaustion attributed to inadvertent fuel siphoning The prevalent cause for the fuel siphoning was failure to replace, or insure proper replacement of, the fuel caps In certain models of the aircraft, the problem is aggravated because (1) all fuel tanks are interconnected, which permits the entire fuel supply to

siphon, and (2) the location of the caps makes them difficult for the pilot to check during preflight inspections. These models were type certified before the Division received DOA, therefore, FAA personnel were involved in the precertification tests.

The FAA regulations in effect when most of these models were type certified specified that total loss of power must not occur if one component of the fuel system fails and that fuel caps should be designed to minimize the possibility of incorrect replacement or loss in flight NTSB and FAA accident investigations, which extended from March 1955 to April 1972, revealed 25 fuel starvation accidents involving Aero Commander aircraft, resulting in 5 fatalities and numerous injuries Improper replacement of the fuel caps was cited as a contributing factor to the accidents

Between 1955 and 1965 Government officials debated with the manufacturer the need for nonsiphoning fuel caps In November 1965 the manufacturer made nonsiphoning fuel caps available to aircraft owners As of May 1972, over 1,600 aircraft had been produced without nonsiphoning caps and only a small number of nonsiphoning fuel caps had been sold to aircraft owners

History of corrective action

The manufacturer issued a service letter on February 3, 1955, which suggested a modification to the existing fuel caps to help prevent improper replacement Also a commercially available cap, considered by the aircraft manufacturer to be an improvement over the existing cap, was incorporated in production aircraft This cap was not adaptable to some 230 aircraft produced before 1955.

As a result of a March 1955 fuel exhaustion accident in which the cap had not been modified, the Civil Aeronautics Administration suggested that an airworthiness directive requiring owners to modify the fuel caps might be warranted. Aero Commander asserted that carelessness on the part of service attendants was the cause of the three known fuel-cap-related siphoning accidents and that any directive should be against the caps themselves rather than against their use on Aero Commander aircraft, because several other manufacturers also used them.

Aero Commander issued a second service letter on October 15, 1955, advising owners that the fuel cap connecting chains needed to be modified to facilitate replacing the fuel caps.

In February 1964 FAA stated that the causes of fuel siphoning and fuel cell collapses on Aero Commander aircraft were (1) improper replacement of the filler caps, (2) failure to check the caps during preflight inspections, and (3) improper maintenance of the caps. Since the two service letters had not eliminated the problem, FAA suggested that Aero Commander take further action In April 1964 the Division issued a third service letter which provided for replacing various parts of the two types of caps in use at that time.

In 1964 a nonsiphoning fuel cap became commercially available which was suitable for installation on several models of light aircraft, including Aero Commanders The Division began installing the new caps on jet and turboprop aircraft in production but not on propeller aircraft

Because of a fatal accident in 1964, FAA suggested on July 14, 1965, that the Division make nonsiphoning caps available for aircraft in service and incorporate such caps in all aircraft under construction. The Division believed that cost of a production change was not justified, but in November 1965 it made nonsiphoning caps already used on one production model available as an option for inservice aircraft Shortly thereafter, FAA again suggested the use of the nonsiphoning caps on all models under construction. Although the Division did not immediately follow the suggestion, it incorporated the nonsiphoning caps used on certain newer models in all other production models in 1968. Also, in 1968 the Division began developing a special nonsiphoning cap for the 230 aircraft produced before 1955.

In October 1966 FAA again raised the question of whether a directive should be issued, but the Division held to its previously stated position that, if a directive were issued, it should be against use of the caps on all aircraft

Later that month the Division stated that the caps had no apparent design deficiency. Citing its experience and referring to other aircraft which used the same caps, the Division indicated that the problem was the improper

replacement of the caps Also, the Division asked for an FAA General Counsel opinion as to whether an airworthiness directive could be issued In December 1966 an FAA southwestern region official advised the Division that recent efforts to solve the problem constituted sufficient action.

In April 1972 an official of FAA's Washington headquarters recommended that the southwest region issue an airworthiness directive to require installation of nonsiphoning fuel caps on the Aero Commander aircraft Southwest region officials expressed reluctance to do so because of possible FAA involvement in a pending lawsuit and suggested that FAA headquarters handle the problem since it was not peculiar to Aero Commander aircraft

In May 1972 an FAA regional official advised the Division that a directive might be necessary In reply, a Division official stated that the caps were used on other aircraft and again suggested that any directive should be issued against the caps themselves As of April 1973, the southwestern region was considering whether an airworthiness directive should be issued

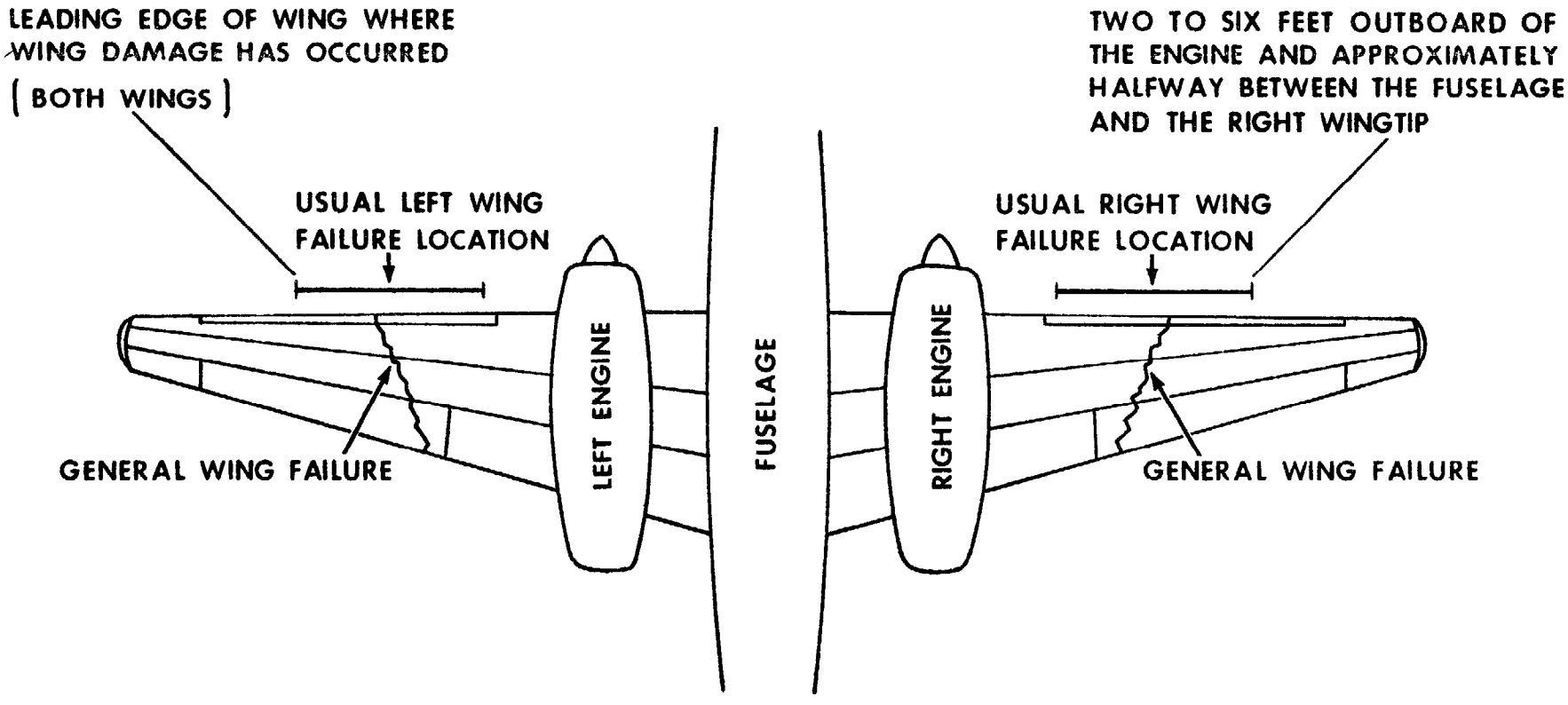
Bethany Aircraft Division indicated that their discussions at various times with FAA officials over the fuel cap problem usually centered around the following facts fuel siphoning was not peculiar to the Aero Commander aircraft, the problem was operational since the cap was easily installed and visually inspectable for proper installation, the incident rate per number of refuelings was extremely low The officials stated that they had made changes in fuel cap design as fast as new designs became available.

Wing structure

Since 1953 certain Aero Commander aircraft have had a series of incidents or accidents in which the outer wing panels have been damaged or separated from the aircraft. Wing damage or failure occurred about halfway between the centers and the tips of the wings, approximately 2 to 6 feet beyond the engine (See illustration on p 98)

Of the approximately 2,000 Aero Commander aircraft produced, 22 have experienced wing damage In 14 aircraft one or both wings failed and caused 24 fatalities, and in 8 aircraft the wings were damaged but caused no fatalities

ILLUSTRATION OF LOCATION OF DAMAGE OR FAILURE TO AIRCRAFT WINGS



These accidents generally occurred during flight under turbulent conditions or during abrupt maneuvers

In 1963 the Chairman of CAB advised the Administrator of FAA of a trend in Aero Commander wing failure accidents and suggested that the effects of turbulence may not have been considered in original manufacturer tests for type certification. FAA advised CAB that the aircraft met or exceeded FAA requirements However, since 1963 the manufacturer has been conducting a series of tests to establish the cause of the problem Bethany Division officials stated that the costs of their testing programs have been substantial and that they included analyses outside the scope of Federal regulations FAA has monitored Division efforts in this area but has not independently attempted to identify the cause of the failures. The tests have repeatedly shown that the aircraft complied with applicable Federal regulations

To prevent excessive pilot control forces in turbulence which could result in wing failures, the Bethany Aircraft Division has initiated a program to test a modification to the control of the aircraft which would compensate for such forces NTSB is studying the causes of wing failures on all light aircraft, including Aero Commander aircraft NTSB has not established a firm completion date for its work

BETHANY DIVISION OF ROCKWELL INTERNATIONAL CORPORATION COMMENTS AND GAO EVALUATORY REMARKS

A draft of the information presented in the case study was furnished to the Bethany Division of Rockwell International Corporation on March 8, 1973. Bethany's comments dated March 16, 1973, and our evaluatory remarks, as appropriate, follow

General Aviation Divisions
North American Rockwell

5001 North Rockwell Avenue
Bethany Oklahoma 73008
(405) 789 5000

March 16, 1973

Mr Richard W Kelley
Associate Director
United States General Accounting Office
Resources and Economic Development Division
Washington, D C 20548

Dear Mr Kelley·

We appreciated receiving your letter of March 8, 1973, which enclosed the Rockwell International portion of the GAO report to the congressional subcommittee We further appreciate the opportunity to comment prior to the submission of your report

We would like to clarify our divisional organization The General Aviation Divisions are comprised of the Albany Aircraft Division in Georgia, the Bethany Aircraft Division in Oklahoma, the Sabreliner Division in Los Angeles, and the Aviation Services Division which has service facilities throughout the United States Since the Bethany Aircraft Division is the only Delegated Option Authorization facility, your GAO audit was limited to this division For this reason, you may wish to limit your introductory description to that facility

This division produces twin-engine aircraft only including three models at the time of the audit from a small seven-place aircraft to the nine-place twin turbopropeller aircraft For the most part, these aircraft are used for corporate operations

In 1970, this division delivered 61 aircraft to dealers and new owners with a sales value of about $15 million In 1971, the Bethany Aircraft Division delivered 37 aircraft with a sales value of about $5 million

We are concerned about the report in principle The audit was outlined to us as an evaluation of the FAA control over the Delegated Option Authorizations of the various corporations The report is described as a statement of facts, and in reading it, we see that is basically what it is It does not include any summary, conclusion, or evaluation

There are many facts that could have been listed, but, since only three areas are discussed, we must assume these are considered problem areas or meaningful in some other sense We have seen no investigation or even conjecture as to how these facts would have changed had we not been under DOA In our opinion, they would have been no different, especially since these service items were in being prior to DOA at this division Service difficulties of this type are handled the same under DOA or standard procedures as far as FAA coordination is concerned It would seem that elsewhere in your report the congressional subcommittee will be told what these case histories indicate If so, and this is available to us, we would appreciate receiving this information since we find it difficult to comment otherwise

The chronology is basically correct, however, there are inferences or opinions stated which could be debated One example is on page 68, paragraph 4 The statement is "In 1955 FAA recognized both design problems" This was merely the time when the first fuel siphoning incident was reported and when the first recognized in-flight wing failure occurred There was not a recognition of design problems since they were considered isolated cases of One, an improper preflight inspection, and, two, improper in-flight maneuvers

There are other similar phrases in the report, however, we would prefer to comment as follows

In the case of the fuel cap, changes were made on the design as fast as they became available The first was in 1955, after 230 aircraft had been produced, when a new commercial flush cap was marketed which was considered virtually fool-proof compared to the previous military cap As your report states, service publications were issued on the original cap as we found ways to change it to make its reinstallation, after fueling, easier and safer The commercial cap was not adaptable to the first 230 aircraft

As soon as a non-siphoning type cap was commercially available in 1964, we initiated production installations on the pure jet and turbopropeller aircraft The cap was also made optional on other production aircraft and

available in kits to the fleet In 1968, we started production installations of this cap on all aircraft and began development of a special non-siphoning cap for the remainder of the first 230 Commander aircraft in the fleet

Our discussions at various times with FAA concerning an Airworthiness Directive on the Commander fuel cap usually centered around the following facts

1 Fuel siphoning is not peculiar to the Commander aircraft

2 The problem was operational since the cap was easily installed and visually inspectable for proper installation

3 The incident rate per number of refuelings is extremely low

The Airworthiness Directive being issued by FAA will require our available kits to be installed on all aircraft not yet modified

We realize any airplane wing will fail if overloaded, however, we have still been duly concerned with the failures on our aircraft Since 1963, we have expended hundreds of thousands of dollars re analyzing and retesting in orde to duplicate failure patterns found on accidents As your report states, each investigation indicates the wing has a margin of safety well above the requirements Many of these investigations have included analyses in areas outside of those required by the regulations and include flight characteristic not prescribed by regulations As technology increases and new state-of-th art arises, new investigations are conducted to see if an increased level of safety can be established

Both ourselves and FAA become concerned when history repeats itself in accidents whether it is the cause or effect Each time these two items were noted in an accident, new discussions ensued and together we have done what we consider appropriate to the facts at hand As previously stated, we doubt if any of the corrective actions or dates would have changed had the Bethany Aircraft Division been under standard procedure surveillanc As originally stated, the line of communications for these type service problems is the same for DOA or standard procedures

We welcomed the GAO audit team with an effort to cooperate fully since we are proud of our division and its relations with FAA

We thank you again for the opportunity to review and comment on this report

Sincerely,

GENERAL AVIATION DIVISIONS
ROCKWELL INTERNATIONAL CORPORATION

Kenneth L Hale
Director-FAA Affairs

KLH un

GAO EVALUATORY REMARKS

Recognition is given in the case study to (1) Bethany's extensive testing of airplane wing failure conditions, (2) Bethany's program for a modification to the controls of the aircraft that would compensate for excessive pilot forces in turbulent weather that could result in wing failure, and (3) NTSB's program for evaluating wing failures on light aircraft, including the Aerocommander Also recognition is given in the case study to the efforts of Bethany to caution pilots of the need for proper replacement of fuel caps to prevent in-flight siphoning of fuel and to production changes to the fuel cap

We directed our review to evaluating the adequacy of FAA actions to identify and correct safety defects in light aircraft In the two cases involving Aerocommander aircraft, our principal concern was in the extended periods of time spent (1) debating the need for a modified fuel cap and (2) studying a common trend in wing failures without successfully identifying a solution to the problem Government-delegated certification procedures had no bearing on these delays

In the mid-1950s when the two potentially hazardous conditions were first recognized, it would have been beneficial for the Government to assess the potential safety impact of the design weaknesses We believe that FAA regional officials should be provided with criteria for identifying design weaknesses promptly, assessing the seriousness of the weaknesses in relation to safety, and undertaking effective and prompt corrective action